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USAGE FORMAL METHODS FOR SITUATIONAL ROOM MODELING

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Akmaral Kuatbayeva

NOTES AND ABBREVIATIONS

ADSL	Asymmetric Digital Subscriber Line
ATC	Anatomical Therapeutical Chemical Classification
ATC-DD	Anatomical Therapeutical Chemical Classiification/Defined Daily Doses
CDA	Clinical Document Architecture
COBIT	Control Objectives for Information and related Technology.
DICOM	Digital Imaging and Communication in Medicine.
HER	Electronic Health Record
ESB	Enterprise service bus
FAT	Fuzzy approximation theorem
FTTH	Fiber to the home
GP	General Practitioner
HL7	Health Level 7
IaaS	Infrastructure as a Service
ICPC	International Classification Primary Care
ISO	International Standartization Organization
ITABOK	IT Architecture Body of Knowledge
OLAP	Online Analytic Processing
OLTP	Online Transaction Processing
PaaS	Platform as a Service
PACS	Picture Archiving and Communication System
PMI	Patient Master Index
SaaS	Software as a Service
SAIF	Service-Aware Interoperability Framework
SOA	Service Oriented Architecture
STPHI	Swiss Tropical and Public Health Institute
SWOT	Strength, Weakness, Opportunities, Threats
TOGAF	The Open Group Architecture Framework
VDI	Virtual Desktop Infrastructure
VPN	Virtual Private Network
XML	Extensible Markup Language
AH	Arterial hypertenzy
JSC	Joint-stock company
DB	Database
BCSD	Blood circulatory system diseases
HB	Hospitalization bureau
CS	Computational system
BOЗ	International healthcare organization
HSMC	Highly specialized medical care
GVFMC	The guaranteed volume on free medical care
GCS	Global computer system
SME	State municipal enterprise

SE	State enterprise
SDPP	State Database Physical persons
SDLE	State Database on Legal entities
DC	The differentiated compensation
SDD	Strategic development department
UIHS	Uniform Information Health system
UNHS	Uniform National Health system
URD	Uniform Repository Data
UP	Uniform payer
ISe	Information security
IIS	Index information society
ICT	Information Communication Technologies
PMA	Products of Medical Appointment
IIN	Individual Identification Number
ITC	Index transparency communications
IS	Information System
IT	Information Technologies
ITQ	Index technological equipment
IR	Information resources
CPG	Clinique payable groups
CCMPA	Committee of control on medical and pharmaceutical activity
CPMS	Committee of payment medical services
LIS	Laboratory information system
Med	Medicines
TEE	Treatment-and-evalution establishments
LB	Local budget
MCS	The multiprocessor computing systems
IQD	International qualifier of diseases
ICD-10	International classification of diseases the 10th revision
MO	Medical Organization
HW	Health worker
SC	Medical Statistical system
FS	Fuzzy (indistinct) statement
NC	Neurocomputer
FL	Fuzzy (Continuous) logic
ISet	Indistinct set
CV	Continuous variable
NN	Neural network
UAI	Unauthorized access to information
FR	Fuzzy relation
FV	Fuzzy variable
NC	National center
OARIT	Office anesthesiology, resuscitation and intensive therapy
SMI	Sharp myocardial infarction

SII	Sharp intestinal infection
SCS	Sharp coronary syndrome
SVBBC	Sharp violation of brain blood circulation or cerebral and vascular diseases
SRI	Sharp respiratory infection
PACS SRI	System of Archiving of Images (PACS)
PMSH	Primary medical and sanitary help
Soft	Software
REM	Right of Economic maintaining
RB	Republican budget
RSSE	Republican state state enterprise
RSE	Republican state enterprise
RIS	Radiological Information System
RK	Republic of Kazakhstan
RAP	The register attached population
RCDH	Republican Center Development Healthcare
SD	Semantic data
ADSP	Average duration stay the patient
SSD	Socially significant diseases
IMP	Information means on protection
HRH	Hospital-replacing help
HRT	Hospital-replacing technologies
ISS	Information security system
SCS	The structured cable system
AMS	Access monitoring system
SMC	Specialized medical care
AHW	Average health worker
SMSES	System Monitoring the Sanitary and epidemiologic Situation
HF	Heart failure
SFA	Service the Focused Architecture
CVS	Cardiovascular system
DMS	Database management system
CSQMS	Control system quality medical services
CSR	Control system Resources
TDQCMPA	Territorial department quality control medical and pharmaceutical activity
TDCPMS	Territorial department committee on payment medical services
MHC	Management on health care
UR	Ultrasonic Research
MAH	Management healthcare area
MDF	Management data flow
FN	Formal neuron
EE	Economic entity
CIHC	Center Informatization Healthcare

DPC	Data-processing center
CRH	Central regional hospital
BDT	Broadband Data transmission
EHRK	Electronic Health care of the Republic of Kazakhstan
EMR	Electronic Medical Record
EPH	Electronic Passport of Health
ERI	Electronic register the inpatient
FLC	Fuzzy logic controller
Fuzzifier	Fuzzifier -indistinct
TSL	Term subsumption languages
FLS	Fuzzy logic system

INTRODUCTION

For the last six years more than in four times increased financing health system at the Republic of Kazakhstan, access to needy segments on the population to receiving preferential medicines is open, each Kazakhstan's citizen can freely choose the doctor and policlinic, two medical trains "Densaulyk" help to render medical aid to people in remote regions [1-5].

The President of the Republic of Kazakhstan decree from February 1, 2010 No. 922 "About the Strategic development plan of the Republic of Kazakhstan till 2020 initiated the the Republic of Kazakhstan State program healthcare development "Salamatty Kazakhstan" for 2011 - 2015". The program "Salamatty Kazakhstan" by 2015 will make branch more effective, is directed on fixing Uniform National Health system success, will allow to make high-quality medical services more available [6 - 10].

By 2020 electronic health care at the Republic of Kazakhstan realization has to provide possibility the automated obtaining the timely, actual, authentic, and sufficient information providing the safe, fair, qualitative and steady health system focused on patient needs [11-14].

Key element for electronic health care will be the electronic health passport providing logical structure for storage and an exchange key data about health of the person and being the tool for the health system tasks realization directed on increase of availability and medical services quality, and also management improvement at all levels. In more detail electronic health care RK components are considered in section 1.5.

Intellectual systems in medicine in the world were widely adopted in medicine various branches. Application methods in medicine artificial intelligence usually is connected with expert systems emergence in the mid-eighties on the last century as 30-year academic period result researches in the artificial intelligence field. Fundamental observations were made in this respect by E.Feygenbaum at the 5th Joint conference on artificial intelligence in 1977. Their essence consisted that experts reach good results, accumulating knowledge and experience; if intellectual programs are organized so that will be able to work in this way, and they will be able to reach good results.

The expert DENDRAL [15] system developed at Stanford university and intended for chemical compounds formulas generation on the spectral analysis basis was one of the first systems using knowledge for the tasks solution. Now DENDRAL is delivered to buyers together with a spectrometer.

The MYCIN [16] system intended for diagnostics and infectious diseases blood treatment became the first actually medical expert rule.

The CASNET [16] system is intended for diagnostics and a choice on glaucoma treatment strategy.

The DXplain [17] system - an intellectual system example to clinical decisions support, is used for assistance in the diagnostics course and contains in the knowledge base the symptoms, laboratory data and procedures connecting them with the diagnoses list. It provides support and justification on differential diagnoses and the subsequent

researches [17]. It’s database contains 4500 clinical demonstrations which are connected by associative communications more than from 2000 various nozologies.

The Germwatcher [18] system was developed for the aid to the hospital epidemiologist. Contains large data volume (BIG data mining) on various microbiological cultures. Includes the knowledge base based on rules which is used for hypotheses generation on possible infections.

The PEIRS [19] system interprets and comments on chemical pathologies reports. The module on automatic machine training which allows the pathologist to create new rules without the engineer PMO participation to knowledge is built in system. Now 2300 such rules are created. On creation of each new rule about a minute is required. Daily the system comments on 100 reports in the field gas composition on arterial blood, the glucose tolerance test, etc.

The Puff [20] system is intended for results interpretation functional pulmonary dough. It uses case information; its base precedents contains tens thousands cases. There is a commercial system version, some hundreds copies which are introduced in a number the countries.

The Medical Information System (MIS) - the complex automated information system for LPU activity automation in which are integrated adoption system support for medical decisions, electronic medical records about patients, medical researches data in a digital form, patient condition data monitoring from medical devices, means on communication between employees, financial and administrative information.

As a rule, developers of various medical information systems don't provide compatibility of these systems with each other. However there is a data standard transmission on HL7, Health Level 7 describing procedures and mechanisms an exchange, management and integration electronic medical information.

Specifics medical information systems consist in the following:

- patient-oriented: a kernel MIS are records about the patient;
- the increased developer responsibility.

Among the Russian development there is a system for syndroms diagnostics for medical emergencies at children DYNES [20], created in the Moscow scientific pediatrics and children's surgery research institute . This system contains information on 42 syndromes which represent the list on diagnostic offers hypotheses. As the treatment choice in many respects is defined by the forecast by possible complications, in system the interrelations syndromes determined by the cause and effect, temporary and associative relations are described.

The program complex Aibolit [21-22] is intended for diagnostics, classification and therapy correction on sharp disorders for blood circulation at children. It is created in the cardiovascular surgery Center named after A.N. Bakulev and actively applied at surgeries and a postoperative treatment choice in the conditions on resuscitation unit. The system includes the mathematical model blood circulation "reacting" to the current information arriving from sensors. She allows not only to carry out diagnostics and an assessment patient condition, but also to help at a choice and the subsequent correction medical actions.

HELP [23] system - the full hospital information system founded on artificial intelligence technologies. It supports not only standard functions for hospital information systems, but decision-making support functions. These functions are incorporated in routine hospital system applications. They support clinical process disturbing signals and reminders, data interpretation, management development on offers by treatment and clinical protocols process. These functions can be activated from usual appendices or join independently after clinical data input in the computer clinical record.

We will note still SETH [24] system, which scope - toxicity of medicines. The system is based on modeling the expert reasonings taking into account for each toxicological class clinical symptoms and the applied doses. The system carries out the medical process monitoring directed on interaction control for mutual medicines exclusion.

There is a Medical Information Technologies catalogue which is prepared with direct participation the CEO Association on development information technologies Elyanov M. M. [25]. It included the description for 800 software products for medicine Russian development. Similar analytical researches domestic MIS were conducted at Program systems Institute in the Russian Academy of Sciences and in Scientific center cardiovascular surgery after A. N. Bakulev.

Among the Kazakhstan medical information systems it is possible to note the following:

1. A portal for cloud services for medicine (Medicloud, SaaS architecture), which functionality ensures trouble-free operation by the doctor with services on the electronic document flow online for any LPU organization.

2. A commercial portal based for doctor activity assessment quality (formation doctors base for the patients rendering high-quality treatment services).

3. The zdrav.kz-portal on healthy lifestyle the population promoting.

4. A portal of hospitalization bureau which functionality consists in development services for patients across Kazakhstan.

So, today technologies of artificial intelligence are applied in the most various areas in clinical medicine. Briefly we will characterize these areas.

Giving disturbing signals and reminders. It is about patients monitoring in real time by bedside monitors means. Expert systems are built in such monitors and estimate conditions for patients and their change. They can also remind need or an order medicine intaken and to email reminders, for example.

Assistance in the diagnostics course. Or in insufficient experience cases the medical staff inside the relevant expert system can give help on the research basis on the patient’s data in difficult cases.

Search on suitable cases (precedents). For example, on the Internet or in a local database. Such intellectual system (agent) has to have knowledge the patient main characteristics and understand that in each case means the word "suitable".

Control and planning therapy. The intellectual system can control incompleteness, errors in the existing medical process or the insufficient accounting on specific patient characteristics in the accepted treatment plan.

Recognition and interpretation images. Rather large number medical images allow automatic interpretation: from flat x-ray pictures till more difficult images like angiograms and tomographic researches results.

Thus, it is about broad usage intellectual systems in various medicine areas. This circumstance demands the analysis on their theoretical bases and for further expansion application scope.

Today big world corporations Google, IBM, Microsoft, GE Healthcare, EMC, Phillips, Sony, Siemens, SAP, etc. are developed and introduce new technologies for improvement medicine quality.

The research conducted in August, 2013 by the Epocrates [26] company showed that nearly a half of 1063 interrogated American doctors daily address to smartphones and tablets. The legislators of the USA and the European countries who faced aging of the population intend to raise health care level due to expansion of use of a telemedicine. In process of improvement of health systems more and more patients get access to the medical records with iPad worldwide. The American doctors give preference in use iPhone and iPad. In 2011, according to the research Manhattan Research, 75% physicians owned at least one Apple product. In 2012 Vitera Healthcare lowered this number, having established that 60% health workers had iPhone, and at 45% - iPad.

For example, the Medical school at Yale university even refused the paper materials used in future doctors training. All students were provided with iPad and wireless keyboards. Other schools followed their example.

The Google Glass technology offered Google has to help doctors to get access to information, key for them, directly during performance surgical, diagnostic or administrative procedures - exactly for this purpose to them now and mobile devices are necessary.

Mobile applications were opened before the clinics staff a door to the world on medical information directly at a hospital bed. For example, the Medscape appendix from the WebMD portal allows doctors to check under way action of preparations, to look through data on procedures, to be aware of the latest medical news. Medscape wins first place in App Store among the most often downloaded medical appendices. Experience of Health eVillagers emphasizes reformative influence of technologies of Apple. This non-profit organization provides mobile medical technologies to the doctors working in such countries as Kenya and Haiti. Thanks to doctors who in remote areas had access to necessary information, lives which otherwise would have no chances were saved.

In 2011 approval on quality control foodstuff and medicines (FDA) received the appendix which allows radiologists to look through results of MRT, KT, PET from the iPhone or iPad screen from management desk. And quite recently FDA gave green light appendices on the private company Welch Allyn which, at connection the key ophtalmoscope to iPhone, allows the doctor to look through the an eye retina image. Also the Vital Art and Science company got permission FDA myVisionTrack - a product which allows people to check with a macular degeneration and other degenerate eye diseases a condition the sight house, by iPhone means. The appendix

automatically notifies the attending physician in case the patient condition sharply worsens.

Other appendix, SkinVision, allows the person to do pictures of birthmarks and other skin educations to estimate risk of developing of pathologies. Further the dermatologist can use this information for statement of the exact diagnosis. In need of SkinVision will help to find also the suitable doctor.

In 2012 in App Store 13 600 appendices connected with the medical sphere were. In GooglePlay over 20.000 appendices connected with the medical sphere area.

The Apple corporation's Health app in iOS 8 and higher gives an easy-to-read dashboard on iPhone user's health and fitness data. It called new tool for developers HealthKit, which allows all the incredible health and fitness apps to work together, and work harder, for customers. It just might be the beginning health revolution. It consists next parameters: Heart rate, calories burned, blood sugar, cholesterol -your health and fitness apps are great at collecting all that data. Customer could also create an emergency card with important health information -for example, blood type or allergies -that's available right from Lock screen.

Samsung S Health has been around for some time on Samsung phones, but it was only with the inclusion of more finely-tuned sensors and a full-blown heart rate monitor on the latest devices that made it a really valuable tool for tracking your health and fitness data. Samsung has updated their S Health app in the Galaxy Apps Store, adding some new features, while removing others for users in some countries. New features include weight management, sleeping time, and oxygen saturation measurement. SHealth shows just heart rate, pression, step count and lots of multiple trackers.

HTC Higher Health is also just fitness tracking application, reminding about exercise and fitness training.

In this regard research relevance on modeling situational rooms in medicine, is caused:

-first, needs the Kazakhstan society for effective functioning uniform national health system, formation modern system medical shots preparation in various level;

-secondly, need studying dynamics situational modeling process for related healthcare issues, algorithms definition, decisive rules, situations set and features on medical processes in the national program conditions "Salamatty Kazakhstan", obtaining scientific data in health care, data visualization, processing large data volumes;

-thirdly, processing numerical and discrete data in data large volume (data mining);

-fourthly, decrease in patients lethal statistics;

-fifthly, scaling and development electronic healthcare in situational management.

The theoretical research conducted by the author gives the grounds to conclude that the development and application problem on situational modeling based on fuzzy logic formal methods with different efficiency degree was solved in the medicine, mathematics and informatics history.

As research object fuzzy logic formal methods interaction mechanisms and intellectual systems medicine acts.

The research objective consists in modeling the situational room for healthcare facilities on the fuzzy logic formal methods basis.

Achievement of the purpose assumes the stage-by-stage solution the following tasks:

- collecting, analysis, classification on materials by a research subject;
- analysis on consecutive and parallel algorithms, neural networks and fuzzy logic;
- the analysis on healthcare situational rooms models;
- analysis GIS algorithms;
- creation health care situational room model;
- development the solution optimum algorithms issues in healthcare situational management on the fuzzy logic basis;
- development methodical recommendations for the decision.

Research hypothesis: Create model of correct statement of the diagnosis to the patient for a certain interval of time.

Private hypotheses:

1. To create model of work of the situational room (center) on the basis of algorithms of fuzzy logic.

2. To test model on fault tolerance.

The theoretical-methodology basis of research is made by fundamental provisions of situation analysis, algorithms of correct statement of the diagnosis, mathematical models.

The empirical base of research was made by results of research work of a scientific world, Law and standards in the field of systems of artificial intelligence in health care.

Reliability and scientific validity of results of research is provided with a support on broad theoretical and empirical base of sources in the studied subject and object of research.

The practical importance of research consists in introduction of modern innovative methods in activity of health care facilities.

Research relevance. The Ph.D. dissertation is devoted to the research fuzzy logic formal methods for situational room modeling. In particular, system complexity comes from the notion of self-organization and computing resources autonomy in the fuzzy logic computing domain.

The research's goal. Design healthcare situational room model based on fuzzy logic formal methods.

General research methodology. Presented research employs mathematical and engineering tasks formalization, program implementation and testing as core tools. Every aspect of the system is first formalized in mathematical and algorithmic terms, followed by unified modelling language specification.

1.The indistinct logical conclusion model for patient diagnosis definition is constructed. This indistinct model differs in usage the improved and added structure functionality the uniting in itself indistinct algorithm, collecting and the data analysis, results assessment on modeling, the knowledge base and parameters control algorithm

on indistinct model that allows to provide output parameters and to improve model accuracy.

2. Detailed approach to an indistinct model assessment on the patient diagnosis which differs in usage statistical data on indistinct model results, implementation model decisive rules concerning their conclusions, the knowledge base for decisive rules combinations that objectivity allows to carry out estimates at redefinition on indistinct model input parameters are presented.

3. The probabilistic algorithm for indistinct model parameters task the diagnosis statement is optimized.

4. Test experiment was made on unstructured data clusters (2500 and 10000 data points, c-means algorithm).

Research theoretical significance. Theoretical results on the thesis make the contribution to knowledge set in the formalization indistinct health care models field and design complex systems on situational management. In particular, they provide valuable information on the correct diagnosis statement the patient, including reflect a percentage ratio on development risk of this or that disease.

Research practical significance. Consists in an assessment algorithms empirics on the indistinct Mamdani, Takagi-Sugeno conclusion and C-means data clustering methods basis.

Publications. Dissertation results were published in 15 pieces of work. 1 article was published in the journal materials indexed by Scopus database, 3 articles were published in journals recommended by the Committee for Control of Education and Science of RK, 8 papers and 3 abstracts were published in the proceedings of international conferences, 1 monography [27-41].

Besides being printed, the results were also reported on following seminars:

Soft computing seminar in 2014 at MATIS department Mechanics and Mathematics faculty (MSU after M.V.Lomonosov), Computer science and Information systems joint seminar at al-Farabi Kazakh National University (Almaty 2015), Seminar on computer science at the Institute of information and computing technologies under Science academy(Almaty, 2015), Joint Seminar at Science laboratory Mathematical modeling technological processes in oil and gas branch and Electrical engineering and Computer science department, joint scientific seminar cardiology #2 and reanimatology and intensive therapy departments at Almaty city's cardiology center.

Dissertation structure and volume. The thesis consists of introduction, four sections, the conclusion, the list used sources and applications. Work is stated on 174 pages, including the used sources list from 173 names.

1 RESEARCH BACKGROUND AND RELATED WORK

1.1 Situational rooms worldwide

The situational/dispatching center/room is the room (the hall, the room, an office) equipped with means of communications (a video conferencing, conference communication and other information interactive submission means), intended for administrative decisions expeditious adoption, control and monitoring objects on various nature, situations and other functions.

The questions connected with features the situational centers organization were investigated by A.N. Raykov, A.V. Grechishnikov, A.P. Ryzhov, V.S. Kretov, A.N. Pavlov, A.V. Petrov, I.S. Tereshchenko, M.M. Tikhomirov, A.Yu. Filippovich, A.V. Shevyryov, etc.

The essential contribution to development in situational technologies of administrative problems was made by V.P. Belov, A.N. Danchul, N.N. Demidov, V.A. Efremov, I.I. Ilyin, S.S. Tereshchenko, Yu.G. Fedulov, A.A. Kuandykov, S.A. Aysagaliyev, Zh.S. Suleymenov, K.K. Shakenov, E.N. Amirgaliyev, S.N. Amirgaliyeva, etc.

Works according to the analysis and modeling complex information systems, in that number with usage structural, object-oriented and process approaches belong to A.B. Antopolsky, G. Butch, A.M. Vendrov, A. Dzhekobson, G.N. Kalyanov, K.Larman, A.V. Leonenkov, J. Rambo, Yu.I. Shemakin, Ja.L. Schreiber, A.Zh. Kaltayev, N.T. Danayev, M.O. Otelbayev, T.Sh. Kalmenov, B.Y.Kanguzhin, M.K. Orunkhanov, M.A. Bektemesov, B.Sh. Kulpeshov, S.A. Badayev, I.T. Pak, A.A. Sharipbayev, U.K. Zhapbasbayev, M.N. Kalimoldayev, T.A. Shmygaleva, G.T. Balakayeva, R.K. Uskenbayeva, D.Sh. Akhmedov, A.H. Akhmedzhanov, M.Dzh.Minglibayev, N.S.Dairbekov, A.S. Berdyshev,E.D.Nursultanov, O.M.Penkin, S.S. Zhumatov, B.Rysbaiuly,E.S.Temirbekov, S.N. Boranbayev, A.B. Kydyrbekuly, D.Zh. Ahmed-Zaki, K.T. Iskakov, G.D.Zhangisina, S.A. Mustafin, Z.B. Rakisheva, B.A. Urmashev, I.M. Ualiyeva, etc.

Works on medical information systems and the their work organization belongs to IBM experts (Bernstein D., M.Menzel, etc.), GE Healthcare, Siemens, Phillips, Google, Apple, Oracle, SAS, SAP, to T.E. Sharmanov, A.T. Sharman, A.Ken, Yu. Pya, A.V. Gusev, F.V. Tapp, A.A. Ponomarev, U. Abdrazakov, Sh. Zhurayev, M. Kozhekov, etc.

The questions including formation and the organization microgroups work for the solution general task including with use of software, fragmentary were mentioned in the works by T. Byyuzen, B. Byyuzen, A.A. Derkach, Yu.V. Brun, O.A. Zhirkov, V.A. Kornilovich, A.I. Mitin, A.N. Raykov, T. Saati, A.B. Yusov, etc.

Internet technologies and technologies of the situational centers developed as various directions which aren't connected among themselves as the decision direction with the distributed architecture - on the one hand and as solutions ergatic (human-machine) control systems - with another. Here it should be taken into account extreme importance that circumstance that these directions both which appeared almost at the

same time became offers an infrastructure management basis on two essentially incompatible economic models: a planned economy - on the one hand ("Cybersyn"), and neoliberal economy at "an invisible hand of the market" - with other ("Internet").

Today in the world about 3000 situational centers are. The most part of the situational centers in the world is under construction on the basis 5 step models S.Bir (Chile).

In world practice the situational centers were developed in the USA Ministry of Defence (William Davidson), Canada, Great Britain and in many other countries. The U.S. President is provided four SCs, also SCs is in this country other departments. In the Russian Federation also there are well equipped SCs at the president, the government, Ministry of Emergency, Rosatom and other departments. Historically the first strategic SCs was introduced as a control facility economy (S. Bir's model), today SCs are considered by many authors as an organizational and technological platform so-called the "crisis centers" formed mainly to ad hoc. In the countries with the economies showing stability in the period of an economic crisis since 2008 - Brazil, Germany, also there are SCs deserving attention.

SCs GMLZ in Germany - the most equipped SCs in Germany (and also one of the best and the most equipped in the world) is considered today "The general information and situational center of the federal center and lands" (Gemeinsame Melde-und Lagezentrum von Bund und Ländern - GMLZ) which was founded by results intensive political debate after terrorism acts in 11.09.2001 and floods in the summer of 2002.

Departments GMLZ:

- crisis situations management, anti-recessionary management;
- the infrastructure for crisis situations and accidents preparation;
- researches, development and equipment, public health care;
- management academy in an emergency and planning;
- archival department (film library, etc.).

Analog GMLZ in Switzerland - Nationale Alarmzentrale between which close cooperation is adjusted.

GMLZ Equipment.

The situational center GMLZ is served by the German information deNIS system, and also constantly growing network of internal and external experts from various areas and departments. Its advanced hardware modernized and updated at the end of 2006, including the multimedia screen for display situation, four 42-inch plasma screens for TV viewing in association with the most up-to-date the digital writing-down and documenting equipment, and also the video conferencing system with 4 motorized system video cameras, shows GMLZ as one of most is modern the equipped Situational Centers of Germany. German information deutsche Notfallvorsorge-Information system (deNIS).

Now on the Internet a separate information set on dangers during accidents or natural disasters, and also for the and fight against dangers. The federal center, federal lands, municipal authorities and the organizations have a set of valuable information which needs to be connected together. The design group staff deNIS investigates more than one thousand Internet sites and checks them for suitability for placement the

information in the general access (including - the sites of emergency, rescue and customer services). Through deNIS to users in the order more than 2 000 references to the Internet sites to against accidents protection subjects - including contact persons and contact addresses are given. Proceeding from it, the instruction and another information it are provided to the central management civil defense. SCs ESR in Brazil. In Brazil exists some decisions corresponding to concept SCs - the main of them are focused on fire - monitoring Amazon forests, including by means the satellite, and other economic tasks. Especially it should be noted the Brazilian project "Geosphere Earth Situation Room" (ESR) which components are "GeoSphere Image", "the GeoSphere Globe" and "Global Visual Library". The project is developed for the service purpose global installations network, and is at the same time clearing house, the research center and the interface for the international researches in the global changes field and Earth resource management, and also the tracking and visualization center on global problems. The company for the first time showed the concept proof "the Earth Situational Room " in 1992 in the Brazilian National Space Researches Center ("Brazilian National Center for Space Research") under sponsor's participation of the UN and Northern Telecom Corporation (apparently, it is "Nortel Networks Corporation" earlier known as "Northern Telecom Limited", in use of "Nortel", Canada). First "Earth SCs" were established in VTs Toho Gas in Nagoye (Japan), in thematic park Vattenfall/Liseberg in Gothenburg (Sweden) and Amazonia Gallery at Smithsonian institute in Washington (USA).

The situational and dispatching centers IBM. More than 50 of only already executed projects:

- USA: Police of the New York State, the State of Missouri Governor (emergency), Police of Detroit (Michigan State), Police of Fresno (California State), Office the sheriff in the Santa Barbara district (California State), Kleyrmont's (California State) police, Washington State Patrol;
- Germany: Verkehrszentrale Hessen roads management (Frankfurt);
- Italy: Autorita Portuale di Civitavecchia ports management (Rome);
- China: Chaoyang Prefecture (The Olympic Games 2008 in Beijing);
- Republic of South Africa: Gauteng Government (FIFA World Cup 2010);
- French Polynesia: Papeete city administration of (Tahiti).

The situational centers IBM put into operation in 2010:

- USA: The highest federal public authorities, Terrorist threats prevention centers states, Memphis city Municipality (Tennessee State), Charlotte city Municipality (North Carolina state);
- New Zealand: New Zealand Police;
- France: National gendarmerie;
- Latvia: Latvia police;
- Australia: Australia police;
- China: Hong Kong police special administrative area;
- Germany: Hesse federal Land Police;

- Great Britain: Municipal police, Association police divisions heads, Northern Ireland Police service, National southwest rugby league, fight Agency with organized crime;
- Serbia: Serbia Police;
- Croatia: Croatia Police;
- Japan: Japan police;
- India: India Police force officers;
- Slovenia: Slovenia Police;
- The Czech Republic: Police of the Czech republic;
- Ireland: Police of Ireland (Gard);
- Sweden: Police of Sweden.

The situational centers IBM are realized on the following technologies: Websphere Portal Server V6 (200 VU or 5 x 20 users) of 4 HS22 Quad Core, Dual Processor, 12GB RAM72 GB, VirtualAgility OPS Center Portal, ESRI ArcGIS 9.2, Websphere Application Server V6 (100 VU), Lotus Sametime V7.5 (100 VU or 100 users).

OGAS - automated management national economy project in the USSR. The nation-wide automated system account and information processing (OGAS) - automated management system project USSR economy based on the cybernetics principles including the computer network connecting the data collection centers located in all country regions.

In the Republic of Kazakhstan the following situational centers works:

1. Security council situational center the Republic of Kazakhstan (President the Republic of Kazakhstan Administration structural division).
2. National Security Committee situational centers of the Republic of Kazakhstan.
3. Space monitoring situational center of National space Agency of the Republic of Kazakhstan.
4. Ministry of Justice situational center of the Republic of Kazakhstan (developer BEE LLP, BIRT technology).
5. Ministry of Internal Affairs situational center of the Republic of Kazakhstan.
6. Ministry of emergency situations situational center of the Republic of Kazakhstan.
7. The situational center of Committee on control of automation of the state services and coordination of activity of the centers of service of the population (are connected public population services 159 centers, it is put into operation in 2011).
8. The Ministry of Transport and communications situational center on transport control (eight systems control is entered in 2014: AIS weighting control, mobile and shopping mall stationary posts, work EIS "Checkup", control process on notices from the Russian and Belarusian check points, is exercised by road equipment work).
9. The Republic of Kazakhstan Financial police situational center (integration from 49 DB more than 40 government bodies, and also the information analysis in open access).
10. Astana akim’s situational center.
11. Almaty region akim’s situational center..

12. East Kazakhstan region akim’s situational center (it is entered since 2011).
13. The regional situational center in Kyzylorda area.
14. IS "Akimat Situational Center (Area)" the developer Parasat Business Consulting LLC with assistance Kazakhstan Information Techlonogies LLC.
15. JSC Kazakhtelekom situational center.
16. KGP "Almaty subway” situational center.
17. Situational center JSC Arselor-mittal Temirtau, etc.

Table 1 - Cloudy situational center comparative advantages

Offline SCs in "usual" understanding	**Cloudy SCs**
Physical locality even in case the solution "mobile housing", recyclable equipment and experts team change	Distribution participants, expert tools and communications means in "cloud" actually realizes the principle of a non-recyclable all control system for SCs
Removability team members is complicated even in efficiency case communication with them.	Removability team members, it is more quick and possible within: recommendatory service, existence a ready experts reserve (with various readiness degrees), heuristic mechanisms groups change depending on changes subject and expert conditions the current situation. Besides, members distribution expert group doesn't depend from location on object management / object problem and its control points.
Formation an SCs operational reserve members is complicated even in efficiency case on communication with them.	The operational reserve is formed on a basis: current assessment on a state expert communities (automatically), and also estimates probable situation expectation, demanding involvement experts in a miscellaneous profile (automatically or experts). By results heuristic selection messages on it are transferred to personal SCs members expert community (accounts). Replacement the demanded member group it is carried out by the quick notifications reserved the maximum readiness.
The expensive equipment is required (including service) and rooms.	The cost of the server equipment and expert software includes the potential creation SCs any architecture for any term. Cost of the user the equipment it

	is limited to personal terminals of members of group, SCs having access to the room in a cloud.
Local control expert is required software (including service).	Local expert software control isn't required as access to system is provided via the cloudy interface.
Costs room protection are required and support confidentiality SCs work.	Protection is limited to software access and protection information administrations, and also network protocol.
Expeditious formation on meetings on to emergency situations demands presence group members in SCs rooms.	Formation on meetings demands existence the operating terminal and inclusiveness in network
The mainly fixed the interface depending on data type and data related points.	The interface quickly changes and it is adjusted under specific objectives virtual SCs customer user.
Ability to integrate with the duplicating SCs demands separate coordination and connection procedures.	The network virtual SCs if necessary can to be formed by the principle related, and to be limited - under the network protocol usage and subject.compatibility.

1.1 Situational rooms of medicine in the world

Today in the world about 3000-5000 situational centers are.

Among the healthcare situational centers in the world it should be noted the following:

In the USA - the Centers for diseases and preventive measures control, located in Atlanta, also national centers for fight about HIV/AIDS, viral hepatitis, STD, and tuberculosis, the centers for epidemics and measures control for them. Also in the USA 3 situational centers for fight against oncological diseases at children are located.

In the USA there is a rating assessment "The best hospitals" from U.S.News & World Report using ranging, and also the second Hospital Compare rating assessment which compares activity indicators, including efficiency treatment indicators, without ranging, in the comparative tables form. Participation the medical organizations in the Hospital Compare program is voluntary.

The Hospital Compare website contains more than 50 indicators for an activity assessment the hospitals participating in the federal Medicare program, and providing the emergency medical care. These indicators measure hospitals activity through a prism of 6 components:

- treatment process;
- treatment outcome;

- use diagnostic visualization means;
- patients satisfaction degree;
- patients safety;
- the cost on the treated case or procedures, and treated patients.number.

Calculation efficiency indicators is made on the basis the data presented by each hospital, with the established algorithms usage. In the assessment opinion basis consumers on suppliers and system quality medical services is put - it is the nationwide, standardized patients pull at hospitals in whom the emergency medical care is provided

In Canada realization the corporate analytical SAS platform helped Ministry of Health to create more effective forecasting models deeper understanding chronic diseases and allowed to upgrade the financing health care facilities program.

In Canada the hospitals rating assessment with uniform ranging isn't carried out. However such assessment instead at the national level huge work on development indicators for an hospitals activity assessment in particular, and health systems in country general is conducted. In a section such uniform indicators the general indicators hospitals activity comparison, without ranging and award serial number to them in the general classification list is carried out.

Development and choice indicators for the hospitals activity analysis are carried out in two directions:

1. Indicators clinical activity.
2. Financial activity.

Indicators on clinical activity cover the following aspects:

- efficiency on clinical activity (quality and results);
- patients safety;
- treatment correctness and availability (as it is quickly possible to receive medical care).

Indicators on financial activity cover the following hospital activity aspects:

- financial solvency;
- ratio efficiency/productivity;
- human resources.

In Hong Kong by the system means reception and automatic analysis addresses citizens constructed on the healthcare facilities basis SAS actions and public administration strategy taking into account the current situation were optimized and corrected.

On the African continent it should be noted the situational centers for control incidence and epidemics in Kenya, the center for ophthalmologic diseases in Zambia.

Information system "Situational Center" (IS "SCs") provides planning and monitoring of work of the region within ensuring process nozology treatment. At a planning stage in system necessary help data and settlement formulas for obtaining full information on resource and financial security process during planning period are put. Thus the system allows to make dynamic recalculation result parameters depending on model variables value (the planned operations number, resource fund for their providing, the expendables cost, a experts salary, etc.).

By planning results the coordinated parameters are fixed in IS "SCs" and monitoring process is started. The actual data necessary for calculations, periodically come from LPU to a DB of IS "SCs" and are used for an illustration the current situation in the region. In essential deviations case from planned indicators the notification users IS "SCs" problems is made, recommendations about correction of a situation are made.

IS "SCs" allows to carry out the following functions:

- modeling situations in region health system;
- optimum resources indicators selection;
- business processes support on adjustment and data quality improvement (for example, duplication identification these patients, classification not correctly entered addresses, diagnoses classification, etc.);
- situations monitoring in health system in a look, evident and clear for the manager;
- indicators configuration which automatically inform users (including by e-mail) at an exit key legal limits values out;
- data presentation by means the Web browser in a tabular, graphic and cartographical look;
- creation interactive and cartographical reports;
- implementation reports on the schedule;
- mass mailing reports;
- data import from programs primary sources to a DB IS "SCs";
- differentiation access rights at the system level.

The first level - collecting primary data. Collecting primary data is carried out by historically developed IS and, if necessary, additional program modules on input the aggregated or primary information.

At the level IS-primary sources thus reduction data structure and reference books to uniform qualifiers and definition for each qualifier is required, within which IS it changes. Other systems will receive actual qualifiers from IS "SCs".

The second level -the integration tire which purpose is data combination systems primary sources in SCs DB.

The specialized integration tire allows to separate transformation data logic from one essence in another, from technical modules of communication with concrete types of formats of data (the file with dividers, Fox Pro, Oracle, etc.). This approach allows to adapt quickly system for change in programs primary sources and, if necessary, it is rather easy to connect new programs and systems.

The third level - a layer adjustment and improvement data quality.

Problems of this level are identification and elimination of duplicates of entries in the register of patients, classification of the residential address, etc. As various mechanisms of adjustment of data which will often demand intervention of the operator will be used, it is expedient for these purposes to use a control system of business processes. This approach will allow to minimize costs of programming at creation new or change of already used processes of adjustment and updating of data.

The fourth level - the level of the analysis, analytics and submission of information to users. This level is realized by means of one of leaders among software

products of this class - Pentaho BI. Information collected within the previous levels illustrates a set of concrete situations in health system of the region.

The situational centers have broad application in various industries and sectors of economy and state regulation. Situational rooms of medicine at the Olympic Games are presented in section 1.2.

1.2 Situational rooms of medicine in the Olympic Games

The Olympic and Paralympic Games are a most difficult mix of technologies, processes and people. It is the large-scale and difficult project in which a large number of suppliers of the most difficult systems and decisions is involved. Besides, the attention of the whole world is riveted on this event that practically doesn't grant the right for a mistake.

Atos, one of leaders of the world market of information technologies, provides the technological party of holding the Olympic Games: Solt-Lake-2002 (providing information structure from Schlumberger Sema), Athens 2004, Turin 2006, Beijing 2008, Vancouver 2010, London 2012, to Sochi-2014 and Rio de Janeiro 2016 of Atos does unique examination in the field of modern IT solutions and integration of information systems, introductions of the latest software to provide instant messages for athletes, the audience, organizers, officials, mass media, the television audience and Internet users around the world. Since 2001 as the international partner and the TOP sponsor of the Olympic Games of Atos provides Games with the last development in the field of information technologies. Atos is one of the international leaders of information technologies (IT). The company has the annual income more than in 5 billion euros and totals more than 45 000 people in 50 countries [42].

Atos is a task creation of the IT solution for the Olympic Games which allows to provide instant messages to athletes, the audience, organizers, officials, mass media, TV viewers and Internet users around the world.

As the leading integrator of the Olympic Games, Atos, eventually, bears responsibility for all Games IT infrastructure. The emphasis is placed on two key IT systems:

- control systems of games;
- information distribution systems.

In IT systems which Atos creates for the Olympic and Paralympic Games, decisions which the company introduces in other markets worldwide are used: projects management, content and knowledge management, changes and risks management, big data, cloud, social collaboration, data-centers and complex IT safety systems.

At the Olympic Games in London-2012, it was applied ON Atos Medical to automation fast emergency aid crews calls, reduction time on calls, improvement quality rendering services to athletes the Olympic and Paralympic Games as athletes the Paralympic Games need more careful leaving and to rendering the emergency ambulance.

In 2012 at the Olympic Games of London 50 812 appeals to the London Service an emergency medical service were recorded. Approximately in day of 2,989 addresses. During the Paralympic Games 35,238 addresses were recorded, is equivalent to average number of 2,937 appeals to ambulance in day. For comparison in 2012 during games, the most loaded in the afternoon for services of an emergency medical service was the first day of the Olympic Games (Friday July 27, 2012; n=3,529) [43].

At the Olympic Games in Sochi the software of Medical Headquarter was applied, the situational center worked as point of collecting statistical coupons according to one concrete address and their rearrangement in electronic ATOS system. The Alarm-center, crisis center, the center of forecasting, the dispatching center, and the logistic center - everything in were is realized in the manual centralized control (classics of the Russian Project Management). The city had the "Olympic" center which was engaged in scheduling ambulance calls ("mink" at stadium Fisht). Work of this center essentially didn't differ from work out of Games - reception of information on a call on object, team to spare crew on rotation, arrival control, registration [44].

The medicine became one of important components of trouble-free operation of the Olympic structures.

Quantity and quality rendering medical services emergency aid during the Olympic Games in Sochi. According to the Minister of Health of Russia, since January 25 and until the end of Paralympic Games help was given to 8695 participants and Games guests (without Sochi residents). From them to 381 athlete, from which 315 - foreigners. Medical aid generally had out-patient character, and 577 people, from them 16 foreign athletes were hospitalized. In Mountain and Coastal clusters 38 first-aid posts and three consulting and diagnostic centers [44] worked.

The group of the Sochi physicians was replenished for the period of the Olympic Games by 1268 doctors with specialization in various directions of medicine who did practical training at foreign colleagues. These are 666 doctors from Krasnodar, 222 from Tatarstan, 380 - from Moscow. Besides, in Dagomys, Krasnaya Polyana and Sochi to Games three hi-tech clinics were constructed, and 35 medical institutions the city alerted the full.

For work on Olympic venues created 52 "Ambulance" crews. Their such dislocation was developed that in one and a half minutes to be on a place state on emergency, and through 15 - to take the patient to hospital in need case. At Fisht stadium created substation "Fast". Work on physicians was coordinated by means the videocard on which all cars locations in Mountain and Coastal clusters were removed, it allowed to change quickly routes, to direct carriages "fast" on calls.

During the Olympic Games 1899 calls were executed, hospitalized 435, from them foreigners - 119. The main place in statistics is taken by injuries, fractures, dislocations, stretchings and everything that is connected with extreme sports. Work on physicians in the Mountain cluster was especially intense [45].

According to the chief physician the Emergency Sochi medical service Meboniya, in five years preceding the Olympic Games, doctors gained invaluable experience. Work in the World Cups and Europe, at test competitions to Sochi, experience loan at colleagues from abroad gave it. Two Olympic weeks were given intense for ambulance doctors - and by calls quantity, and on injuries character. For the the Olympic Games period also the "ambulance" crews number and in Greater Sochi with usual 44 to 52 was increased. The increased number crews, and also traffic jams lack because a ban on entry into Sochi for transport from another town influenced reduction of the detained calls.

In February, 2013 the detained calls of 3 and 4 categories (that is not urgent) there were 35-40%, in February, 2014 - only 1,2%.

The Olympic experience for doctors an emergency medical service - unique as skills of work with sports injuries and special cases are acquired. As the post-Olympic heritage Sochi "ambulance" unique up-to-date carriages the expert class which were already appreciated by residents got. The equipped ambulance substation around Fisht stadium remains for further city ambulance crews work that is very convenient both for inhabitants Sochi, and for physicians. Time in way to the patient is considerably reduced if to compare to service from a site of the station, nearest to the Olympic Park, "fast" near the Adler railway station [45].

At the state level in the Russian Federation the regulatory base which will come into force in July, 2014 is developed. In it all temporary intervals in which help has to be given are shown. In case of emergency paramedics will have to reach to patients within 20 minutes. On other calls the crew has to come in process of release.

For the Republic of Kazakhstan this direction is actual, in connection with preparation for carrying out Universiade 2017 and preparation for "EXPO-2017".

Situational rooms in the Olympic Games can be a launch pad for development the interaction mechanisms and further development on the accidents medicine centers. Data and functionality in the medicine accidents situational centers are provided in section 1.3 on the example the Republic of Kazakhstan and the Russian Federation.

1.3 Situational rooms in emergency situations and medicine of accidents

Medicine accidents - medicine area which task is the health care (up to specialized) delivery organization the victim in emergency situations (in the conditions on mass appearance victims or diseased). In similar conditions often there is a situation "one doctor - a great number of patients" ("Aybolit"), unlike other medicine where practice "one doctor - one patient" is usual.

Emergency situation - suddenly arisen event as a result of which two or more persons were lost, or three or more persons suffered/got sick and are in a serious condition.

Distinguish emergency situations local (1-10 victims), territorial (10-50 victims), regional (50-500 victims), republican (more than 500 victims) and the international level. There is a concept "emergency situation in medicine" - situation when bodies of health care (various level) don't cope on a place with flow of victims.

Tasks of Service of medicine of accidents are:

- medical investigation in a emergency situation (ES) zone;
- victims medical sorting;
- healthcare organization and delivery by the victim;
- the organization victims evacuation from emergency zone;
- attraction on additional medical forces and means for the help to victims in need case;
- organization victims hospitalization;

- the management on actions medical formations and establishments, settlements administrations in emergency zone;
- medical support a wrecking: fire extinguishing, works on mine clearing, works on elimination radiation, chemical, biological hazard, any other types of the wrecking connected with risk for rescuers and the civilian population (watch on a venue of works);
- a medical support of carrying out the political, sporting and other events connected with mass concentration of people (watch on an action venue);
- control of maintenance of readiness of medical institutions and formations to work in the conditions of an emergency;
- forecasting of emergence of an emergency and planning of actions for elimination of medical consequences of an emergency;
- training of staff of the public emergency services in methods of first aid, the organization and regular carrying out doctrines with the staff of the emergency services on joint elimination of medical consequences of an emergency;
- scientific work on improvement of methods of rendering the emergency medical care in the conditions of an emergency (together with other medical and scientific institutions).

The Russia medicine accidents service is under supervision Ministry of Health of the Russian Federation. In the course activity usually works in close interaction with rescue units the Ministry on Emergency Situations [46].

The central airmobile saving group "Center-spas" of the Ministry of Emergency Situations of the Russian Federation - the only formation of the Ministry of Emergency Situations which part doctors officially are, equipped with the modern medical equipment and medicines. This formation was given airmobile hospital. As a part of other divisions the Ministry Emergency Situations physicians aren't present. To the rescuer's position people with medical education willingly are accepted, but they won't be equipped with the medical equipment, medicines and have no license for delivery health care. "Center-spas" doesn't treat directly Service of medicine of accidents, but takes active part in delivery health care by the victim at an emergency. Also there are resuscitation and antishock groups (RAG) as a part of the militarized mine-rescue parts (MMRP). Two resuscitators, with the necessary equipment who go down in mine together with office of mine rescuers for assistance to injured miners are a part of RPG. Till 2011 independent managements of MMRP were under the authority of Minpromtorg, Rostekhnadzor and the Ministry of Energy. In 2011 all MMRP the Ministries of Emergency Situations are placed under authority. This one more exception of the general rule.

SMK head institution - “Defence” All-Russian Center on Medicine Accidents (ARCMA) MHSD Russian Federation. It is founded in 1993. Is engaged in scientific, educational and organizational work in the Medicine of Accidents field, participates and directs at assistance to victims in an emergency federal and international level. As a part versatile hospital field and aviamedical evacuation department (sanitary aircraft) - solves the problems connected with assistance and transportation of patients and victims by air in the territory of the Russian Federation and abroad. Participates in

various humanitarian operations together with Russian Federal Border Service and Russia Emercom. Often physicians on field versatile hospital work at base airmobile hospital Centerspas group Emercom Russia or the joint (summary) hospital around an emergency is developed. Expansion "Protection" own hospital is possible. Also aviamedical evacuation of victims is carried out by the air transport of the Ministry of Emergency Situations with use special aviaevakomoduly, the Ministry of Emergency Situations which are in common developed by experts and "Protection". The field "Protection" versatile hospital was formed before Ministry of Emergency Situations hospital. However work was always conducted together with divisions of the Ministry of Emergency Situations, the hospital was affiliated to an operations group of the Ministry of Emergency Situations, remaining in departmental accessory of Ministry of Health of the Russian Federation. In "Protection" the Headquarters ARSMA (All-Russian Service of Medicine of Accidents) which was headquarters of this direction of Ministry of Health of the Russian Federation were created.

The Territorial Center Medicine Accidents (TCMA) - institution of regional submission. Is engaged in elimination of medical consequences of an emergency of local, territorial and regional level in the territory of the corresponding area. The Regional Center of Medicine of Accidents (RCMA) - the institution similar to TTsMK, in subjects of the Russian Federation where there is no division into areas (the republic, the autonomous region, etc.). In Moscow - the separate center of Medicine of Accidents - the Scientific and practical Center of the Emergency Medical Care (CEMC).

Stations of ambulance and emergency medical service aren't included into Service of medicine of accidents, are considered as reserve formations of SMK, but on SMP the most part of pre-hospital medical care by the victim lies. Take the most active part in elimination of medical consequences of an emergency.

The Federal Medical Biological Agency (FMBA) (in the early nineties carried the name "Federal Management Medical-biological and Extreme Problems", "FUMBEP" - the term sometimes occurs in documents of that period and in literature) - the assignee of the 3rd Head department of Ministry of Health of the USSR. "Protection" was organized in independent establishment with direct submission to Ministry of Health in due time, from two divisions on FMBA and many physicians from hospitals and medical medical units FMBA worked part-time in "Protection". Is engaged in a medical support of the enterprises of the nuclear industry and power, military industrial complex, space branch and others, and also the "closed" settlements at the secret enterprises, elimination of medical consequences of an emergency at these enterprises and in settlements. Since 2008, employees of FMBA even more often are involved in elimination of medical and sanitary consequences of various emergencies outside the "closed" territories, together with "Protection", Emercom of Russia and local TTsMK. Are created mobile hospital and mobile medical crews. Unlike the centers medicine accidents local level (TTsMK, RTsMK, etc.) which VTsMK "Protection" don't submit directly (only in respect operational activity and collection information), and officially submit to local health care bodies, FMBA mobile divisions are included into the structure federal submission independent local authorities. FMBA have hospitals and

medical medical units where there is an opportunity to hospitalize victims, than the continuity in treatment at various stages is reached.

Are a part of TTsMK: Quick and dispatching department: collection of information, interaction, management of formations.

Clinical department: the crew of the emergency medical care (CEMC) - continuous formations TTsMK. As a part a duty shift - the doctor the anesthesiologist-resuscitator, with the general experience exit work on "ambulance" not less than 10 years and with experience in a hospital, two paramedics with a similar experience on "ambulance", the driver. BEMP are located in various points in the territory of under control TTsMK (usually, near large federal automobile highways). The sector along the federal highway from MKAD to area border, including all roads, the cities, settlements, the enterprises, airfields, the railroads and other enters a zone of responsibility of BEMP. Reserve formations - the crew of the emergency reaction (CER) - the staff of healthcare institutions in settlements involved in case of an emergency.

Mobile pneumoframe hospital - inflatable modules with the equipment.

Department of sanitary aircraft - helicopters. The BO-105 helicopter is based on Ramenskoye's airfield, the platform for watch is in the city of Klin. The helicopter takes off on large road accidents on the route M-10 Moscow - St. Petersburg, only during daylight hours. Hospitalization victims in a city hospital Klin. Development of department, the organization of helipads and watch of helicopters in other regions of the Moscow region is planned. The most probable location of the following helipad - the route M-4 Moscow - Rostov on Don. Receipt of the BK-117 and Ka-226 helicopters is in the long term planned.

The scientific department - cooperates with department Medicine on Accidents at MONICA (The Moscow Regional Research Clinical Institute - lead agency on health care the Moscow region).

Educational department - carrying out classes in first aid with the staff on divisions the Ministry of Emergency Situations the Moscow region and with the staff other emergency services.

Psychological laboratory - psychologists and psychiatrists - the help to victims at an emergency and periodic testing and employees control TTsMK.

Auxiliary services - a human resources department, accounts department, a medicine store, a warehouse, a motor transport service and other.

The center can work in three modes [46-47]:

The mode daily activity - occasions to BEMP call - any emergencies (it is more than 3 injured or 2 dead) - road accident, the fire, a technogenic or natural disaster, a building collapse, explosion threat, acts of terrorism, taking of hostages, mass riots and fights, knife and gunshot wounds, a mine and explosive trauma, a train trauma, plane crash, falling from height, mass poisonings, cases detection especially dangerous infections, any other emergency situations. BEMP can leave on a situation with one-two heaviest victims according to the order the senior doctor quick and dispatching department. 90% calls - large road accidents on federal highways, outside settlements. A problem BEMP - to arrive to a place, to carry out medical investigation and sorting,

to request additional forces (ambulance and rescuers from the next settlements), to direct assistance to victims on an emergency place. The stock medicines and expendables BEMP is designed for 25 victims. There is a possibility independent hospitalization of victims. BEMP Equipment corresponds to the level office of anesthesiology and reanimation in a hospital. Information on an emergency comes from local stations of ambulance, firefighters, rescuers, militia and traffic police to quick and dispatching department and directly to the doctor of BEMP. Also BEMP is involved in medical evacuation - transportation of the heaviest resuscitation patients from a hospital in a hospital. Is attracted to a medical support of mass actions (watch).

The mode of threat of emergence of an emergency - expansion of mobile hospital, mobilization of REM, mobilization of bed fund in hospitals, expeditious interaction with other services.

The emergency mode - work in the conditions of an emergency of regional or federal level.

Center Medicine of Accidents the Republic of Kazakhstan.

With the purpose of ensuring high-quality and expeditious rendering the emergency medical care at emergency situations, the order of Ministry of Health of the Republic of Kazakhstan in December, 1994 created the Republican scientific and practical center extreme and medical-biology problems Ministry of Health of the Republic of Kazakhstan which in 1997 was renamed into the Center of accidents medicine. In August, 2007, for increase efficiency to emergency response, the Center medicine of accidents was placed under authority the Ministry of Emergency Situations.

The accidents medicine center functions according to laws of the Republic of Kazakhstan "About emergency situations natural and technogenic character", "About rescue services and the rescuers status ", the Code of the Republic of Kazakhstan "About people health and system health care", the Cabinet Republic of Kazakhstan resolution September 27, 1994 No. 1068 "About creation service the emergency medical care of the Republic of Kazakhstan in emergency situations", the resolution of the government of the Republic of Kazakhstan of August 28, 1997 No. 1298 "About the state system of the and elimination of emergency situations" and other regulations of the Republic of Kazakhstan [48].

The medicine accidents center is the coordinating body which is carrying out interaction government bodies on the healthcare organizations in the medicine accidents sphere.

For the purpose providing the population across all Kazakhstan territory timely emergency medical and psychological assistance, and elimination medical and sanitary consequence in a emergency zone situations natural and technogenic character, according to the government resolution No. 30 of January 28, 2010, 10 territorial branches the accidents centers medicine of were transferred to the Center of medicine of accidents.

The purpose of activity of the Center of medicine of accidents is the organization, coordination and participation in rendering the emergency medical and psychological

assistance at an emergency, and also medical and psychological support of the personnel of rescue forces and executive bodies in the field of emergency situations.

The main objectives of the Center of medicine of accidents are:

- elimination of medical consequences of an emergency;
- medical investigation in zones of threat and/or emergence of an emergency;
-supervision over medical and sanitary consequences of an emergency in the territory of RK by forces of service on duty and dispatching, their assessment, forecasting and development of offers to the guide of the Ministry of Emergency Situations to medical and sanitary ensuring rescue and other urgent efforts;
-development of instructive-methodological and directive documents on the organization of activity of Service of medicine of accidents;
- conducting scientific and technical development on problems of medicine of accidents;
- implementation of treatment-and- actions (medical examination, treatment, rehabilitation) concerning the staff structures of the Ministry of Emergency Situations.

For implementation of the Code of the Republic of Kazakhstan "About health of the people and health system" of September 18, 2009, articles 11, 21 of the Law of the Republic of Kazakhstan of July 5, 1996 No. 19-I "About emergency situations of natural and technogenic character", and also for the organization of harmonous system of rendering the emergency medical care by the victim at emergency situations at all stages developed and approved the Resolution of the government of the Republic of Kazakhstan No. 608 of June 17, 2010 "Rules of granting, types and volume of medical care at emergency situations" and for the accelerated paperwork when exporting medicines out of borders of the territory of the Republic of Kazakhstan when rendering the emergency medical care the Resolution of the government of the Republic of Kazakhstan No. 736 of July 19, 2010 is developed and approved. "Rules of export of medicines, products of medical appointment and medical equipment from the territory of the Republic of Kazakhstan as a part of material means of the medical and rescue organizations and formations leaving from the territory of the Republic of Kazakhstan for participation in elimination of emergency situations".

Today in structure of the Center of medicine of accidents 11 branches function: in Astana, Almaty and in the Aktobe, Atyrau, East Kazakhstan, Karaganda, Kyzylorda, Mangistau, Pavlodar, North Kazakhstan, South Kazakhstan areas. For promotion of knowledge, informing the population, increase of image and promoting of a profession of the expert of medicine of accidents, and also for preparation of printing materials, reviewing of the presented articles from territorial branches in the Center of medicine of accidents Editorial Council is created. The work result Editorial Council in 2010-2012 the publication in mass media of 92 articles, 302 lectures are given, 17 interactive lessons and 127 classes in rendering the first pre-medical aid in case of accidents with total of the captured pupils of 10-11 classes of 5650 people are conducted.

According to the Media plan of performances 6 interviews to TV channels "Astana", "Khabar", the 7th channel, STV on such subjects as creation of route medical-saving points on the most emergency and dangerous sites of the roads sounded in the Message of the President of the Republic of Kazakhstan Nazarbayev N. A. were

given. to the people of Kazakhstan of January 28, 2011 "We will construct the future together!", interaction of divisions of the Ministries of the Republic of Kazakhstan and the Russian Federation in the field of rendering the emergency medical care in border territories, elimination of cross-border emergency situations, simplification of crossing of borders medical formations of TsMK, development of transport medicine in the Republic of Kazakhstan [36].

With the participation of formations of the Center of medicine of accidents in the international cooperation in the of emergency situations and elimination of their consequences the medical Russian-English phrasebook was developed. The phrasebook included general phrases and expressions, medical terminology and the dictionary.

Methodical recommendations about training of employees of rescue services and formations for rendering the emergency medical care in the conditions of emergency situations were developed for instilling of skills of the pre-medical help. Recommendations about carrying out a theoretical and practical training are made, the minimum volume of hours and subject necessary for digestion of material is determined.

Together with the Republican scientific and practical center of psychiatry, psychotherapy and narcology of Ministry of Health of the Republic of Kazakhstan (further - RNPTs PPIN) developed and published methodical recommendations:

1. The emergency psychological assistance at an emergency.
2. Medical-psychological rehabilitation of the persons who endured an emergency.
3. Techniques of psychological rehabilitation of the persons who endured an emergency.
4. Methods and methods of self-control at extreme situations.

Methodical recommendations are considered and approved at a meeting of the Academic Council of RNPTs PPIN, there are reviews.

For application in professional activity of psychologists of the Ministry of Emergency Situations of the Republic of Kazakhstan the made methodical recommendations were submitted in the TsMK territorial branches and the Ministries of Emergency Situations subordinated organizations.

The illustrated booklets "The principles and rules on first aid" are developed, spread around and dispatched on branches of the Center of medicine of accidents, "Flood", "Childbirth in way", "The main methods on first-aid treatment", "Is careful - an entsefalitny tick", "Rage", "Freezing injuries", "Anthrax", "Foot-and-mouth disease".

Annually, within instilling of skills of rendering the pre-medical help and for promoting of a profession of the expert of medicine of accidents the medical personnel of branches of the Center of medicine of accidents holds competitions between sanitary teams of higher educational institutions, and also medical colleges. Besides, annually all staff of the Center of medicine of accidents takes part in the stock "Blood donor day".

Operational work.

In the Center of medicine of accidents work of the round-the-clock on duty control offices through which interaction is carried out with territorial Departments on emergency situations, GU "Republican Crisis Center", Managements of health care, services 112, 102, 103, emergency and operational services on receiving and information transfer about the occurred emergency situations of natural and technogenic character in the territory of the republic is organized.

For receiving and information transfer on the duty control office is provided telephone, radio - facsimile, the Internet (e-mail) - communication, e-mail, IP-with phone. For execution of the round-the-clock watch all necessary domestic conditions are created.

The main formations of the Center of medicine of accidents are groups of medicine of accidents and crew of the emergency reaction (OMK and REM).

The organizational and regular structure of Service of the emergency reaction of the Center of medicine of accidents consists of 3 groups of medicine of accidents which are deployed in the cities of Astana, Almaty and Ust-Kamenogorsk and 38 crews of the emergency reaction in 11 branches.

Crews are provided with a necessary reserve of medicines, laying of the emergency medical care, ladder and vacuum tires, an obstetric set, and also the medical equipment and products of medical appointment - electrocardiographs, glyukometra, defibrillators, portable medical ventilators, transport resuscitation systems.

As a part of each crew of the emergency reaction 3 experts - the doctor, the paramedic and the driver-hospital attendant. Medical structure of REM - 65 units, the average medical personnel - 84, drivers - 52 units.

All health workers have the certificate of the expert.

Necessary emergency medical care by the victim which consists in anesthesia, a stop of bleeding, a transport immobilization, carrying out antishock actions and training of victims for further transportation in medical institution is provided.

Medical support.

Divisions of the Center of medicine of accidents carry out a medical support practically of all large governmental activities of political and cultural level which are carried out by government bodies of management and the Ministry of Emergency Situations in the territory of the Republic.

So, in 2009 the medical support of the Kazakhstan mountatin trip "Nursultan - 2009", 15 sessions of Assembly of the people of Kazakhstan, preventive measures for the admission of the raised water consumption down the river Syr-Darya around a dam of the Koksaray counterregulator of the Southern Kazakhstan area was carried out; expeditions of the ecological union Tabigat to the region of Besshatyr barrows (reserve "Three-copecks Piece - Emel"). Together with RGP "Kazaviaspas" help to victims at ignition of the fuelling car in the territory of the Republic Afghanistan was given, with the subsequent evacuation of victims in medical institutions [36].

In 2010 the mobile medical group of the Center of medicine of accidents carried out a medical support of precautionary works on the admission of the raised water consumption down the river Syr-Darya around a dam of the Koksaray counterregulator in the South Kazakhstan area, medical care 575 addressed is provided.

The group of medicine of accidents of branch of the Center of medicine of accidents of Almaty provided medical care in a flooding zone around the item Kyzyl-Agash, Aksu area, Almaty region. For the time spent the emergency medical care is provided to 508 victims, including 30 children in a zone of disaster.

Crews of the emergency reaction of branch of the Center of medicine of accidents for Almaty and on East Kazakhstan carried out a medical support of works on the of floodings and to decrease in their consequences in the territory of the East Kazakhstan region. Help 305 addressed is given.

The crew of the emergency reaction of branch of the Center of medicine of accidents of Almaty provided medical care to staff of the military unit 28237 which is on the Thin lake No. 6 at a glacier of Manshuk Mametova in Almaty region.

The mobile medical group of the Center of medicine of accidents carried out a medical support of the group involved on construction works of the antiflood counterregulator on the Syr-Darya river in the Southern Kazakhstan area which was carried out according to an order of the Ministry of Emergency Situations of the Republic of Kazakhstan by forces of medical formations of branches of the Center of medicine of accidents of the South Kazakhstan area and Almaty. Around works more than 350 people received necessary medical care for the time spent.

In 2011 formations of branches of the Center of medicine of accidents took part in the organization of a medical support:

- the 7th Winter Asian games of 2011, elections of the Head of state, the World Islamic Economic forum, the Summit of SCO, Islamic conference, organization of events devoted to the World Day of Civil protection, festive actions by RK Independence Day;
- in April 2011 REM of branch of the Center of medicine of accidents for EKR took part in a medical support when flooding near the river Old Sogra. Help to 61 persons is given;
- from June 10, 2011 to November 11, 2011 a goal of crew of the emergency reaction of branch of the Center of medicine of accidents for Almaty carried out a medical support of works on clearing of forest blockages in the territory of regional park "Medeo" of Almaty region. Medical care 479 addressed is provided;
- REM of branches of the Center of medicine of accidents on Astana and Mangistau areas took part in rendering the emergency medical care by the victim at mass riots during the period since December 16-19 in by Zhanaozen Mangistau area. Medical care 54 addressed is provided (gunshot wounds and injuries of the top and lower extremities - 30 people, urgent childbirth-1, hypertensive crises-10, diseases of an urinary system of-3 people, ORZ-10). Medicines, the medical equipment, preparations of blood and blood substitutes of 68 liters and 145 liters of plasma of blood are transferred.

Participation of the Center of medicine of accidents in medical and sanitary providing a wrecking for rendering the emergency medical care abroad increased. Together with Kazaviaspas, on February 2 and on March 14, 2011 evacuation of citizens of the Republic of Kazakhstan from a conflict zone in Egypt is carried out and at an earthquake in Japan.

Medical examinations.

In 2009-2012 specialists of the Center of medicine of accidents it was captured by medical care and routine inspection of 1800 people, from them:

In 2009 1000 people were examined, in 2010 specialists of the Center of medicine of accidents performed medical examination of 570 people, in 2011 specialists of the Center of Medicine of Accidents for Almaty branch performed medical examination of the military personnel in division No. 28237 No. 68303. In total 7 experts were involved, 230 people are examined, see figure 1.1 [48].

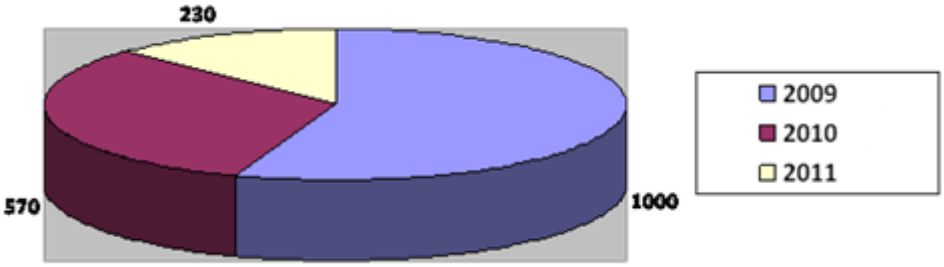

Figure 1.1 - Structure of professional survey medicine accidents in 2011

Participation in preparation events.

Specialists of the Center of medicine of accidents take obligatory part in the planned command and staff and tactical and special drills staged by the Ministry of Emergency Situations and territorial Departments on an emergency.

For the purpose of working off of skills of rendering the emergency medical care at emergency situations, the group of medicine of accidents on large international collecting seminars and doctrines, such as "Kazspas", "Caspian Sea-2011", "Zher-2011" is annually developed.

In 2009 it is taken part in command and staff doctrines:

"Spring - 2009", "Zhetysu - 2009", "Kazspas - 2009", "Boskyn - 2009", "Earth - 2009", "Interaction - 2009".

In 2010 took part in the command and staff doctrines, "Koktem-2010", "Kazspas-2010", "Winter 2010", tactical and special doctrines - "Bulak-2010".

In 2011 tactical and special and command and staff drills on increase of availability for service in the emergency mode were staged:

- according to the Plan of work of the Ministry of Emergency Situations of the Republic of Kazakhstan for 2011, during the period from March 17 to March 18, 2011 GU "Center of Medicine of Accidents" of the Ministry of Emergency Situations of RK took part in the command and staff doctrine "Koktem-2011";

- from May 12 to June 2, 2011 took part in the tactical and special doctrine "KAZSPAS-2011" around the Ministry of Emergency Situations educational and training Center "Rocky city Astana" in Almaty region, 37 people of staff and 12 pieces of equipment were involved, medical care is provided 263 addressed;

- since June 28-29, 2011 in the tactical and special doctrine "Elimination of Medical and Sanitary Consequences at Road Accident in the territory of EKR";

- according to the order of the Minister of Emergency Situations during the period from September 20 to September 22 to Shymkent the Center of medicine of accidents took part in the command and staff doctrine "Zher-2011". During RKShU 37 people of staff and 11 pieces of equipment were involved, medical care is provided 23 addressed;

- according to the order of the Minister of Emergency Situations No. 161-l of August 25 2011 the crew of the emergency reaction of the Center of Medicine of Accidents for Mangistau Area branch took part in the international doctrine "Caspian Sea-2011".

Fast management of medicine of accidents of the situational centers requires the modern software, in particular the system developed by GIS for the accelerated reaction and finding of critical points of medicine of accidents in a short space of time, for the purpose of the solution of problems.

1.4 GIS systems

Geographic information system (GIS) - system of collecting, storage, the analysis and graphic visualization of spatial (geographical) data and the related information on necessary objects.

The concept of a geographic information system is also used in narrower sense - as tool (software product) allowing users to look for, analyze and edit both a digital district map, and additional information on objects [49].

GIS includes possibilities of the database management systems (DMS), editors of raster and vector graphics and analytical means and is applied in cartography, geology, meteorology, land management, ecology, municipal management, transport, economy, defense and many other areas.

There are following types of GIS:

On territorial coverage: global (global GIS), subcontinental, national, often having the status state, regional (regional GIS), subregional, local, or local (local GIS).

On subject domain of information modeling.

City municipal, Urban GIS, subsoil user's GIS, mining-and-geological GIS[49], nature protection GIS (environmental GIS), etc.; among them the special name as especially widespread, received land information systems.

On problem orientation.

The analysis, assessment, monitoring, management and planning, decision-making support are defined by the solved tasks (scientific and applied), among them inventory of resources (including the inventory). The integrated GIS, IGIS (integrated GIS, IGIS) combine functionality of GIS and systems of digital processing of images (data of remote sensing) in the uniform integrated environment.

Distinguish also polylarge-scale, or large-scale and independent GIS (multiscale GIS) are based on multiple, or polylarge-scale representations of spatial objects (multiple representation, multiscale representation), providing graphic or

cartographical reproduction of data on any of the chosen levels of a large-scale row on the basis of the only data set with the greatest spatial permission.

Existential GIS (spatio-temporal GIS) operate with existential data.

Implementation of geoinformation projects (GIS project), creation of GIS in the broadest sense, includes stages: predesign researches (feasibility study), including studying of requirements of the user (user requirements) and functionality of the used software GIS, the feasibility study, a ratio assessment "expense/profit" (costs/benefits); system design of GIS (GIS designing), including a stage the pilot project (pilot-project), development of GIS (GIS development); its testing on a small territorial fragment, or a test site (test area), prototyping, either creation of a prototype, or prototype (prototype); introduction of GIS (GIS implementation); operation and use [50].

Scientific, technical, technological and applied aspects of design, creation and use of GIS are studied by geoinformatics.

Data in GIS describe real objects, such as roads, buildings, reservoirs, forests. Real objects can be shared into two abstract categories: discrete (houses, territorial zones) and continuous (relief, level of rainfall, average annual temperature). For representation of these two categories of objects vector and raster data are used.

Raster data are stored in a type of sets of the sizes ordered in the form of a rectangular grid. Cells of this grid are called as pixels. The most widespread way of obtaining raster data on a surface of Earth is the remote sensing which is carried out by means of satellites. Storage of raster data can be carried out in graphic formats, for example TIF or JPEG, or in a binary look in databases.

Vector data. The most widespread types of vector objects are next:

Points. Are used for designation of geographical objects for which location, but not their form or the sizes is important. Possibility of designation of object a point depends on card scale. While on the world map of the city it is expedient to designate dot objects, on a map of the city the city is presented in the form of a set of objects. In GIS the dot object is represented in the form of some geometrical figure of the small sizes (a small square, a circle, a dagger), or as the pictogram transferring type of real object serve for the image of linear objects. The polyline - the broken line made of pieces of straight lines. Polylines represent roads, railway tracks, the rivers, streets, a water supply system. The admissibility of the image of objects polylines also depends on card scale. For example, the large river in scales of the continent can quite be represented by linear object whereas already in scales of the city its image is required by vulgar object. The characteristic of linear object is length.

Polygons (grounds).

Serve for designation of vulgar objects with a clear boundary. Lakes, parks, buildings, the countries, continents can be examples. Are characterized by the area and length of perimeter.

Semantic data can be attached to the vector: for example, on the card of territorial zoning the characteristic like zone can be attached to the vulgar objects representing zones. The structure and types of data are defined by the user. On the basis of the numerical values appropriated to vector objects on the card the thematic card on which

these values are designated in the flowers according to a color scale, or circles of the different size can be under construction.

Continuous fields of sizes can be described by vector data. Fields thus are represented in the form of isolines or planimetric lines. One of ways of representation of a relief is the irregular triangulable grid (TIN, triangulated irregular networks). Such grid is formed by a set of points with the attached values (in this case height). Values in any point in a grid turn out by interpolation of values in knots of a triangle to which this point gets.

Vector data usually have much more the smaller size, than raster. It is easy to transform and perform them over them binary operations. Vector data allow to carry out various types of the spatial analysis, for example search of the shortest way in a road network.

Structure of GIS.

1. Data (spatial data):

- position (geographical): location of object on a terrestrial surface;
- not position (attributive): the descriptive.

2. Hardware (COMPUTER, networks, stores, scanner, digitayzer etc.).

3. Software.

4. Technologies (methods, operations procedure etc.).

Formal questions which GIS can answer:

1. What is in …? (the place, on the indication of characteristics "street", "building", "number", "the name of the area" decides).

2. Where it is? (spatial analysis).

3. What changed since …? (to define temporary changes on a certain square).

4. What spatial structures exist?

5. What if? (modeling that will occur if to add the new road).

According to the WHO data confirmed by many authors, the state of health for 50% depends on a way of life (including here and economic and social situation of the person), for 20% of hereditary factors, for 20% of influence of environment (including also working conditions, which now more than at a third of the working don't conform to hygienic requirements) and only for 10% of a condition of health care. Difficulties of an assessment of a state of health of the cities are rather fully reflected in the international requirements coordinated by experts.

Formation and development of Medical geography (or "Medicine geography) as scientific direction, has centuries-old traditions, however the solution of many questions of this science still demands the further deep studying. This interdisciplinary direction studies an environment and socio-economic factors to reveal degree and regularities of their influence on human health. Understand certain natural systems as a complex of an environment: the landscapes, physiographic features, natural zones representing interrelation of natural components - a relief, climate, soils, waters, vegetation, animal. Socio-economic factors include features of life and activity of people, the industry, agriculture, transport and means of communication, the non-productive sphere [51].

To the main directions of scientific and applied researches in the field of medical geography traditionally carry the following:

- medical-geographical assessment of separate elements of the nature, the natural complexes and economic conditions influencing a state of health of the person;
- development of medical-geographical forecasts for the rendered habitable and new areas, and also for territories within which the nature as a result of economic activity of the person will most intensively be transformed;
- drawing up the medical-maps and atlases reflecting positive and negative influence of habitat and social and economic conditions on a state of health of people;
- studying of spatial regularities of separate diseases and drawing up cards of their distribution [51].

Around the world the organizations connected with health sector increasingly rely on the decisions provided by the GIS technology promoting increase of efficiency of activity in this the major for our life and economies of area, its modernization and to transfer to modern level of service of the population, needs of the state and society. The powerful tools of integration of diverse data, their spatial analysis offered GIS, modeling and evident visualization help to provide complex support of the tasks solved by medical institutions, to expand a circle of the carried-out researches and inspections, to present their results in a cartographical look, convenient for further work and understanding.

Means of GIS help the public health organizations to improve data collection on questioning of the population and the provided services, drawing up reports on their basis, to the analysis and synthesis of data on a state of health of the population and spread of different, including infectious diseases and other illnesses for a long time. The interactive maps and databases which are their cornerstone created in the environment of GIS allow to improve information exchange between the organizations and interaction with citizens, promote process of adoption of the leading decisions, development of the new conceptual direction called Health 2.0.

GIS technology can help with realization of many basic functions of public health branch:

Assessment of the available and perspective assets (the analysis and development of infrastructure of health care facilities, resources, the realized programs for increase of level of health of the population, etc.) . GIS supports all aspects of tracking of public health, providing a platform for collecting and the analysis of the factors of the surrounding natural and social and economic environment influencing it, and also these various inspections and medical examinations, databases about patients and so forth GIS successfully work and at mobile devices, helping to collect data in field conditions, providing a reliable spatial binding of information received in a digital form. GIS can serve as a crucial component for distribution of human and technical resources and their planning, including modeling and issue of recommendations to experts in the analysis of geographical distribution of customer services and identification of places where, for example, the arrival time of ambulance crews exceeds standard indicators, and also for the general increase of efficiency of the medical services rendered to the population.

Elaboration of strategy taking into account its spatial components, including a choice of the near and remote purposes of development, forecasting of their possible consequences by joint consideration and the analysis of specific medical data and information of social and demographic character, data on environment, the administrative information supplied about infrastructure of public health bodies, medical organizations and the services provided by them.

Situational awareness. GIS provides to the persons making decisions in health sector, the overall operational picture for planning and correction of actions including at emergence of emergency situations, such as the outbreaks of dangerous diseases and fast spread of infections, or at threat of bioterrorist attacks. Officials use GIS for tracking of results of realization of the taken actions, the complex analysis of data sets of different subject and purpose and, in wider prospect - for the optimum and more adapted for a concrete situation distribution of resources according to the current requirements. And the population gets convenient access to the network services based on GIS for obtaining information on medical services interesting them in places of their accommodation or in wider spatial context [51].

Ensuring effective management, service improvement of quality, insurance, marketing. The unique means of data collection offered in GIS powerful and in many respects, including "in the field", managements of them, their modeling and the analysis, collaboration with a set of data sets help the organizations to modernize own working processes, to improve interaction and exchange of information with colleagues in other organizations. Heads can trace in an evident look a condition of public health in a geographical (spatial) context, more fully understand and consider the various factors having impact on human health or developing of diseases and also to analyze and fully to involve the resources which are available at their order. Conferences on application of GIS in health care are held in the different countries. It should be noted annual international conference of the ESRI company on this subject where the last innovations in the field of medical geography, information on the latest technical trends in application information and, first of all, geoinformation approaches to the solution of tasks and problems of health care are represented. Esri has a wide experience of introduction of GIS in the sphere of public health and in the organizations of health care, it is partially generalized in the books and brochures on this subject published by publishing house of the company, in the specialized periodical of News for Health & Human Services (Healthy GIS). It is grouped in the following sections: Health of the population (Public Health), Service of the population (Human Services), System of hospitals and other medical institutions (Hospital and Health Systems), Control of care of sick (Managed Care), Scientific programs and researches (Academic Programs and Research). the 1st All-Russian conference "Geographic information systems in health care of the Russian Federation: data, analytics, decisions" I passed in St. Petersburg on May 26-27, 2011. This release of ArcReview included the short review of results of this conference and a number of articles based on reports which on it were submitted [52].

Examples medical gis of systems.

1. Medical-geographical GIS of the Republic of Tatarstan.

The project of creation of a medical-demographic geographic information system of the Republic of Tatarstan was developed for the analysis and control of these and some other social processes in 2011 (group of postgraduate students of professor Dr. in geosciences. Rubtsova V. A., Dr. in sociology sciences Ildarkhanov F. A. and Dr. in phys.-math. sciences, professor Ablayev F.M.) [51]. This project includes a combination of new information technologies and modern mathematical methods in the solution of a wide range of tasks of the analysis and the forecast of demographic events, planning of both strategic, and individual measures in the solution of social and economic tasks. The undoubted leader in this branch are the software products of the Esri company realized in the form of uniform ArcGIS system.

The major factors of excess mortality influencing the expected life expectancy of the population to the Republic of Tatarstan are connected with three components:

- very high blood circulatory system diseases mortality (63,8%), unlike the majority of economically developed countries which isn't decreasing for the last decades;
- supermortality from accidents, poisonings, injuries, murders, suicides at able-bodied age, especially at men;
- rather high mortality from diseases of respiratory organs and, to a lesser extent, from infectious diseases.

Thus, modern crisis of public health in Russia is caused not so much by "old" causes of death, such as infectious diseases, but also the come "new" types of pathology, first of all blood circulatory system diseases. And social trouble promotes rapprochement of the endogenous and exogenous reasons of mortality. From positions of management process human resources - the most burdensome of all assets. Almost boundless variety and unpredictability of behavior and habits of people do them incredibly difficult for estimation, and the human body is much more difficult, than any electromechanical knot arriving with the ordered practical specifications. Nevertheless, people - the only element possessing ability to make additional cost. All other variables - money and their "relative" the credit, raw materials, plants, the equipment and energy - can offer only inert potentials. By the nature they in itself add nothing and can't add while the person, there is it the worker of the lowest qualification, the most skillful professional or the top manager, doesn't use this human potential, having forced it to work and bring economic effect.

Health of the population is directly connected with the worsening ecological situation. The ecological factors influencing a state of health of the person are closely connected with technogenic changes of a landscape, physical conditions of the environment of activity, climatic features of a living environment. Pollution of the atmosphere and water objects belong to constantly operating ecological risk factors for health of the person.

To support a competitive position in the market of the XXI century, it is necessary for mankind and it is necessary to find the methods increasing his knowledge of people. The most profitable and long-term solution of the problem of demographic deficiency consists in helping each person to become more productive (in direct and figurative

meanings). It obliges to find out, properly to invest in the potential of human productivity.

To one of approaches to studying of the matters and search of optimum decisions the medical-demographic geographic information system of the Republic of Tatarstan just also is. She is urged to be responsible for accumulation and processing of the various information attached to the territory, formation of tabular, graphic and cartographical reports for search of answers and the solution of three main objectives of management of the region taking into account requirements of medical-geographical branch:

Optimization of resources and their planning on prospect.

Analysis and forecast of territorial distribution medical-demographic and socio-economic indexes.

Identification of relationships of cause and effect between indicators of the territorial distributed factors and responses in the form of medical indicators and, as a result, - quantitative and quality standard of medical, environmental and other risks.

The internal part of a medical-demographic geographic information system of the Republic of Tatarstan is presented by several sets of spatial data brought to the general system of coordinates and a uniform projection and containing information on elements of a geographical basis, medical and demographic features of the population in a section of municipalities of the republic and their centers. On the basis of base of geographical data in the "desktop" ArcGIS appendix a series of cards for the subsequent publication in the Internet (Intranet) is prepared. The web application consists of a set of interactive thematic and basic layers with possibility of their connection or shutdown which list is located on the main page to the left of the cartographical image

The list of thematic layers isn't final and constantly extends, new cards are created and updated lost relevance that is very important for tracking of dynamics and forecasting of a medical-demographic situation in regions of the republic.

The interactive electronic map in an evident look displaying the accumulated data with a binding to the territory and with layers of a different thematic orientation will become one of the main results of implementation of the project. It will give opportunity of fast carrying out the complex demographic analysis in the set parameters both in short-term, and in the long term. Social and economic data, data on population, the income of people, etc. will be involved in the analysis. Besides, basic spatial data and data on infrastructure will become necessary components, they are important for the analysis of spatial behavior of the population.

Medical-demographic GIS allows to create and connect quickly to the analysis new data, it is easy to address to other existing data and to connect them with spatial information that allows to reveal and those features and interrelations which aren't visible from tables, charts and schedules. The data lacking for detailed business of the analysis, for example, about the population, an arrangement of the enterprises, banks, real estate objects, it is possible to add quickly to a database, having received them from customers and the third-party organizations.

Unlike the ordinary paper card, the electronic card (which cornerstone in the annex to the ArcGIS environment is base of geodata) created in GIS contains as displayed at present, and the "hidden" information which can be "made active" easily as required. The user can look through each layer card separately, and can combine at once some layers, or choose information separate, necessary at present from various layers and to bring her to the card displaying results of the solution of a certain analytical task. It can also model various situations, every time receiving images according to an objective, and without need to create the new card. The created cards can both be printed in paper form, and to exchange them with colleagues and partners or to provide to the general public, for example through social networks.

Thus, spheres of application and potential audience of the created system are rather wide. All information received thanks to the GIS technologies can be used not only specialists geographers, and and ordinary people: scientists, businessmen, doctors, lawyers, officials, marketing specialists, builders, ecologists and other interested persons. This geographic information system will allow to display and analyze business information by new methods, to reveal the interrelations hidden earlier, examples and trends, to promote more effective management of the region and its forward development.

2. GEOS in medicine.

Geoanalytical information system for health care on the basis of a platform of Geos (GIS for medicine). The system is intended for the solution of a wide range of regional information and analytical tasks of healthcare institutions with a binding to spatial data.

By means of this system workers of health care will be able to carry out the complex analysis of data on incidence across various territories, to compare rate of developing of diseases to seasonal factors, changes in weather conditions, air pollution levels, etc.

All health care facilities are placed on the map of the settlement to the physical addresses, on the same card thematic layers zones on factors which have impact on incidences and the course of epidemic processes are created.

The mechanism of an address binding allows to display on the electronic card, as isolated cases of a disease, hospitalization, a lethal outcome, and the incidence centers. To group in households, organized collectives (schools, preschool institutions, etc.), to the treatment-and-preventive organizations. Zoning of the territory on an administrative-territorial sign gives the chance of a comparative assessment of incidences in a section of administrative districts, municipal areas, polyclinic sites.

For an evident assessment of development of epidemic process possibility of inclusion of charts of "the last periods" for each territory, and also an assessment of structure of incidence, for example, on age is provided in dynamics.

In general, geoanalytical system "Geos: The medicine" provides solutions of problems of monitoring of habitat and health of the population for the purpose of adoption of the optimum administrative decisions directed on improvement of quality of life of the population. High informational content at visualization of the data which are poorly connected among themselves considerably facilitates carrying out the

analysis, search of relationships of cause and effect and promotes better perception of information the persons making decisions.

3. GIS of Healthcare Committee of St. Petersburg.

The analytical geographic information system of health care is urged to solve 4 main objectives of branch of health care of the subject:

Optimization of resources of health care, planning of resources on prospect;

Analysis and forecast of territorial distribution medical-demographic and socio-economic indexes;

Identification of relationships of cause and effect between indicators of the territorial distributed factors and responses in the form of medical indicators and, as a result - an assessment of medical, environmental and other risks [52-54];

Improvements of opportunities of access for the population to information on medical services, to medical institutions that increases quality of the provided help.

These are the main, but not all tasks in which professionally developed GIS of the region, the cities or areas can help with branch of health care. The geographic information system can be integrated into BI system, and can exist separately and independently, being integrated into system of collecting medical data (medical information systems, MIS) which in this or that look is available in the regional medical information and analysis centers (MIAC), territorial authorities of management of health care, regional governing bodies of health care, the large medical centers.

4. In the Republic of Kazakhstan GIS of System in separate areas of the republic were introduced, also by request of Ministry of Health of RK Electronic atlases of health were created and transferred to the RK treatment-and- institutions. Similar works were carried out in Kyzylorda area in 2007 - 2008. Among the Kazakhstan GIS of developers it is possible to note Academy of preventive medicine, JSC Kazakhstan GIS Centre, "The Kazakhstan center of geographic information systems", Center of Remote Sensing and GIS Terra LLP with the DigitalGlobe company. Divisions of JSC Kazakhstan GIS Centre possess modern computer and the software for performance of GIS of projects for various fields of activity. In the 2003rd year the Academy of preventive medicine initiated the State program of development of a telemedicine in rural areas of Kazakhstan which were financed by Ministry of Health. Now in the country 186 telemedical centers function, over 12 thousand teleconsultations that allowed many citizens living in the remote regions to get access to highly skilled medical consultations are carried out [55-56].

In 2008 the Academy of preventive medicine executed the project on creation of the electronic atlas of health care and objects of social and economic purpose of the Kyzyl-Orda area by means of methodology of the Geographical Information Systems (GIS). The methodology of GIS allows to extrapolate on electronic cards information on a geographical arrangement of healthcare institutions, medicinestores, medical laboratories, existence of medical and paramedical staff, availability of medical care, and also data on dynamics of diseases, the demographic parameters and factors of environment influencing health of the population [57-58].

The obtained data gave opportunity to analyze medical information in a context with demographic processes, geographical and ecological factors, and also other spheres of economic activity, social and cultural life of Kyzyl-Orda area.

In 2012 the Academy of preventive medicine was the main performer of national research of health of households of Kazakhstan, within the project of Ministry of Health of RK and the World bank "Transfer of Technologies and Carrying Out Institutional Reform in Sector of Health Care of the Republic of Kazakhstan". This research captured representative selection of the population of all regions of Kazakhstan. Around the city Almaty, research were included by more than 850 households in which persons at the age of 15 years were interrogated and are more senior. Questioning included the questions concerning healthy behavior, a state of health, access for the population to medical care, receiving medical services and their payment. Besides, such parameters as level of arterial pressure, a rosto-weight index and other important biomarkers were defined. Results of this large-scale research will allow to increase substantiality in management and decision-making on the basis of information about health of the population, by the best understanding of how households interact with health system, and also other characteristics, important for health care.

Due Ph.D. dissertation scientific research there are next issues related to GIS systems in Kazakhstan:

- 2GIS - not correct showing results for search engine (for ex. Blood centers showing not full);
- Google Maps - for request in Kazakhstan Republic shows results in Russian Federation, shows results more in Astana and Almaty, other cities poor information about healthcare organizations;
- Yandex Maps -more precised for blood centers, poor information about first aid, hospitals and medical centers, see figure 1.2 and 1.3;
- ArcGIS - poor information about Kazakhstan healthcare organizations;
- in all listed above GIS systems - poor information about farmacy, hospitals, first aid.

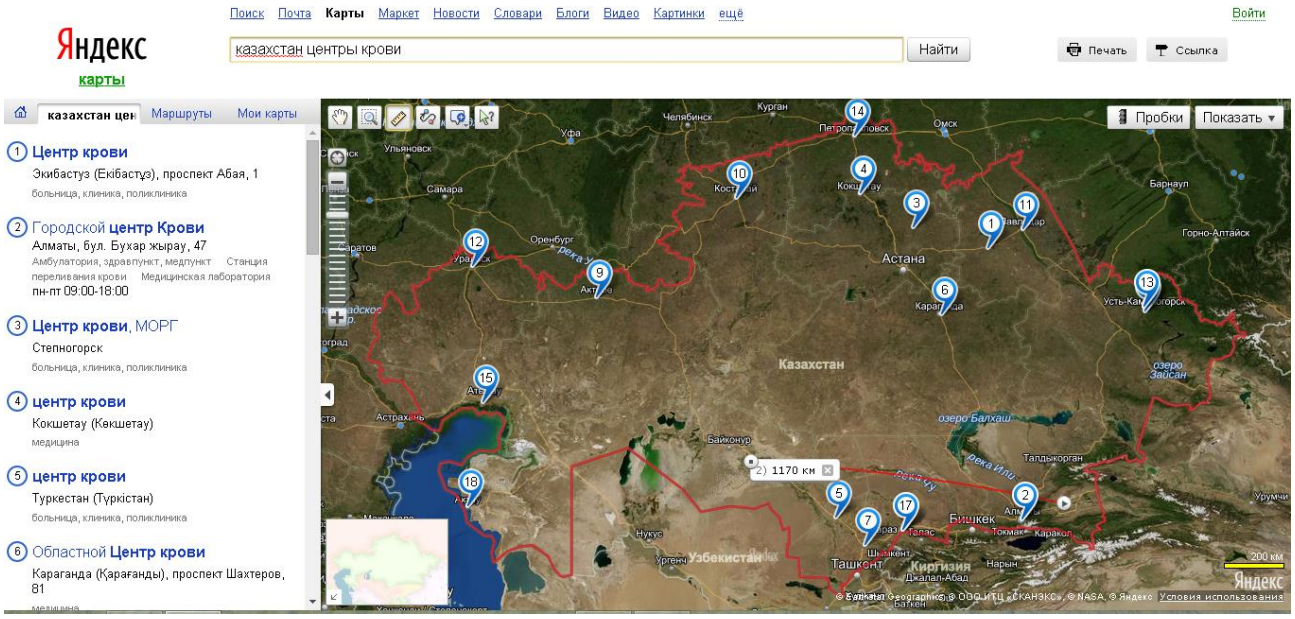

Figure 1.2 - Blood centers at Yandex Maps GIS

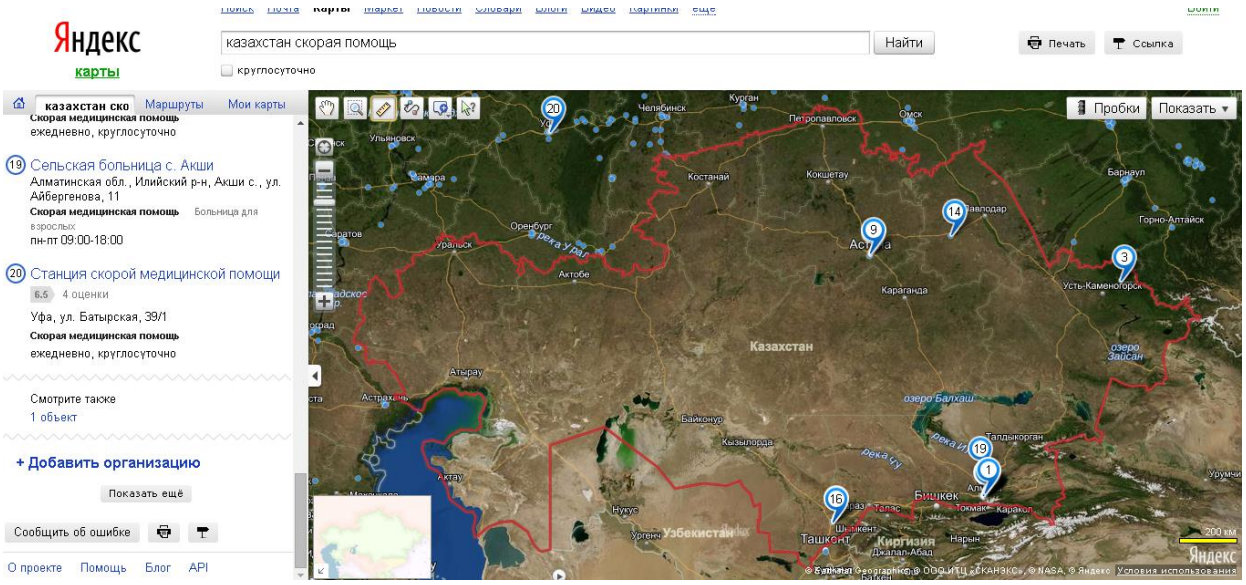

Figure 1.3 - First aid station distribution at Yandex Maps GIS

Due research author had created GIS for Kazakhstan's healthcare government organizations, see figure 1.4.

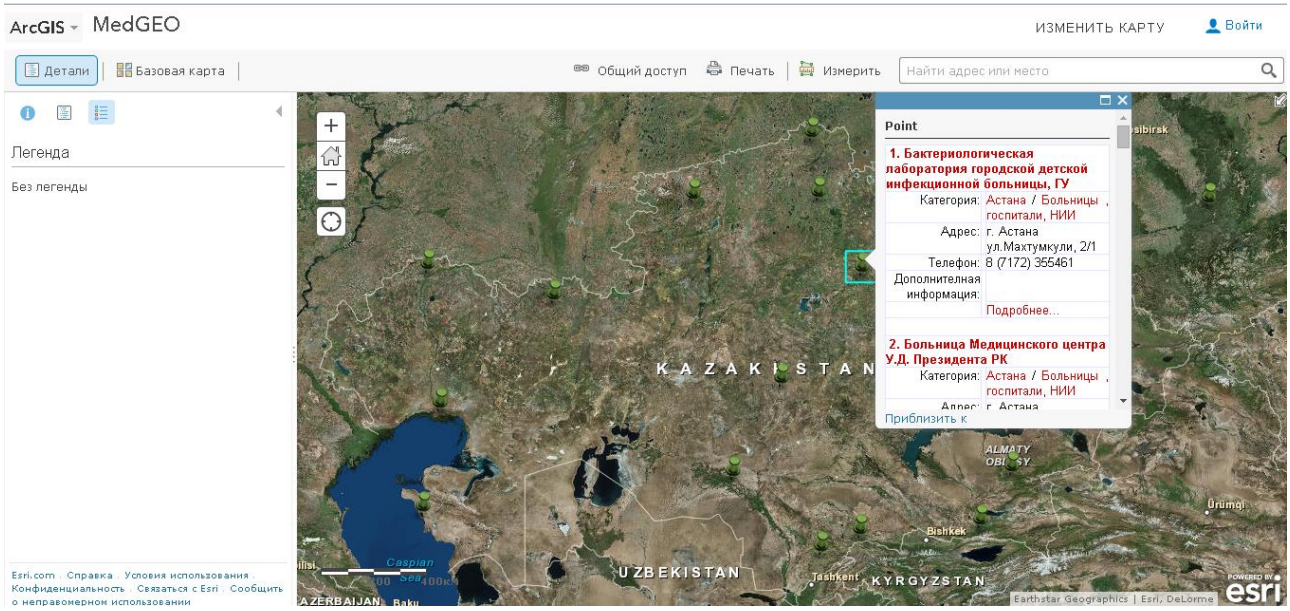

Figure 1.4 - GIS for government Healthcare organizations, build on ArcGIS platform

1.5. Electronic healthcare of the Republic of Kazakhstan

The Uniform National Health System (UNHS) found the reflection in the State program "Salamatty Kazakhstan" for 2011-2015 the President of the Republic of Kazakhstan approved by the Decree of November 29, 2010 No. 1113.

In the Message of the Head of state the people of Kazakhstan of January 28, 2011 were given instructions on completion of process of introduction of ENSZ by 2013.

Problems of 2011 of introduction of ENSZ are: further improvement of rendering the stationary help on the basis of a free choice of the patient, development of the competitive environment, ensuring availability of highly specialized medical care, improvement of quality of medical services, development of the differentiated payment for health workers of a hospital and turning on of the stimulating mechanisms on out-patient and polyclinic sector [59-61].

The Uniform payer of the guaranteed volume of free medical care (GVFMC) within the stationary and hospital-replacing help at treatment of diseases is created, except for medical services, psychiatric, infectious and tubercular in the person of Committee of payment, Ministry of Health of the Republic of Kazakhstan with territorial departments (TD to WHOM). Thus direct payment for services GOBMP is carried out on the basis of the contract of the state order for rendering of services of GOBMP, concluded between TD to WHOM and the accredited organization of health care by continuous quality control of medical services depending on the end results. Thus it is necessary to consider integrity of system, various types of communications (including system - and factor dependable), structure and the organization, a multilevelness and existence of hierarchy of levels, management, the purpose and expedient nature of functioning, self-organization, functioning, reforming and development of health care [62-65].

The system analysis of the organizations of health care and state of health of people reveals high degree of interdependence of various elements and aspects of social and economic and political development. These aspects become more and more closely interconnected what it is possible to judge by results of the analysis of level of health and demographic processes in economically developed countries of the world. Effective development of health system causes positive consequences in other sectors of national economy [66].

All-system property of this sphere of life support is that change (easing) of any its element, for example a preventive link, makes negative impact on all other its services and divisions, lead to deterioration of work of system in general. To the contrary, any positive change of a preventive link sharply improves activity of all components of system.

The most characteristic signs which are present at many definitions of health system are reduced to the following:

- the movement to integrity and functional unity;
- increase in a variety of structural divisions of system and the functions which are carried out by them;
- the system analysis of the organizations of health care and a state of health of people reveals high degree of interdependence of various elements and aspects of social and economic and political development. These aspects become more and more closely interconnected what it is possible to judge by results of the analysis of level of health and demographic processes in economically developed countries of the world. Effective development of health system causes positive consequences in other sectors of national economy [67-69].

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- existence and expansion of communications: quantitative and qualitative, positive and negative, one-planned and multidimensional, intrasystem and intersystem;
- complexity (polyfunctionality) of behavior, nonlinearity of characteristics;
- increase of level of informatization;
- the irregular, statistically not distributed in time receipt of influences (environment factors);
- multi-aspects: medical-social, economic, psychological, ecological, technical and technological;
- counter intuition (cause and effect are rigidly unambiguously not connected neither in time, nor in space);
- nonlinearity.

For completeness of parameters and properties of health system it is necessary to allocate still organizational managerial characteristics. Creation of the operated health

system demands identification of such elements and relations between them (structural structure of system) which realize its purposeful functioning. The elements of any contents necessary for function realization are called as parts or components of system. Set of parts (components) of system forms its element (component) structure. The ordered set of the relations between parts necessary for function realization forms structure (a structure, an arrangement, an order) of system, i.e. set of its elements and interrelations between them. Thus the concept "communications" can characterize at the same time both a structure (statics), and functioning (dynamics) of system.

Introduction of ENSZ allowed [70-75]:

- to create the competitive environment between the medical organizations by introduction of the principle of a free choice by the patient of the doctor and the medical organization;
- to increase motivation medical the organizations (as suppliers of medical services) on rendering high-quality and available medical care;
- to provide the rights of patients for high-quality and safe medical services;
- to introduce effective international standards of quality management of medical services (introduction of protocols of diagnostics and treatment with uniform approach of compensation of expenses and clinical maintaining the patient, carrying out accreditation of the medical organizations);
- to introduce the differentiated compensation of health workers focused on the end result;
- to increase transparency of process of rendering medical services;
- to increase efficiency of use of resources of the state;
- to develop and introduce the clinical managements and the protocol in the priority directions;
- to introduce VSMP transfer to regions;
- to reduce document flow level in a hospital by change the requirement and introductions electronic technologies;
- to increase overall performance of the personnel due to training (team, design training, training on workplaces, training at leaders);
- to introduce the staff of social workers and psychologists;

The market relations in health care will open prospects for development of the competitive medical organizations. But at the same time noncompetitive organizations will be reorganized, transformed, etc.

Also in 2011 according to the order of the Minister of Health of RK of 20.05.2011 No. 310 "About the approval of Rules of compensation of health workers", created conditions for the differentiated compensation of health workers depending on the end result and monitoring of action of payments of an additional component of the per capita standard to the organizations of primary medical and sanitary help is begun (further - PMSP).

The complex per capita standard is a method of uniform distribution of financing to each inhabitant taking into account all need for the out-patient help.

Advantages of this complex consist:

- standardization of a range and level of rendering services;

- financing of all out-patient sector through a partial fondoderzhaniye;
- resource-saving in the PMSP organizations;
- stimulations of development of technologies in the PMSP, KDP and KDTs organizations;
- money "follows" the patient;
- developments of the competitive environment in APO sector;
- improvement of quality of the given help in APO sector.

Thus, by 2015 the modern and competitive system of financing of health care and payment of medical services, and also the modern and effective control system of health care conforming to the international standards will be created.

The basis for implementation of the national project "Creation of Uniform Information Health System of the Republic of Kazakhstan" is the State program of reforming and development of health care for 2005-2010. Further improvement of EISZ happens within the State program of development of health care of the Republic of Kazakhstan "Salamatty Kazakhstan" for 2011 - 2015.

Uniform information health system of the Republic of Kazakhstan - a complex of program technical means and technologies of the data connected together by transmission media united by the general ideology, approaches by the qualifiers and other means providing complete structure of management of health care on the basis of uniform procedures of collecting, processing, aggregation and the analysis of information.

The owner of EISZ RK is the state represented by Ministry of health and social development of the Republic of Kazakhstan. Thus according to the Concept of "Uniform national health system of the Republic of Kazakhstan", each medical organization working within this system will be supplied with the software of EISZ RK.

The following companies of Medinform LLP worked on creation of EISZ RK (ACROSS Medstat, Medical info, TEP the medical organizations and governing bodies, Licensing of the medical organizations, Financing of the republican organizations, Formation of indicators on local and republican to budgets, Accounting of the republican organizations, the Salary, Formation of fund of compensation in healthcare institutions, Frames health care, the Register of students of medical schools and medical faculties, the Analysis of execution of letters and control documents, the Accounting of narcotic medicines, Medical examination of school students, Country people (Aul program), Motherhood and the childhood, the Register of patients with diabetes, the Register of patients with oncological diseases, the National register of patients with tuberculosis, the Register of sick HPN, AIS-policlinic, AIS-Statsionar), JSC NAT Kazakhstan (The centers of blood, automation and the accounting of patients, etc.)

The software developed by Medinform LLP:

1. A subsystem "Medstat" - in a subsystem is organized standard multilevel input and processing of all statistical forms of account on activity of the medical organizations. Control of the entered data is carried out both intra uniform, and interuniform and interannual. Tables can be formed at the level the area - area - the

republic. On the basis of this complex all summary annual reports in all forms of the statistical reporting at the level area republic are formed. This subsystem provides: preparation of the statistical and analytical reporting on results of activity of bodies of health care of any degree of depth of specification and level of coverage of objects of system, depending on inquiry parameters; adoption of the administrative decisions directed on increase of efficiency of activity of division of MHSD of the RK.

2. Subsystem "Medinfo". The subsystem allows to receive on the basis of the Medstat Database the main indicators on health care in the form of analytical tables and schedules. By means of necessary syntax of teams algorithms of calculation of indicators are created, the book and computer version of the annual reference book "Health of the Population of RK and Activity of the Medical Organizations in a Year" is formed. Thus the subsystem provides the automated formation of the documents necessary during daily activity which drawing up can be formalized with use of the registration data which are already entered into a subsystem. The checked, reliable information constructed on the basis of primary and registration documents according to regulations of Ministry of Health and Social development of RK is subject to accumulation.

3. The subsystem of "TEP of the medical organizations and governing bodies of system of health care", is directed on collecting, adjustment and support of databases on technical and economic indicators of the organizations of health system. The entrance document for a subsystem is approved by Ministry of Health "TEP card of the medical organizations" which includes such indicators as location, submission, F.I.O of heads, data on the license, LPO power, number of visits per shift, forms of ownership, the served population, states, information on the available sanitary and other motor transport, the characteristic of the buildings standing on balance or rented, the list of the medical equipment and products of medical appointment, etc. The subsystem allows to receive a large number reporting and analytical tables on all entered indicators in a section the medical organization-region-area-republic. From a database it is possible to receive information practically on each state or private medical organization of the republic. Quarterly data from the medical organizations are flown down in regional health department with further transfer to republican base. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

4.Subsystem "Licensing of the medical organizations". The subsystem provides maintaining the register and a database on licensing of the medical organizations for different types of activity - medical, pharmaceutical, educational, and also on activity with narcotic substances. The created database allows to receive systematic and reliable information about the quantitative analysis of the state and private medical organizations, to carry out the analysis of activities of subcommittees for licensing, check of observance of qualification requirements, and also to provide information in government bodies on the questions which are within the competence of the licensor. Exchange of information from region health department and the interested departments is provided. Creation and maintaining a database assumes filling of forms of licenses and annexes to them for each licensor with systematic information transfer in the

general database containing more than 14 thousand records. At the moment the subsystem in part "Licensing of pharmaceutical activity" works from the level of regional management farmacy control. Monthly data from regional DB are transferred to the republican. In turn from a republican DB of licenses the updated information comes to regional farmacy managements . Output documents are the printing of the license, with the appendix, and also various reporting and analytical forms for other departments (Agency statistically, Tax committee of the republic и.т.д.). We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

5. Complex of the programs "Formation of Fund of Compensation in the Organizations of Health Care". The complex of programs provides input, adjustment, control of information on formation of the staff list and fund of compensation of all organizations of health care. The complex of programs consists of two parts: tariff lists and calculation of a wages fund. When developing Resolutions and Decrees of the Government of the Republic of Kazakhstan on system of compensation of employees of the organizations of health care were used. In a complex all settlement indicators and tariff coefficients necessary for calculation of an official salary of the employee are considered. Drawing up the staff list of each organization of health system is result of work of a complex. This created at the level of the separate organization are reported to higher bodies of management of health care for obtaining summary reports. The output reporting and analytical documents formed on all entered indicators promote the qualitative analysis of a condition of compensation of workers of health care and planning of the funds allocated for compensation. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

6. Subsystem "Health care staff". The system designation consists in automation of process of the analysis and accounting of medical, scientific shots and the average health workers (AHW) of health system of the Republic of Kazakhstan. Functioning of system consists in collecting, processing, storage of databases and delivery on information request, necessary for the account and the analysis. The created databases allow to receive systematic, reliable information about list and the quantitative analysis of structure of the state and private medical organizations, for the solution of questions of preparation and retraining of personnel, on the movement (re-deployment) staff, control of security with staff in this or that region, etc. Entrance documents for the solution of problems of this system are cards of the accounting of scientific shots, doctors, SMR, and also the corresponding standard reference information approved by MHSD РК.

7. Register of students of medical schools and medical faculties. Maintaining the register of students of medical schools, will allow to receive systematic, reliable information about a payroll, structural (a nationality, a social status) structure of the state and private medical schools, about the movement (re-deployment) of students, and as result - control of training in HIGHER EDUCATION INSTITUTION, arrival and employment of young specialists on workplaces after distribution, security with medical shots in this or that region. The entrance document is "The card of the student"

with the instruction more than 25 parameters such as passport part, faculty, specialty, training language, form of education, course, progress etc.

We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

8. The automated information ASKID system is intended for the accounting of the entering and outgoing mail, and also for tracking document flow in the ministry or other governing body in system of MZ RK and behind performance of the instructions of the management written on control documents. Proceeding from a main objective of creation of system of the document flow database consisting in formation, the system first of all provides the mechanism of interaction of divisions of Ministry of Health, stores general information about object of the main account "document". Thus much attention of systematization of data of the concepts put in them which are stored in base of system, classification and standardization is paid. Maintaining a database on the entering and proceeding information allows to execute in due time directive, control documents, letters of the population. Input of documents is carried out in two languages (state and Russian). Data are brought daily. For any period of time various research opinions, reminders and inquiries in the parameters chosen by the user are issued.

9. Program complex "Medical Examination of School Students". The developed software is directed on creation and support of databases in a section of areas with information on a state of health of children of age of 12-18 years. Monthly the base is replenished with information on dynamic supervision and improvement of school students. On the basis of the available data issue of the analytical tables characterizing a state of health of children of 12-18 years in a section the area - the area-republic is possible. The software is established in all regions. The entrance document is "The card of inspection of the schoolboy(schoolgirl) at the age of 12-18 years with all indicators (passport part, growth, weight, diseases, dispensary group, etc.) . Data are brought and corrected in computer base in areas, transferred to areas and further merge at the level of the republic on the main Medinform server and after processing are transferred to MHSDRK for the analysis. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

10. Program complex "Country people" (Aul program). The program complex provides creation and support to the personified DB on country people within the Aul program, for dynamic supervision and improvement of country people. Screening program and the card of inspection of the villager are developed for medical examinations of adult country people (passport part, growth, weight, pressure, risk factors (smoking, the use of alcoholic beverages), diseases, dispensary groups, process of dynamic supervision and improvement). The database constantly is replenished with data on screening to inspection and dynamic supervision of residents of the village. The software is established in all regions. The entrance document is "The card of inspection of the villager". Data are brought and corrected in computer base of regional and central regional hospitals with the subsequent transfer to regional and regional bodies of health care and further merge at the level of the republic.

We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

11. Policlinic Automated Information System (AIS). This complex, provides the solution of problems of collecting, storage, processing and representation in a form of information, convenient for the doctor, of the patient, and also granting the administrative character to information necessary for improvement of the organization of medical process. This system is based on processing "The statistical card the ambulatory patient and includes a complex "Registry" and "Statistics department". The program complex allows to form various output forms for the out-patient and polyclinic organizations as medical character (a form 39 at "The accounting of visits in policlinic, out-patient clinic", a form 12 "Report on incidence", a form 30-is sensible " the Report on activity of LPO", etc.) and issue of various registers on payment of medical services. Possibility of a choice of various indicators from databases for the analysis of quality of the carried-out treatment is provided. Information from policlinics of times a month is transferred to city public health departments and branches RGKP "National Center of the Analysis and Assessment of Quality of Medical Services" of MZ RK and by that updating a DB of these enterprises. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

12. Hospital Automated Information System (AIS). The system first of all is intended for the automated maintaining the clinical record, the expeditious data processing facilitating differential diagnostics and control of a state, expeditious submission of medical information on questions of treatment. This system includes the Accident Ward and Statistics department complex. On the basis of the daily data arriving from a reception (receipt, transfers, an extract) and data of a metodotdel (processing of "The statistical card of the patient who left a hospital") various analytical and reporting documents for the out-patient organizations as medical character are formed (forms 7 and 16 "Structure of patients in a hospital', forms 13 and 14 - annual reporting indicators, etc.) and issue of various registers on payment of medical services. Possibility of a choice of various indicators from databases for the analysis of quality of the carried-out treatment is provided. Monthly data are reported to the regional authorities of health care and RGKP NTsA OKMU for replenishment of a DB of these enterprises. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

13. Subsystem "Motherhood and childhood". A complex of tasks "Motherhood and the childhood" - the operational tasks allowing to make operational decisions to Ministry of Health in the field of health protection of mother and the child. The complex of tasks is intended for expeditious tracking birth rate, maternal, infantile and child mortality, incidence of newborns (aged from 0 till 27 days), including is purulent - septic diseases and infectious incidence of children till 5 years. The "Infantile and Child Mortality" complex is established in hospitals and the out-patient and polyclinic organizations of the republic. The entrance document is, the form 154/u-04 approved by Ministry of Health RK "The card of the accounting of the died child aged till 5 years". The map is filled in only on the live-born. Monthly information on electronic media is reported to governing bodies of health care. According to collected information analytical and reporting documents are formed. The personified database

on child and maternal mortality, the reasons of mortality and incidence is formed. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

14. National register "Diabetes". Maintaining the created register on diabetes of the republic allows to receive systematic, reliable information about incidence, disability, mortality of patients with diabetes, its reasons, late complications, efficiency of treatment-and-preventive actions. It gives the chance to control a condition of the help to patients, the level of providing with insulin, the tableted sugar replacable preparations and delivery systems. Maintaining the register provides filling on each revealed patient of the special card (more than 50 parameters) with systematic information transfer in the general databank. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

15. Republican register of patients with oncological diseases. Maintaining the register allows to receive systematic and reliable information about registration and the dispensary accounting of patients with oncological diseases, possibility of control of the help to patients, providing with medicines. As entrance documents the approved forms No. 090/at, 066/at and 030/at serve. At data input there is an automatic control to the obligatory instruction on a mistake and options of possible value of mistakenly entered parameter. At any time the medical personnel of the medical organization can receive on demand the summary document or the reference according to that information which is in their local base. Input of primary information is carried out in oncological clinics with the subsequent data transmission in health regional department, and then in Ministry of Health of RK on channels of an electronic network for the general arch. Data are updated monthly. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company [76].

16. National register of patients with tuberculosis. The subsystem of "The national register of patients with tuberculosis" allows to receive systematic, reliable information about incidence, disability, mortality of patients with tuberculosis, its reasons, late complications, efficiency of treatment-and-preventive actions. It gives the chance to control a condition of the help to patients, the level of providing with medicines during treatment of the patient with tuberculosis or during chemoprophylaxis of persons from group of "risk" with providing data on by-effects from application of preparations. Maintaining the register provides filling on each revealed patient of the special card (more than 50 parameters) with systematic information transfer in the general databank where different types of control (a record duality, a medicine legitivnost и.т.д are carried out.) . The database on patients in a section of areas is corrected quarterly. Feature of this computer system is not only collection of information about the dispanserizuyemy contingent, studying of features of structure of patients with active tuberculosis, but also collection of information about tuberculosis cases on WHO. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

17. The automated information support "Urology - Control of treatment of patients with a chronic renal failure" the Task is intended for the accounting of the dispensary patients needing a hemodialysis and the patients with an allotransplantirovanny kidney needing the supporting immunosupressivny therapy during all life.

Maintaining the register allows to receive the systematic, reliable information necessary for dynamic supervision over a condition of the patients with the chronic renal failure (CRF) needing treatment by a hemodialysis and receiving expensive immunosupressivny preparations. Data from "The card of the patient on a hemodialysis" and "the Control card of dispensary supervision of the patient with an allotransplantirovanny kidney" are brought in the computer for storage and further processing. On the basis of these data references and analytical tables, and also information on consumption of medicines are automatically formed.

On the basis of the brought data in each region registers of the patients needing expensive treatment are formed. We will combine a complex regarding standard reference information with other program complexes developed by the Medical inform company.

Among domestic developers of medical systems it is also necessary to note SoftPatner LLP with the Informatization of Medical Institutions project which main objective creation of the complex medical information system (CMIS) for maintaining information on the patient on the basis of the electronic medical record (EMR) uniting in itself concepts of the electronic out-patient card (EOPC) and the electronic clinical record (ECR) is. The current tasks of the project are: providing doctors with information for support at decision-making on methods and ways of treatment of patients, providing heads of the treatment-and-preventive establishments (TAPE) with operational information for the analysis of activity of LPU, information exchange between participants of medical and diagnostic process.

Within the project automation of subordinated establishments of Medical Control center of affairs of the President of the Republic of Kazakhstan is made. Automation began with Hospital of Administration of the President of the Republic of Kazakhstan in Astana.

On object the system which covers all range of medical services of this establishment is brought into operation. The final task of the project costs in association of all subordinated medical and sanatorium institutions in a uniform information complex.

Automation on objects of Medical control center of affairs of the President of sieves the following tasks:

1. Management of a flow of patients

- registration of patients and necessary personal information on them;
- creation of the electronic medical record (EMR);
- search of electronic medical records of patients in various parameters;
- distribution of primary flow of patients at a stage of registration and search of their data in base;
- formation of the plan of hospitalization;

- export and updating of data on patients from databases of other information systems;
- differentiation of flows of patients at a registration stage.

2. Management of the schedule of doctors - scheduling of doctors, laboratories and various services.

3. Management of bed fund - the account and planning of bed fund.

4. Formation of an electronic medical record of the patient (EMK) - EMK is a uniform storage of medical information on the patient.

5. Stockpile management of LPU. A medicinestore - control of process of the movement of medicines and expendables in LPU.

6. Management of financial resources of LPU - control of cash flows of LPU. Interaction with economic systems (1C).

7. Interaction with radiological information system - scheduling of doctors, laboratories and various services.

8. Interaction with laboratory information system - transfer of the directions to KDL, return of results of researches to EMK, scheduling of laboratory doctors, etc.

9. Analysis of work of medical institution.

Statistical reports - accumulation in system of information on activity of LPU in process of work of the personnel in it, allows to refuse paper forms of the medical account completely. As the medical reporting in system, it is possible to realize ready options of the approved medical-statistical forms of the reporting (the state statistical reporting both official registration and forms of account of healthcare institutions of various profile), and also other reports used by medical institutions for the analysis of the activity.

10. Automation of activity clinical-diagnostic laboratory

Functions of activity of the clinical-diagnostic laboratory (CDL):

- registration of the directions for laboratory researches;
- biomaterial registration;
- control of analyzers;
- fast connection to system of new analyzers;
- depending on the analyzer — connection can be unidirectional or bidirectional, or maintain the list of loading;
- automatic validation of the results of the analysis of the patient transferred by the analyzer;
- automatic registration of results of quality control in the magazine;
- input and authorization of results via the Work sheet module;
- data exchange with analyzers in real time;
- automatic check at input of result in a template on compliance to its reference limits;
- graphic identification of disturbing results (the results supporting reference limits are allocated with color indicators);
- inside laboratory control;
- automatic registration of the results of quality control received from analyzers in the magazine;

- automatic creation of schedules of Levi-Dzheninga by results of daily measurements of control samples;

- formation of templates of any form for input of results and the printing of forms of answers the staff of laboratory;

- formation of the internal reporting of KDL in the set parameters, for the set period and so forth.

For today this project is the full on the volume of automation of medicine in the Republic of Kazakhstan.

EISZ program complexes [77]:

medical-statistical system - the patient-focused system which provides informatization of all processes of interaction of patients with the medical personnel.

In a database the personified data on the medical services rendered to the patient collect from the moment of the birth (the appeal to the medical organizations, the held medical and diagnostic events, the revealed diseases, the appointed and rendered to the patient medical services, including the consumed medicines if passed treatments directly in the medical organization, planning and monitoring of performance of preventive actions).

The control system of resources resolves strategic and operational issues personnel and material support of medical institutions, taking into account their real requirements, and also provides use of uniform reference books and codifiers.

The system of monitoring of a sanitary and epidemiologic situation solves problems of collecting, generalization and the analysis of information, timely informing responsible divisions of Ministry of Health and local authorities about a sanitary epidemiological state in all regions of the Republic.

The control system medicinal providing a medicinal turn with monitoring exercises the automated control of processes of production, the movement and use of medicines, means of medical appointment and medical equipment.

As a part of this system four complexes of tasks are allocated. The first - a complex on formation of information resources in questions of physical and economic availability of medicines. The second - on formation of information resources according to the of medicinal diseases and medicinal mortality. The third complex - on formation of information resources on consumption of free medicines at the out-patient level. And the fourth - on formation of information resources about quality of medicines.

The control system of quality of medical services allows to increase quality of control of activity of the medical organizations and the personnel of activity of the medical organizations and the personnel regarding the rendered services on the basis of formation of object indicator indicators. The system provides information support of retraining and certification of medical shots. All cases of the wrong diagnoses and the complaint of patients are considered in this System on the basis of strictly documentary information on the established diagnoses and the appointed medical services.

The control system of finance exercises control of financial streams of branch.

Creation of EISZ RK gives the chance for governing bodies of health care:

- in due time to make administrative decisions;
- to carry out financing of medical services in the new principles;
- to carry out monitoring of indicators of health of the population, volumes and quality, the provided medical care;
- to operate quality of providing medical services.

For the medical organizations:

to plan preventive actions;

- to operate system of preparation and rational distribution of personnel resources;
- to increase efficiency of the made decisions due to access to reliable and full information;
- to automate processing of the state and departmental forms of account;
- to exclude duplication of maintaining and flows of information (registration of information in a place of its emergence);
- to provide efficiency and availability of information to experts;
- access of a wide range of users to information sources in the sphere of their professional activity, education, science, etc.

Implementation of the EISZ project allows to get to the population the following advantages:

- access for the citizen of the Republic of Kazakhstan to "The electronic passport of health", ensuring continuity at delivery of health care;
- providing necessary medical information to patients;
- increase of efficiency and efficiency of medical care of patients;
- improvement of quality of the provided medical care due to ensuring bigger knowledge of the medical personnel of new medical technologies, introduction electronic and decrease in paper document flow, control of correctness of statement of the diagnosis, prescription of medicines and preventive actions;
- informing patients on working hours of the organizations of health care and certain experts, about sequence of hospitalization in hospitals and graphics of work of consultants in the out-patient and polyclinic organizations;
- possibility of storage and repeated use of the saved-up medical information on the patient, and as a result, an exception of duplication of numerous researches;
- increase of safety of use of medicines due to improvement of knowledge of the medical personnel and patients about the medicines registered in the Republic of Kazakhstan and their side effects;
- informing patients on a sanitary and epidemic situation countrywide, in separately taken region, on separately taken disease.

For integration of ENSZ and EISZ portal formats, such as "Bureau of hospitalization", "The register of the attached population", "The electronic register of inpatients", "An additional component to the medical and sanitary help", "The electronic register of oncological patients", "Provision of medicines", "A control system of medical equipment", "The register of pregnant women" and "The register of patients with virus hepatitises "B" and "C"" were introduced.[77]

Within information support of realization of Uniform national health system the Bureau of Hospitalization portal functions.

For formation of the uniform centralized information database about the actual number of the attached population to the organizations of health care giving primary medical and sanitary help The Register of the Attached Population portal continues to function.

For information and technical maintenance of process of compensation of expenses the "Electronic Register of Inpatients" portal continues to function.

For introduction of an additional component to a tariff of primary medical and sanitary help, calculation of cost of points of system of indicators in a section of each region the "Additional Component to the Medical and Sanitary Help" portal continues to function.

For automation of processes of formation of the electronic register of oncological patients and compensation of expenses of oncological clinics in delivery of health care of the specified category of patients with ensuring compliance of quality of treatment to the international standards the "Electronic Register of Oncological Patients" portal was created.

It should be noted also developed information systems by request of National Medical Holding. By JSC National Medical Holding it was formed in 2008 according to the resolution of the government of the Republic of Kazakhstan with absolute participation of the state in its authorized capital. The national medical holding unites 6 innovative health care facilities located in the territory of a medical cluster in Astana is a National scientific center of motherhood and the childhood, the Republican children's rehabilitation center, the Republican diagnostic center, Republican scientific center of neurosurgery, Republican scientific center of emergency medical service and the National scientific Cardiology center.

Main objective of JSC National Medical Holding is creation competitive at the international level "Hospitals of the Future" which will provide to citizens of Kazakhstan, the near and far abroad a wide range of medical services on the basis of the advanced medical technologies, modern hospital management, the international quality standards and safety. Among them such services as emergency aid, out-patient and diagnostic service, obstetrics and gynecology, the neonatal help, internal diseases, neuro and a heart surgery, and also rehabilitation treatment.

Within the project creation of "Hospital of the future" is planned creation of a full cycle of hi-tech services on the basis of clinics of holding by development of clinical and administrative processes, uniform system of information technologies, laboratory and other auxiliary services, medical education and applied science. Creation of "Hospital of the future" provides introduction of the transparent business focused hospital management.

Other important task of National medical holding is introduction the patient - the focused principle of medical care. It will demand high ethical standards and preparation of the motivated highly professional shots working under the international clinical protocols and technologies.

As important condition of implementation of the Hospital of the Future project accreditation by the international commission of JCI which is "the gold standard" for the medical organizations of the developed countries acts. It provides access to the

international resources allowing to improve constantly quality, to reduce risks. Accreditation of JCI bears advantages not only to health workers and the organizations, but also to those who at them is treated, in particular due to minimization of medical mistakes, observance of the rights of patients and confidentiality of medical information to raise degree of hospital safety of patients and medics.

On March 2, 2012 JSC National Scientific Center of Motherhood and Childhood I received the official decision of the joint international commission of Joint Commission International about accreditation on the international standards. It is the clinic of such level, the first in the former Soviet Union which gained the international recognition in health sector.

On March 22, 2013 JSC Republican Scientific Center of Neurosurgery I received the official decision of the joint international commission of Joint Commission International about accreditation on the international standards.

It should be noted that creation of "Hospital of the future" is impossible without introduction of Uniform hospital information system with electronic record of patients and a digital archiving of data. All this unites in the concept "paperless hospital", one of the most perspective directions of hospital management of 21 centuries.

1.6 Model provision medicines at the Republic of Kazakhstan

The concept of medicinal policy of the Republic of Kazakhstan for 2012-2016 was developed for implementation of the Code of the Republic of Kazakhstan of September 18, 2009 No. 193-IV ZRK "About Health of the People and Health System".

Now the Uniform distributor is determined by supply of medicines for needs of public sector of health care. According to the experts the Samruk-Kazyna Pharmacy LLP company covers about 70% of requirement at the stationary level. The guaranteed purchasing market for domestic pharmaceutical industry that promoted increase in local production in 2009 for 21% in comparison with 2008 is created, thus the tendency to growth is noted. The system of out-patient provision of medicines is improved. The official system of provision of medicines is introduced: the Republican official commission is created; the lists of the fixed (vital) medicines which lost action are replaced with the form, the first edition of the Republican form is published in 2008.

The Medicinal information center with branches in regions which will eliminate a defect of objective medicinal information was created and will make the qualified contribution to rational selection and use of medicines. Rational selection and prescription of medicines is also promoted by the approved Protocols of diagnostics and treatment of diseases, the list and which contents are constantly improved. For last period measures for transition to the new monitoring system of quality of medicines are taken. National standards appropriate pharmaceutical the practician (A good manufacturing practice (further - Scientific Production Enterprise), Appropriate distributor practice (further - NDP), Appropriate pharmaceutical practice (further - NAP), Appropriate clinical practice (further - NKP), Appropriate laboratory practice are approved (further - the NLP)); the professional inspectorate is formed, the

regulatory legal base is improved. Programs of preparation, retraining and professional development of pharmaceutical shots are considerably revised. The five-year program of training of bachelors of pharmaceutical business, since September, 2010 - the program of training of masters of pharmacy is entered.

Weaknesses:

- insufficient level of provision of medicines in rural areas;
- lack of price regulation in pharmaceutical sector;
- insufficient level of information technologies;
- high level of self-treatment by medicines of prescription dispensing;
- insufficient level of preparation and professional development of pharmaceutical and medical shots;
- not all domestic producers conform to requirements of GMP;
- low level of involvement of professional associations in development of pharmaceutical sector, services, including in professional development of pharmaceutical and medical shots;
- insufficient cooperation between the public and private sector in pharmacy.

Opportunities:

- the state in every possible way keeps development of pharmaceutical sector of the republic, to it testify;
- existence of questions of development of pharmaceutical sector in Strategy of development of the country;
- realization of the State program of development of health care of the Republic of Kazakhstan "Salamatta Қазақстан" for 2011 - 2015;
- realization of the State program on the development of the Republic of Kazakhstan forced industrial innovatively for 2010-2014;
- realization of the State program on development of pharmaceutical industry for 2010-2014;
- implementation of the "Transfer of Technologies and Carrying Out Institutional Reform in Sector of Health Care of the Republic of Kazakhstan" project with assistance of the World bank on a component E "Partner interaction on pharmaceutical policy";
- the state realizes that the cost of medicines and medicine treatment are important factors of health care and can have decisive impact on the patient's choice upon transition from stationary to more effective с the smallest expenses of out-patient (primary) help;
- sustainable economic development of Kazakhstan allows to increase annually the amounts of financing for ensuring availability of medicine treatment to wider groups of the population and to invest development of pharmaceutical sector in general;
- the Republic of Kazakhstan expresses commitment to training on examples and systems of other countries, taking into account the difficulties and problems revealed together with the international experts; there is a political will for achievement of the objectives with an orientation on implementation of the tasks;
- the initiatives begun in previous years aren't realized fully yet and demand further attention (The uniform distributor, Medicinal information center).

Threats:

- the growing prices of medicines and the increasing cost of medicine treatment;
- opening of customs borders in a combination with lack of effective mechanisms of identification in the address of the forged medicines;
- insufficient use of capacity of the private sector;
- long character and nonflexible procedures of updating of training programs of preparation and professional development of pharmaceutical and medical shots in quickly changing pharmaceutical environment;
- lack of means and incentives for full introduction of the international standards appropriate pharmaceutical the practician subjects of the domestic pharmaceutical market.

By 2016 in the Republic of Kazakhstan only the medicines made according to the quality standards of GMP PIC/S or other comparable standards will be allowed to the state registration. GMP PIC/S will be the obligatory standard of production in the Republic of Kazakhstan. Kazakhstan expresses intention to become the member of PIC/S by 2016 and to harmonize the current legislation with requirements of PIC/S. As a result of obligatory introduction of compliance to the GMP standards (both for production of a domestic production, and for imported) serial certification of medicines will be gradually abolished according to the estimated risk and historical data of compliance. It will reduce regulatory loading for the companies and will allow them to focus quality control on questions of high risk.

Implementation of this Concept is supposed by means of the following regulations:

1. The code of the Republic of Kazakhstan of September 18, 2009 No. 193-IVZPK "About health of the people and health system";
2. The decree of the President of the Republic of Kazakhstan of February 1, 2010 No. 922 "About the approval of the Strategic development plan of the Republic of Kazakhstan till 2020";
3. The decree of the President of the Republic of Kazakhstan of March 19, 2010 No. 958 "About the statement of the State program on the development of the Republic of Kazakhstan forced industrial innovatively for 2010 - 2014";
4. The decree of the President of the Republic of Kazakhstan of November 29, 2010 No. 1113 "About the statement of the State program of development of health care of the Republic of Kazakhstan "Salamatty Kazakhstan" for 2011 - 2015";
5. The resolution of the government of the Republic of Kazakhstan of February 10, 2010 No. 81 "About the Strategic plan of Ministry of Health of the Republic of Kazakhstan for 2010-2014".
6. The resolution of the government of the Republic of Kazakhstan of August No. 791 4 "About the Program for development of pharmaceutical industry of the Republic of Kazakhstan for 2010 - 2014"

For a solution of the problem of optimization of provision of medicines within economy of budgetary funds Ministry of Health developed Rules of the organization and implementation of monitoring of the prices on the PM, IMN, and also their formation within GOBMP approved by the order of the Ministry of April 12, 2013 No. 223 (further - Rules).

For the purpose of correction of the received information and monitoring of the prices on PM, IMN the Ministry carries out comparative analyses of internal and external pricing taking into account the international experience.

Thus, one of the main criteria for carrying out the analysis of external reference pricing will be existence of the GMP standards (Good Manufacturing Practice) and the country a similar standard of living of the population.

After carrying out the analysis of the received information, the prices of the medicines and products of medical appointment recommended for registration are approved by authorized body and go to RGP "National Center of Examination of Medicines, Products of Medical Appointment and Medical Equipment" for placement in uniform information base of the prices of the State register of medicines, products of medical appointment which to be supplemented on a constant basis. The state register of medicines, products of medical appointment and medical equipment is available on the site www.dari.kz. The list of GOBMP is regulated by the following NPA:

- the order No. 356 on the approval of the list of the medicines, products of medical appointment within the guaranteed volume of free medical care which are subject to purchase at the Uniform distributor for 2015-2017;
- order of the deputy. The Minister of Health of the Republic of Kazakhstan of November 4, 2011 No. 786. No. 7306 About the approval of the List of medicines and products of medical appointment for free providing the population within the guaranteed volume of free medical care at the out-patient level with certain diseases (states) and specialized medical products is registered in the Ministry of Justice of the Republic of Kazakhstan on November 25, 2011;
- the resolution of the government of the Republic of Kazakhstan of July 5, 2014 No. 767 "About modification and additions in the resolution of the government of the Republic of Kazakhstan of October 30, 2009 No. 1729 "About the approval of Rules of the organization and carrying out purchase of medicines, preventive (immunobiological, diagnostic, disinfecting) preparations, products of medical appointment and medical equipment, pharmaceutical services in rendering the guaranteed volume of free medical care" (the Kazakh option);
- the order of the Minister of Health of the Republic of Kazakhstan of May 11, 2011 No. 285 "About the approval of the List the orfan of the medical technologies intended for treatment of rare diseases in the Republic of Kazakhstan";
- order of the Deputy. The Minister of Health of the Republic of Kazakhstan of August 6, 2012 No. 536 "About entering of additions into the order of the Minister of Health of the Republic of Kazakhstan of May 11, 2011 No. 285 "About the approval of the List the orfan of the medical technologies intended for treatment of rare diseases in the Republic of Kazakhstan";
- the order of the Vice-Minister of Health of the Republics Kazakhstan of June 26, 2014 No. 351 "About entering of additions into the order of the Minister of Health of the Republic of Kazakhstan of May 11, 2011 No. 285 "About the approval of the List the orfan of the medical technologies intended for treatment of rare diseases in the Republic of Kazakhstan";

- the order of the Minister of Health of the Republic of Kazakhstan of April 28, 2014 No. 221 "About the statement of algorithms of formation of lists of medicines, the products of medical appointment used within the guaranteed volume of free medical care and consideration of the budgetary demands";

- the order of the Minister of Health of the Republic of Kazakhstan of June 2, 2014 No. 370 "About modification of the order of the Minister of Health of the Republic of Kazakhstan of April 12, 2013 No. 223 "About the approval of Rules of the organization and implementation of monitoring of the prices of medicines, products of medical appointment, and also their formations within the guaranteed volume of free medical care";

- the order of the Minister of Health of the Republic of Kazakhstan of May 18, 2012 No. 347 "About modification and additions in the order of the Deputy. The Minister of Health of the Republic of Kazakhstan of November 4, 2011 No. 786 "About the approval of the List of medicines and products of medical appointment for free providing the population within the guaranteed volume of free medical care at the out-patient level with certain diseases (states) and specialized medical products";

- the order of the Minister of Health of the Republic of Kazakhstan of December 27, 2012 No. 903 "About the statement of the limit prices of the medicines bought within the guaranteed volume of free medical care for 2013";

- the Samruk-Kazyna Pharmacy company was created for increase of stability and competitiveness of pharmaceutical branch of the Republic of Kazakhstan, development of pharmaceutical industry by consolidation of government procurements of medicines.

Object of activity of the Company are:

- the organization of the open auction for purchase of medicines within the guaranteed volume of free medical care;

- the organization of storage of medicines according to requirements appropriate distributor the practician and Legislations of the Republic of Kazakhstan;

- the organization of processes of logistics of medicines in the state medical organizations;

- creation of information system for integration of processes of logistics of the Uniform distributor, the customer and suppliers, and also for obtaining actual information on a turn, the commodity remains.

The uniform distributor carries out provision of medicines more than one thousand medical institutions of the country, organizing timely transportation of medicines even in the most remote corners of the republic all means of transport all the year round and in any weather.

In the company the effective mechanism of planning of purchase and deliveries is developed. The Uniform pharmaceutical information system is introduced. EFIS SK-Farmation is the control system of logistic operations and warehouses allowing to carry out online monitoring of execution of contractual obligations, observance of appropriate storage conditions and transportation of medicines, and observance of a residual expiration date.

At the expense of own means of the Uniform distributor not reduced strategic reserve of medicines on socially important diseases is created.

In SK-Farmation the 1C-accounts department for the accounting of medicines is used, for the warehouse account there was an automated workplace separate program, and till 2014 in parallel account was kept by the logistician on the Sail program. since 2014 "SK-Farmation" developed the own UPIS (Uniform Pharmaceutical Information System) program which is in own way unique. It provides continuous online communication both with hospitals, and with logisticians; there is a tracking and existence of medicines in hospitals, and expiration dates of the medicines which are stored in warehouses. The system allows to trace all way of medicine - from the producer to hospital - in the online mode, to control expiration dates of medicines, storage conditions, their existence in warehouses [78].

Introduction of automatic introduction and the accounting of demands for supply of medicines and products of medical appointment from hospitals will be the following stage. It considerably will accelerate work, will unload hospitals, will relieve of paper work and will allow to observe the further movement on each demand. Today already there are positive responses. At meeting in Ministry of Health with representatives of 16 regional governments of health care on provision of medicines it was noted that became very convenient to work with EFIS that there is no need to direct paper demands - everything becomes online. Everything who works according to this program, noted such advantages as saving of time to registration of demands, accuracy of demands, etc. Further SK-Farmation plans to improve this program that any citizen of RK could get access to system of EFIS. Unfortunately, there are negative cases when in hospitals speak to the patient about lack of necessary medicine, and with EFIS he will get access to information that it is bought within GOBMP, in what quantity is shipped, in what rest this day the hospital according to the trade name has. Information system allows to provide the accuracy and timeliness of deliveries, opportunity immediately to react to the arising requirement, to check existence of the necessary preparations in other hospitals of the region for redistribution in case of emergency and so on. In general the introduced technologies will help to make system of provision of medicines within the guaranteed volume of free medical care of the most transparent and available services to end users - patients [79].

1.7 The blood centers in the Republic of Kazakhstan

The resolution of the government of the Republic of Kazakhstan of 21.12.2007 No. 1251 approved the Program "About measures for improvement of service of blood in the Republic of Kazakhstan for 2008-2010." the main developer of the program is the Republican Center of Blood. The purpose of the program is safety, qualities and availability of the transfusion help in the Republic of Kazakhstan. Tasks of the program are [80]:

- improvement of standard and legal base and organizational structure of service of blood;
- introduction of modern technologies on the basis of modernization of material base;

- professional development of specialists of service of blood;
- development of donorship of blood and its components on the basis of introduction of the international experience of its organization;
- creation of system of a quality assurance of products of blood;
- creation of the National register of donors and a control system of stocks of products of blood in the Republic and other questions. RTsK carries out the activity according to the Charter, the State licenses on medical and pharmaceutical activity and other constituent documents. Today the Republican center of blood is 250 high-trained professionals, including: 3 candidates of medical sciences. All structural divisions are equipped with the modern equipment and devices, meeting the international standards. In RTsK use disposable expendables on preparation of blood and its components. RTsK lets out in wide assortment components and preparations of blood, including leycocites filtered. RTsK by the state order provides with blood products 23 republican organizations of health care, on a paid basis - 114 medical organizations. Besides, carries out on a paid basis more than 20 hematologic on HIV and other infections of a blood test, fractions to 20 000 liters of plasma on blood preparations, makes sublimation drying of various materials. Doors of the Republican center of blood are always open for long-term cooperation on donorship, approbation and preparation of blood and plasma, production of components, preparations of blood and diagnostic standards of blood and on providing with them.

Today in the republic 23 centers of blood - 14 regional, the city center of blood in the city of Almaty, the Republican center of blood, the Research and production center of transfusiology and 6 city centers in the cities which don't have the regional status function.

The number of donations annually makes about 270 thousand, volumes of preparation of donor blood and its components of 170 thousand liters. The states of the regional centers of blood are completed by experts with the higher medical education for 82%, the average medical personnel - for 92%. Hematologic service - one of the youngest. In its activity there are a lot of unresolved problems, including growth of hematologic incidence. Overdue diagnostics, inadequate therapy, shortage of necessary preparations, etc. can be the reason. Also the problem of shots is particularly acute. If the number of hematologists in Kazakhstan made below the settlement indicator taken for norm in the former USSR, in 2000 on 1 rate 100 thousand of the adult, were the share of 0,5 rates of 100 thousand of children's population. Thus unevenly distribution of hematologists on areas. In the majority of regions of the republic in the organizations of health care there are no the released rates of doctors-transfuziologist. The allocated 0,25-0,5 rates of the doctor-transfuziologist are occupied by part-time workers who often have no specialization and certificates of transfuziologistist that is explained by retraining course duration. Absence of the approved standards of equipment of offices of a transfuziologist can lead to inadequate storage of components of blood. Modern methods of immune-hematologic researches don't take root, the uniform system of monitoring and an assessment of efficiency of transfusion therapy, registration of post-transfusion complications isn't developed.

In the light of the events, it is necessary to recognize that creation of the research and production center is caused by need of introduction in activity of service of blood of the republic of the international quality standards, creations of own school of sciences of transfusiology, and also integration into the world community of transfuziologistist.

The purpose of creation of service of blood, to the corresponding best international practice and providing quality, efficiency and safety of transfusion therapy assumes realization of the following tasks: improvement of regulatory base of service and development of personnel potential; development of gratuitous voluntary donorship; improvement of system of laboratory screening and preparation of components of blood; creation of a common information space of service of blood of the republic; introduction and development of effective quality management system of production in each center of blood; ensuring effective functioning of the equipment in the centers of blood; structural transformation of service of blood in regions according to the international principles; planning and the organization of scientific applied researches in the field of transfusiology; taking measures to studying and use of experience of the application of components of blood based on proofs; providing blood with preparations through development of contract fractionation of raw materials.

Thus activity of service is inexpedient without creation of a uniform electronic database on donors, and also information network of blood of the republic and the services providing the information on persons to whom donorship is contraindicated between centers.

The thematic discussions, seminars of experts promoting are also necessary to exchange experiment and achievements on such important aspects as providing health system with components of blood, introduction of the new principles of the organization of safe donorship and the modern methods of treatment based on application of effective production technologies of components of blood and medicines from blood plasma. Such actions will become not only a good platform for communication of experts of the different countries, but also will help the solution of actual problems of science and practice of hematology and transfusiology.

The current state of service of blood in the Republic of Kazakhstan is characterized by stable indicators of development. Thus there are problems demanding the decision, such as limited financing of service of blood which causes the insufficient level of introduction in practice of technologies of ensuring infectious and immunological safety of components of blood.

Lack of modern production of preparations of blood is one of serious problems of service of blood of Kazakhstan. In Kazakhstan the production of preparations of blood which is available in a number of the centers of blood has no necessary capacities and is morally obsolete.

Thus, safety, qualities and availability of the transfusion help to citizens provides realization of a complex of urgent measures for improvement and development of this service for of transfer of infectious diseases through donor components of blood along with their rational and effective use that in turn, improvement of regulatory legal base and organizational structure of service of blood demands; introduction of modern

technologies on the basis of modernization of material base; professional development of specialists of service of blood; development of donorship of blood and its components on the basis of introduction of the international experience of its organization; creation of system of a quality assurance of products of blood.

1.8. The free software for medicine

The free software (further SPO), free software - the software which users have the rights ("freedom") for its unlimited installation, start, and also free use, studying, distribution and change (improvement), and distribution of copies and results of change. If on the software there are exclusive rights, freedoms appear by means of free licenses. As well as the free and free of charge distributed software, SPO can be used and usually to receive free of charge (but the specific distributor can raise a payment for obtaining at it copies, for channels of delivery, carriers - compact disks or additional services). However freeware usually extends in an executable look without initial codes and is proprietary software and that ON was free, its initial codes from which it is possible to create executable files, together with the corresponding licenses have to be available to recipients. Because the word "sale" call both sale of the original, and distribution of copies for money, and paid licensing (usually on not free conditions), some nevertheless consider free software a subset of the free. Often distinguish free and open source software (open source) - though availability of an initial code to SPO is obligatory, and many open programs are at the same time free, but opened sometimes call also some not free proprietary software (for example, commercial software with an open source code, Shared source).

Widespread packages of SPO in medicine are given below:

1. Public health and biosurveillance Information of an epitaxial layer - a public state, the statistical software for the epidemiology developed by the Centers for control and of diseases.

2. Spatiotemporal Epidemiological Modeler - the tool which is originally developed at the Research IBM for modeling and visualization of spread of infectious diseases.

3. Open Dental-the first public stomatologic administrative package with very ample opportunities on record management, records of receptions of the patient, and management of a stomatologic office.

4. CottageMed - the cross-platform electronic system of medical documentation founded on FileMaker. CottageMed extends under GPL.

5. FreeMED - management of practice and electronic records of patients in system. It allows to trace medical data, in detail, with preservation not only the diagnosis, but also the reasons of medical collisions. FreeMED extends under GPLGaiaEHR - the developed use of modern public electronic medical documentation of PHP and JavaScrip.

6. GNUmed - application of WxPython which uses PostgreSQL.

7. GNU Health - free, centralized, well scalable information system of hospital and health care facilities.

8. Hospital OS - Information system of hospital of the free license in Thailand

9. HOSxP - information system of hospital, including Electronic medical documentation (EHR), in use in more than 70 hospitals in Thailand.

10. Mirth (software) is the public cross-platform engine of the HL7 interface which allows bidirectional sending messages of HL7 between systems and statements on repeated transport channels.

11. openEHR - the open standard specification in medical informatics which describes management and storage, search and an exchange of medical data in electronic medical documentation (EHRs) after a two-level paradigm of modeling.

12. OpenEMR the open source based on PHP, system of electronic medical documentation (EMR).

13. OpenMRS - developed by community, the open license, structure of EMR for hospital. The expanded and scalable EMR based on Java.

14. OSCAR McMaster, public software of electronic medical documentation (EMR). The component of billing of the software is specialized for needs of the Canadian health workers.

15. THIRRA (EHR) is the network application of EHR developed first of all for narrow-band access of a network. SPO was let out according to the Public License Mozilla and includes feature of biosupervision of infectious diseases. THIRRA uses PHP5, CodeIgniter and PostgreSQL.

16. VistA - Administrations of veterans united the electronic system of medical documentation available to non-governmental use as OSEHRA VistA or OpenVista or WorldVistA.

17. ZEPRS application of ZEPRS - electronic scalable system of electronic turn which allows health workers to look through turn and records to the doctor, using the web browser.

18. SmartCare, the C# windows based application of EHR, with working installations in Zambia, Ethiopia and South Africa. SPO is developed with the state with the low budget on development of IS of health care, narrow-band connection in developing countries, using SmartCards to store information of turns and records. Its main group of developers is based in Zambia where the government accepted it as the national EHR [40].

Administrative software of medical practice:

1.ClearHealth covers five largest areas of operations on practice including planning, billing, EMR, safety of HIPAA and receivables.

2.FreeMED - management of practice both electronic, and the computer makes entry of system. It allows tracing of medical data, in detail, with preservation not only the diagnosis, but also the reasons of medical collisions. FreeMED extends according to the license GNU LGPL. FreeMED - a failure-safe control system of practice of FOSS HIPAA which addresses with billing.

3.GNU Health - the free, centralized, well scalable Free Software and information system of hospital.

4.MedinTux MedinTux - the French control system of medical practice with the web interface, and also desktop which had to operate office of emergency aid of hospital originally. Being very modular, SPO was added to operate also many various smaller methods. SPO works on GNU/LINUX, Mac OS X, Microsoft Windows.

5.Open Dental - management of stomatologic practice of OpenEMR free management of medical practice, electronic medical documentation, letters of the instruction and medical application of billing.

Management of health system:

1. DHIS-administrative information system of the Open source of DHIS and storage of data (license: license BSD).

2. HRHIS-system of medical information for management of human resources for the health developed by university of Dar es Salaam, Faculty of informatics for Ministry of Health and Social security (Tanzania) and the financed Japan International Cooperation Agency (JICA) (the license: GPLv3).

Display/visualization of medical data:

1. Drishti - a volume package of visualization for viewing of computer data on a tomography. Capable to import image DICOM stacks.

2. Endrov-viewing of data and editor.

3. ITK - Segmentation and a registration tool kit.

4. InVesalius-3D medical software of reconstruction of display.

5. ITK-SNAP Interactive-the software for 3D navigation of the image, the summary and automatic segmentation.

6. Ginkgo CADx - the Cross-platform public viewer of DICOM and dicomizer.

7. MITK - A medical Tool kit of Interaction of Display for interactive medical processing of the image.

8. Orthanc - the facilitated DICOM version.

9. OsiriX - the 3D medical DICOM editor for Mac OS X. The additional DICOM module with support of the DICOM network.

10. ParaView-large-scale instrument of visualization.

11. 3Dslicer-a platform for medical visualization of the image and development of algorithm. Support of DICOM, segmentation and registration, Distribution processing of MRI and support of images of surgery.

12. Voreen rendering of volume - library visually to investigate volume data sets. DICOM is supported, and Voreen is used in medical visualization, and also for visualization of electronic data on microscopy.

13. The tool kit of visualization of VTK, is widely used in parallel calculations.

14. Xebra (medical software of display).

15. GIMIAS, focused on technological process on environment, it is developed for biomedical calculation and visualization of the image and modeling of process.

Medical information systems [36,40].

Caisis - network information system for storage, and the analysis of data of the cancer patient intended to eliminate a gap between clinic and research (the license: GPL).

Research in medicine.

The LabKey server - the expanded platform for integration, the analysis and division of all types of biomedical these researches. It provides safe, network access to data of researches and turns on the adjusted data processing pipeline.

Mobile devices.

Ushahidi Allows people to provide information on crisis by means of an exchange of text messages, using the mobile phone, e-mail or a web form. Information on analyses of data of the patient in submission of the map of the patient.

The distributed Free Software packages in medicine: Biot-Linux, Debian-med, Ubuntu-med.

Compatibility testing

1. The office of the National Coordinator together with MITRE developed public SPO under the name Cypress for medical information technologies (ONC) to check the software of EHR for compliance to values of the standard of a stage of 2 uses of clinical qualitative measures.

2. The commission on Certification developed the public program under the name Laika for Technology of Medical information (CCHIT) and MITRE to check the software of EHR for compliance to standards of data on compatibility of CCHIT, including messages of HL7 v2 of Laboratory and HITSP C32 XML.

In chapter 2 stages of modeling of the situational room of health care are described.

Chapter 1 Conclusions

Basic issues related to situational rooms in healthcare are next:

1. Preliminary control and subsequent continuous maintenance.
2. Integration with the used healthcare systems and different big data types databases.
3. Lack of automatic updating on time, i.e. isn't present the count change of patients data in databases, social and economic conditions influencing people behavior, limiting by small data intervals (for ex. in EISZ one query gives not more than 10 rows on each page and duplicates last 2 rows, not efficient database mining.
4. Quality of medical data: different data types (MRT, CT, blood analysis etc., data written to note book by medical nurse by hand - risk of Human interaction due to medical process).
5. Image processing and convert to uniform data type (PACS system problem).
6. Put correct diagnosis based on patient's big data analysis (25 year disease history stores).
7. Complex group expert estimation for healthcare (there are lack of BIG data inside disease symptoms and syndroms).
8. Related to this issues listed above it's necessary to design situational room models in real-time and according time changes on most "fresh" data samplings periodical check system's quality work.

In the Republic of Kazakhstan the existing information health systems have a number of shortcomings, in particular:

1. Restrictions for selection of data.
2. Absence of the qualitative structured uniform medical data.
3. Absence of specialized registers of patients on separate categories, in particular it is still not approved and the register of cardio parients and sick BSK isn't created.
4. Duplication of information both on paper, and on electronic media, in databases.
5. Low coefficient of informatization of health care (according to 2014 on average 1 personal computer with outdated characteristics and passed depreciation, i.e. technologically outdated fell on 8 people of the medical personnel on categories), also on introduction of information systems of EISZ and ENSZ trainings were provided only for the management of medical establishments, without training of the younger medical personnel.
6. Low extent of introduction of tools of mobile medicine (integration of databases between stations of ambulance, policlinics and hospitals, a binding to GIS to systems for viewing of a hospital - quantity of beds, the necessary experts, the corresponding equipment, etc.), on average in Kazakhstan ambulance comes within 1-2 hours that doesn't conform to the standards of the Republic of Kazakhstan approved by the Prime minister of RK in 2011. On average each emergency doctor spends 25-30 minutes asking the patient on a state and the clinical record on papers which are often lost at elderly patients or are utilized by patients by mistake.

7. Mistakes at statement of the diagnosis depend not only on qualification of the medical personnel at all levels, but also on quality and completeness of the provided information, and also on the clinical record of the patient, predisposition of hereditary development of the diagnosis, a way of life and ecology of that region in which the patient is. In particular, oncological biomarkers in Kazakhstan not always precisely show this or that diagnosis and doctors carry out operational intervention in the patient's organism that not always leads to an ultimate goal - correct statement of the diagnosis.

In Healthcare organizations in Kazakhstan there are next issues related to Big data mining:

1. For ex. Clinic #19 Almaty has more than 100.000 people assigned to it with different diseases and analysis for period. Clinic #4 has near 46400 people assigned to it. Inside EISZ and ENSZ systems there are different subsystems that has a datatype conflict and limited by rows due to request.

2. Data security- several protocols used at present time are not stable and reliable.

3. According MHSD in 2014 there were 1 computer (with old or not profit characteristics) for 8 medical personal staff.

Considering this situation, empirical studying of such situations and indistinct models in health care is an actual task.

2 SITUATIONAL ROOM MODELING

In this chapter the mathematical problem definition, boundary conditions, modeling algorithms of the situational room on the basis of formal methods of fuzzy logic is considered by the author.

Situation - an original one-shot of emergence of a set of events, confluences of all vital circumstances and provisions opening to perception and activity of the person. Types of situations and situational systems are presented in figures 2.1 - 2.2.

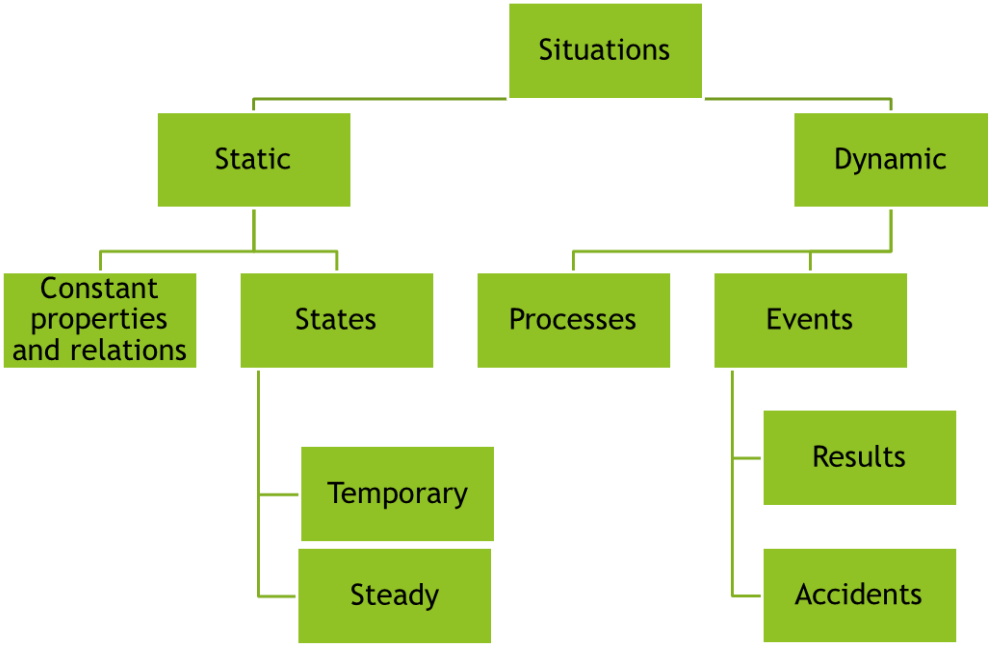

Figure 2.1 - Situations diagram

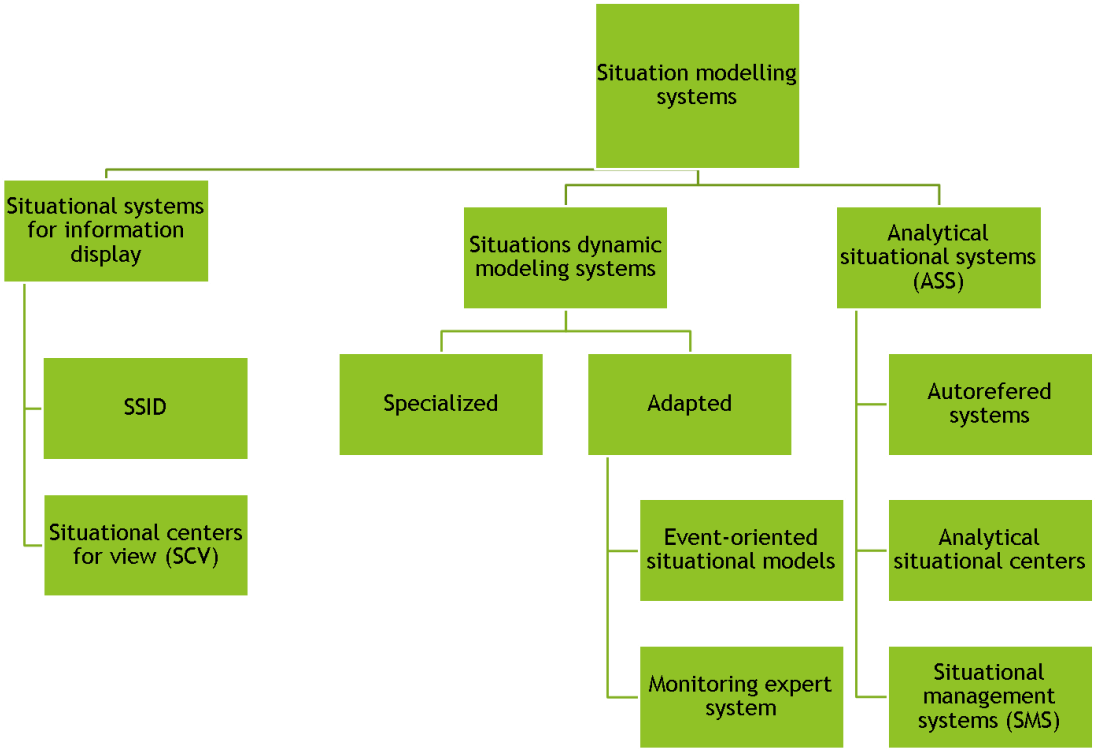

Figure 2.2 - Situational modeling system types

Situational systems are classified by next:

- system of situational display of information (SSDI);
- system of dynamic modeling of situations (SDMS);
- analytical situational systems (ASS);
- the situational centers of supervision (display - SCsO);
- SSOI with remote access (distributed - RSSOI);
- system of situational management (SSM);
- the autoreviewing systems, the analytical situational centers (ASC);
- THIS - situational models.

Classification of situational systems:

System of Situational Display of Information (SSDI).

The situational centers of this class are subdivided into the Situational Centers of Display (SCD) and the distributed SSOI. The majority of SSOI represent SCsO and are applied quite widely: from control of the equipment of cellular communication before supervision over a space situation. The distributed SSOI situational centers provide remote access to various stages of performance of process, for example production of printed materials.

The main objective of the situational centers of display - display of the situations arising in subject domain on the basis of which the operational structure makes the operating decisions within certain tasks. SCsO are based on a basis of the powerful computing environment and having in most cases stationary character.

System of Dynamic Modelling of Situations (SDMS).

Specially developed SDMS practically don't exist now therefore instead of them use (sometimes adapting) other classes of systems. In this regard SDMS can divide into two categories: specialized and adapted. For dynamic modeling (imitation) of situations it is possible to use two approaches: the first - a task of basic data and the subsequent analysis of the arising situations in SSOI or ASS; the second - representation of situations, their interrelations and sequence of emergence by means of systems of imitating (dynamic) modeling.

Analytical Situational Systems (ASS).

Carry the systems of situational management some to ASS the autoreviewing systems, the analytical situational centers and expert systems of real time. Systems of situational management realize the principle of situational management which assumes that the quantity of conditions of system is great, the number of possible decisions and situations is limited, and the decision is made depending on a situation. In other words, it is necessary to define a situation on the basis of basic data and to make the relevant decision [81].

2.1 Mathematical task

Before passing to creation of model of situational management, we will formulate the main objective which needs to be solved in the course of creation of model of management.

If the set of decisions {P (t)} has l power, the problem of management will be solved if it is possible to find such splitting a set of situations { S (t) } into l of classes at which all situations of S(t) will be carried to any certain class Ki to which unambiguously there corresponds some solution of Pi. And this splitting possesses that property that for the situations carried to the class Ki, the solution of Pi, really it is useful from the point of view of the purposes of management.

However in some concrete situation of S(t) it can appear that it is impossible to specify the only solution of Pi, the most useful in this situation. Such decisions can be some, and different specialists in management of this object will prefer different of these decisions. This reason (in practice almost always the taking place) leads us to a problem definition not of splitting situations {S (t)} into classes (at which each concrete situation belongs in accuracy to one class), and to a problem definition about finding of a covering of a set of situations {S (t)} set of the classes Ki. In this case such situation at which some situations of S(t) at the same time belong to several classes Ki is allowed. It is required only that any concrete situation of S(t) belonged at least to one class Ki.

The essence of situational management also consists in creation of the method allowing on the basis of the description of situations of S(t) in a natural language to build system of the generalized descriptions of the classes Ki. We will call situations of S(t) and the description of these situations respectively microsituations and microdescriptions, and the classes Ki and their descriptions - macrosituations and macrodescriptions.

Microdescriptions. We will allocate a number of the elements which are carrying out in it a certain functional role in a natural language. Thus we will understand the separate words, phrases and syntagmas (finished in the semantic relation of the phrase) as elements of language. We will allocate first of all group of concepts:

1. We will designate concepts as ai, and a set of the used concepts - as A. We will distinguish two types from concepts: concepts classes and abstract concepts. The first type of concepts is connected with reflection in language of data on uniform physical objects of the outside extra language world. These data come to system in the form of some complexes of signs.

We will explain it on a simple example. The concept - the class "diagnosis" includes all types of diseases which we are inclined to call this word. In the world surrounding us there is no diagnosis, however, there are specific representatives of this concept class. Each of them is perceived by our sense organs in the form of some set of values signs. Body temperature, pressure, heart rate, etc. can be among these signs. In language under some laws to the concrete physically existing diagnoses the word "diagnosis" which is concept class is compared to all these. For example, words and phrases, characteristic signs, electronic systems of data processing can be other examples of concepts classes.

Unlike concepts classes, abstract concepts have no direct analogs in that world which surrounds us. These concept arise in language system by means of special "mechanisms". The concepts put such into words and phrases as the purpose, red, a straight line point, etc. can be examples of such concepts. The number of various

concepts of any natural language is potentially infinite. Always it is possible to enter into it one more concept class or abstract concept.

2. The second important functional group in any natural language are names and identifiers. By means of names in language system allocation (personification) of separate concepts from concepts classes is made, in particular. The following words, phrases and syntagmas can be examples of names: Ivanov, the house No. 12 down the street Vavilova, the house which was built by Jack. We will designate a set of names through I, and separate names through ij. The set of names, as well as a set of concepts, is potentially infinite [82].

3. The third functional group is the group of the relations of R. The elements entering into group of the relations (designated by ri) describe the binary relations which are established between couple of concepts or concept and a name. Can be examples of the relations: the part - whole, the reason consequence, object action, object place to be at the same time, to be crossed, serve for, etc.

It is very important to emphasize that any of the relations can be expressed in language by means of many words, phrases, syntagmas or grammatical means. For example, in syntagmas: the ambulance car approaches the intersection, SMP comes nearer to the intersection, ambulance rushes to the intersection, between the concepts classes "ambulance car" and "intersection" the same relation which can be expressed, for example, by the words "move to the patient" is established.

4. The last group of elements of language (for bases of situational management) is a group of imperatives. Carry all words, phrases and syntagmas indicating action which needs to be carried out to imperatives. Expressions can be examples of imperatives: to turn on the device MRT to replace the treatment mode No. 3, etc. We will designate a set of imperatives through P, and elements of this set - through pj. Instead of the term "imperative" we will use the term "elementary decision". Number of various elementary decisions, the otrazimykh in language, potentially infinitely.

We will consider now some hypothetical control system which is required to be designed in the conditions of lack of model of object of management. Some information forming the description of the current situation comes to each present situation of time for an entrance of a control system. Without dividing various types of entrance impacts on a control system, we will designate them a set Q = <q1, q2..., qm>. We will assume that some basic lists of concepts classes, names, relations and elementary decisions which can be accepted according to technology of object in management process are a priori set. Then at the first stage of the information processing containing in a set Q there is a transition from this set to the microdescription of a situation in the form of the certain structure reflecting the relations which are available at this present situation of time between the concepts entering the described situation.

Generalizing "mechanisms". In situational management three types of similar mechanisms are used: removal of names, generalization on signs and generalization on structures. Procedure of removal of names is most simply carried out. Names are simply excluded from the description of a situation and expressions of a look (ani) are replaced with a. Such transition allows to receive the generalized descriptions suitable

for all objects getting to one concept class instead of the concrete statements relating to the personified objects.

Generalization on signs serves for formation of concepts classes and abstract concepts. Mechanisms of this kind are well-known in recognition of images where they are the main. Their essence consists in creation of such f1 function from signs <l1, l2..., ln> which would estimate degree of accessory of this physical concept (a complex of feelings or, more precisely, a set of values of signs) to a certain concept class.

For concepts - the classes used in usual language it is very often impossible to construct function of belonging to concept class which would accept only two values: belongs and doesn't belong. Such concepts classes and abstract concepts as "the reasonable decision", "close result", "a stream of leukocytes" have no accurately outlined borders. Different people differently form reference of objects to these sets [83].

2.2 Formal methods

In computer science, specifically software engineering and hardware engineering, formal methods are a particular kind of mathematically based techniques for the specification, development and verification of software and hardware systems.[85] The use of formal methods for software and hardware design is motivated by the expectation that, as in other engineering disciplines, performing appropriate mathematical analysis can contribute to the reliability and robustness of a design.[86] Formal methods are best described as the application of a fairly broad variety of theoretical computer science fundamentals, in particular logic calculi, formal languages, automata theory, and program semantics, but also type systems and algebraic data types to problems in software and hardware specification and verification.

Formal methods can be used at a number of levels:

Level 0: Formal specification may be undertaken and then a program developed from this informally. This has been dubbed formal methods lite. This may be the most cost-effective option in many cases.

Level 1: Formal development and formal verification may be used to produce a program in a more formal manner. For example, proofs of properties or refinement from the specification to a program may be undertaken. This may be most appropriate in high-integrity systems involving safety or security.

Level 2: Theorem provers may be used to undertake fully formal machine-checked proofs. This can be very expensive and is only practically worthwhile if the cost of mistakes is extremely high (e.g., in critical parts of microprocessor design).

As with programming language semantics, styles of formal methods may be roughly classified as follows:

Denotational semantics, in which the meaning of a system is expressed in the mathematical theory of domains. Proponents of such methods rely on the well-

understood nature of domains to give meaning to the system; critics point out that not every system may be intuitively or naturally viewed as a function.

Operational semantics, in which the meaning of a system is expressed as a sequence of actions of a (presumably) simpler computational model. Proponents of such methods point to the simplicity of their models as a means to expressive clarity; critics counter that the problem of semantics has just been delayed (who defines the semantics of the simpler model?).

Axiomatic semantics, in which the meaning of the system is expressed in terms of preconditions and postconditions which are true before and after the system performs a task, respectively. Proponents note the connection to classical logic; critics note that such semantics never really describe what a system does (merely what is true before and afterwards).

Some practitioners believe that the formal methods community has overemphasized full formalization of a specification or design.[85-86] They contend that the expressiveness of the languages involved, as well as the complexity of the systems being modelled, make full formalization a difficult and expensive task. As an alternative, various lightweight formal methods, which emphasize partial specification and focused application, have been proposed. Examples of this lightweight approach to formal methods include the Alloy object modelling notation,[85] Denney's synthesis of some aspects of the Z notation with use case driven development,[87] and the CSK VDM Tools

Formal methods can be applied at various points through the development process.

Once a formal specification has been produced, the specification may be used as a guide while the concrete system is developed during the design process (i.e., realized typically in software, but also potentially in hardware). For example:

If the formal specification is in an operational semantics, the observed behavior of the concrete system can be compared with the behavior of the specification (which itself should be executable or simulateable). Additionally, the operational commands of the specification may be amenable to direct translation into executable code.

If the formal specification is in an axiomatic semantics, the preconditions and postconditions of the specification may become assertions in the executable code.

Specification languages:

1. Abstract State Machines (ASMs)
2. A Computational Logic for Applicative Common Lisp (ACL2)
3. ANSI/ISO C Specification Language (ACSL)
4. Alloy
5. Autonomic System Specification Language (ASSL)
6. B-Method
7. CADP
8. Common Algebraic Specification Language (CASL)
9. Java Modeling Language (JML)
10. Fuzzy logic
11. Knowledge Based Software Assistant (KBSA)

12. Process calculi
13. CSP
14. LOTOS
15. π-calculus
16. Actor model
17. Esterel
18. Lustre
19. mCRL2
20. Perfect Developer
21. Petri nets
22. Predicative programming
23. RAISE
24. SPARK Ada
25. Spec sharp (Spec#)
26. Specification and Description Language
27. TLA+
28. USL
29. VDM
30. VDM-SL
31. VDM++
32. Z notation
33. Rebeca Modeling Language

Model checkers:

1. SPIN
2. PAT is a powerful free model checker, simulator and refinement checker for concurrent systems and CSP extensions (e.g. shared variables, arrays, fairness).
3. MALPAS Software Static Analysis Toolset is an industrial strength model checker used for Formal Proof of safety critical systems
4. UPPAAL

Benefits Of Formal Models

Formal methods offer additional benefits outside of provability, and these benefits do deserve some mention. However, most of these benefits are available from other systems, and usually without the steep learning curve that formal methods require.

Discipline: By virtue of their rigor, formal systems require an engineer to think out his design in a more thorough fashion. In particular, a formal proof of correctness is going to require a rigorous specification of goals, not just operation. This thorough approach can help identify faulty reasoning far earlier than in traditional design.[Bowen95]

The discipline involved in formal specification has proved useful even on already existing systems. Engineers using the PVS system, for example, reported identifying several microcode errors in one of their microprocessor designs.[Miller95]

Precision: Traditionally, disciplines have moved into jargons and formal notation as the weaknesses of natural language descriptions become more glaringly obvious. There is no reason that systems engineering should differr, and there are several formal methods which are used almost exclusively for notation.[84-85]

For engineers designing safety-critical systems, the benefits of formal methods lie in their clarity. Unlike many other design approaches, the formal verification requires very clearly defined goals and approaches. In a safety critical system, ambiguity can be extremely dangerous, and one of the primary benefits of the formal approach is the elimination of ambiguity.[86-87].

2.3 Fuzzy logic

Fuzzy logic is a relatively new chapter of formal logic whose aim is to formalize the reasonings involving predicates that are vague in nature (as an example small, near, similar). An example of such kind of reasoning is “If a tomato is red, then the tomato is ripe. Since this tomato is very red, this tomato is very ripe”.

Fuzzy logic is a form of many-valued logic that deals with approximate, rather than fixed and exact reasoning. In comparison with traditional binary logic (where variables may take on true or false values), fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false.[88] Furthermore, when linguistic variables are used, these degrees may be managed by specific functions.

The term "fuzzy logic" was introduced with the 1965 proposal of fuzzy set theory by Lotfi A. Zadeh.[88] Fuzzy logic has been applied to many fields, from control theory to artificial intelligence. Fuzzy logic had, however, been studied since the 1920s, as infinite-valued logic-notably by Łukasiewicz and Tarski.[88-89].

In mathematical logic, there are several formal systems of "fuzzy logic"; most of them belong among so-called t-norm fuzzy logic.

The most important propositional fuzzy logics are:

1. Monoidal t-norm-based propositional fuzzy logic MTL is an axiomatization of logic where conjunction is defined by a left continuous t-norm and implication is defined as the residuum of the t-norm. Its models correspond to MTL-algebras that are pre-linear commutative bounded integral residuated lattices.
2. Basic propositional fuzzy logic BL is an extension of MTL logic where conjunction is defined by a continuous t-norm, and implication is also defined as the residuum of the t-norm. Its models correspond to BL-algebras.
3. Łukasiewicz fuzzy logic is the extension of basic fuzzy logic BL where standard conjunction is the Łukasiewicz t-norm. It has the axioms of basic fuzzy logic plus an axiom of double negation, and its models correspond to MV-algebras.
4. Gödel fuzzy logic is the extension of basic fuzzy logic BL where conjunction is Gödel t-norm. It has the axioms of BL plus an axiom of idempotence of conjunction, and its models are called G-algebras.

5. Product fuzzy logic is the extension of basic fuzzy logic BL where conjunction is product t-norm. It has the axioms of BL plus another axiom for cancellativity of conjunction, and its models are called product algebras.

6. Fuzzy logic with evaluated syntax (sometimes also called Pavelka's logic), denoted by EVŁ, is a further generalization of mathematical fuzzy logic. While the above kinds of fuzzy logic have traditional syntax and many-valued semantics, in EVŁ is evaluated also syntax. This means that each formula has an evaluation. Axiomatization of EVŁ stems from Łukasziewicz fuzzy logic. A generalization of classical Gödel completeness theorem is provable in EVŁ.

The CFL (Compensatory Fuzzy Logic) is a branch of Fuzzy Logic. This is a new multivalent system that breaks with traditional axioms of such systems to achieve better semantic behaviour to classical systems.In processes involving decision making, trade with the experts leads to obtaining complex and subtle formulations and requires compound predicates. The truth values obtained on these compound predicates must possess sensitivity to changes in the truth values of basic predicates. This need is met by the use of the CFL, waiving compliance of the classical properties of conjunction and disjunction and rather opposing to them the idea that the increase or decrease of the truth value of the conjunction or disjunction caused by change the truth value of one of its components can be compensated with a corresponding decrease or increase in the other. This increase or decrease in truth may be offset by the increase or decrease in another component. This notion makes the CFL logical and useful. There are cases in which compensation is not possible. This occurs when certain thresholds are violated and there is a veto preventing compensation. Compensatory Fuzzy Logic consists of four continuous operators: conjunction (c); disjunction (d); fuzzy strict order (or); and negation (n). The conjunction is the geometric mean and its dual as conjunctive and disjunctive operators.

Fuzzy logic and probability address different forms of uncertainty. While both fuzzy logic and probability theory can represent degrees of certain kinds of subjective belief, fuzzy set theory uses the concept of fuzzy set membership, i.e., how much a variable is in a set (there is not necessarily any uncertainty about this degree), and probability theory uses the concept of subjective probability, i.e., how probable is it that a variable is in a set (it either entirely is or entirely is not in the set in reality, but there is uncertainty around whether it is or is not). The technical consequence of this distinction is that fuzzy set theory relaxes the axioms of classical probability, which are themselves derived from adding uncertainty, but not degree, to the crisp true/false distinctions of classical Aristotelian logic.

Bruno de Finetti argues [90] that only one kind of mathematical uncertainty, probability, is needed, and thus fuzzy logic is unnecessary. However, Bart Kosko [106-140] shows in Fuzziness vs. Probability that probability theory is a subtheory of fuzzy logic, as questions of degrees of belief in mutually-exclusive set membership in probability theory can be represented as certain cases of non-mutually-exclusive graded membership in fuzzy theory. In that context, he also derives Bayes' theorem from the concept of fuzzy subsethood. Lotfi A. Zadeh argues that fuzzy logic is

different in character from probability, and is not a replacement for it. He fuzzified probability to fuzzy probability and also generalized it to possibility theory [87-89].

More generally, fuzzy logic is one of many different extensions to classical logic intended to deal with issues of uncertainty outside of the scope of classical logic, the inapplicability of probability theory in many domains, and the paradoxes of Dempster-Shafer theory

Leslie Valiant, winner of the Turing Award, used the term "ecorithms" to describe how many less exact systems and techniques like fuzzy logic (and "less robust" logic) can be applied to learning algorithms. Valiant essentially redefines machine learning as evolutionary. Ecorithms and fuzzy logic also have the common property of dealing with possibilities more than probabilities, although feedback and feed forward, basically stochastic "weights," are a feature of both when dealing with, for example, dynamical systems. In general use, ecorithms are algorithms that learn from their more complex environments (Hence Eco) to generalize, approximate and simplify solution logic. Like fuzzy logic, they are methods used to overcome continuous variables or systems too complex to completely enumerate or understand discretely or exactly [91].

There are many misconceptions about fuzzy logic. To begin with, fuzzy logic is not fuzzy. In large measure, fuzzy logic is precise. Another source of confusion is the duality of meaning of fuzzy logic. In a narrow sense, fuzzy logic is a logical system. But in much broader sense which is in dominant use today, fuzzy logic, or FL for short, is much more than a logical system. More specifically, fuzzy logic has many facets, see figure 2.3.

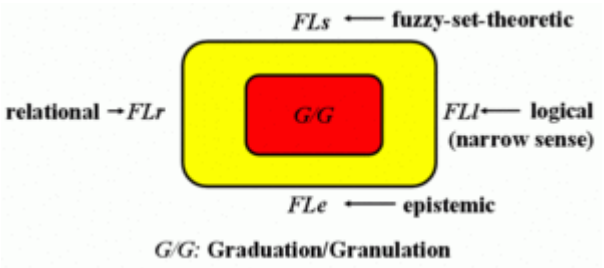

Figure 2.3 - Fuzzy logic facets

There are four principal facets:

1. The fuzzy-set-theoretic facet, FLs;
2. The logical facet, FLl;
3. The epistemic facet, FLe; and
4. The relational facet, FLr.

The basic concepts of graduation and granulation form the core of FL and are the principal distinguishing features of fuzzy logic. More specifically, in fuzzy logic everything is or is allowed to be graduated, that is, be a matter of degree or, equivalently, fuzzy. Furthermore, in fuzzy logic everything is or is allowed to be granulated, with a granule being a clump of attribute-values drawn together by indistinguishability, similarity, proximity or functionality. For example, Age is granulated when its values are described as young, middle-aged and old, see figure 2.4. A linguistic variable may be viewed as a granulated variable whose granular values are

linguistic labels of granules. In a qualitative way, graduation and granulation play pivotal roles in human cognition.

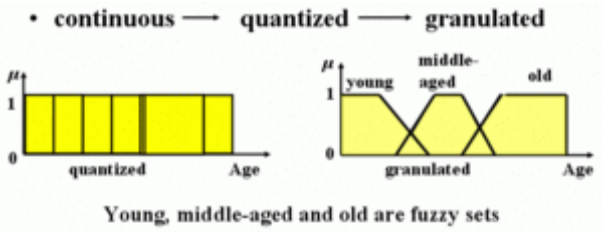

Figure 2.4 - Granulation of age.

The distinguishing features of the four principal facets are the following.

FLs

The fuzzy-set-theoretic facet, FLs, is focused on fuzzy sets, that is, on classes whose boundaries are unsharp, e.g., the class of beautiful women, the class of honest men and the class of tall mountains. The concept of a fuzzy set was introduced in (Zadeh 1965). The theory of fuzzy sets is central to fuzzy logic (Pedrycz and Gomide 1998).

In more detail, fuzzy sets are graduated in the sense that membership in a fuzzy set is a matter of degree. A fuzzy set, A, in a universe of discourse, U, is defined by a membership function which associates with each object, u, in U, the degree to which u is a member of A. A fuzzy set is basic if its membership function takes values in the unit interval. More generally, the membership function may take values in a partially ordered set. There are many types of fuzzy sets, among them fuzzy sets of Type 2 (Zadeh 1975; Mendel 2000), L-Fuzzy sets (Goguen 1967), bipolar fuzzy sets (Zhang 1998; Benferhat, Dubois, Kaci and Prade 2005) and intuitionistic fuzzy sets (Atanassov 1986). In a general setting, intersection and union of fuzzy sets are defined in terms of t-norms and t-conorms (Klement, Mesiar and Pap 2000).

FLl

The logical facet of FL, FLl, is fuzzy logic in its narrow sense. FLl may be viewed as a generalization of multivalued logic. The agenda of FLl is similar in spirit to the agenda of classical logic (Hajek 1998; Novak, Perfilieva and Mockor 1999). Truth values in FLl are allowed to be fuzzy sets.

FLe

The epistemic facet of FL, FLe, is concerned with knowledge representation, semantics of natural languages and information analysis. In FLe, a natural language is viewed as a system for describing perceptions. An important branch of FLe is possibility theory (Zadeh 1978; Dubois and Prade 1988). Another important branch of FLe is the computational theory of perceptions (Zadeh 1999, 2000).

FLr

The relational facet, FLr, is focused on fuzzy relations and, more generally, on fuzzy dependencies. In FLr, a granulated function, $f*$, is described as a collection of fuzzy if-then rules of the form: if X is Athen Y is B , where A and B are fuzzy sets carrying linguistic labels like small, medium, and large (Figure 2.3). In this sense, X and Y are linguistic variables (Zadeh 1973). The concept of a linguistic

variable and the associated calculi of fuzzy if-then rules (Zadeh 1973, 1974; Mamdani and Assilian 1975; Bardossy and Duckstein 1995) play pivotal roles in almost all applications of fuzzy logic. A granulated function, f∗ , may be viewed as a summary of f , with f∗ being a granular value of f . An important special case of a granular function is a granular probability density function (Figure 4). In this perspective, perception of a probability distribution may be described as a granular probability distribution.

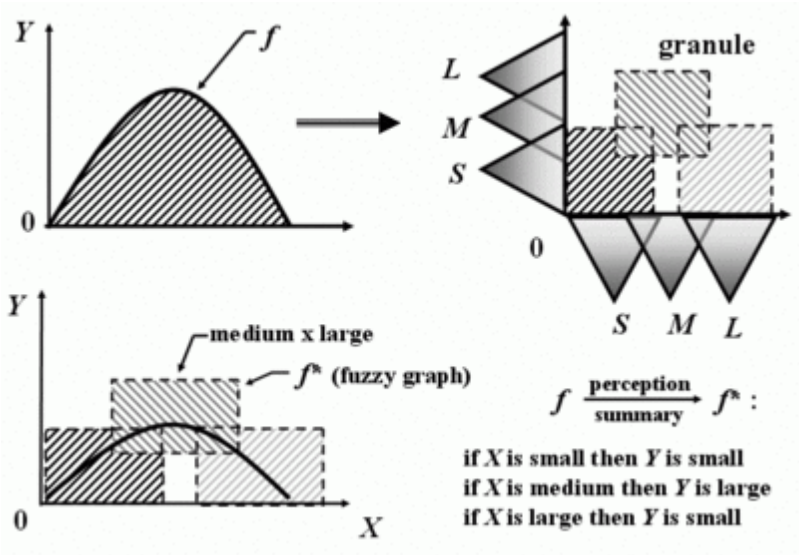

Figure 2.5 - Granulation of a function. S (small), M (medium) and L (large) are fuzzy sets. f∗ may be viewed as a summary of f

Generalized constraint

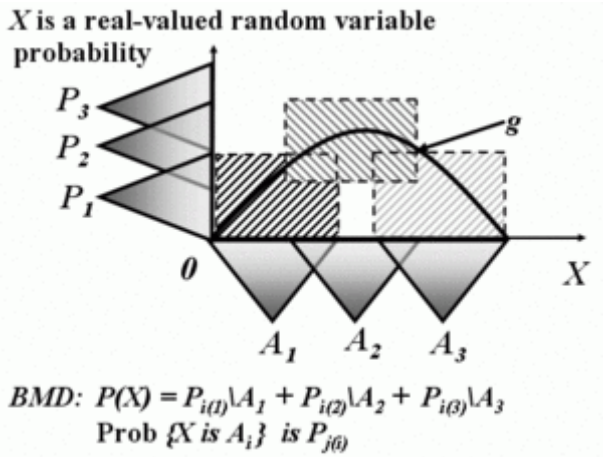

Figure 2.6 - Granulation of a probability distribution

The centerpiece of fuzzy logic is the concept of a generalized constraint (Zadeh 1986, 2006). Constraints are ubiquitous. In scientific theories, representation of constraints is generally oversimplified. Over simplification of constraints is a necessity because existing constraint definition languages have a very limited expressive power. The concept of a generalized constraint is intended to provide a basis for construction

of a maximally expressive constraint definition language--a language which can also serve as a meaning representation/precisiation language for natural languages.

Formally, a generalized constraint is expressed as GC(X) X isr R , where X is the constrained variable, R is the constraining relation, and r is an indexical variable which serves to identify the modality of the constraint. The principal modalities are:

- possibilistic (r=blank);
- veristic (r=v);
- probabilistic (r=p);
- usuality (r=u);
- random set (r=rs);
- fuzzy graph (r=fg);
- granular (r=gr); and
- group (r=g).

The primary constraints are possibilistic, veristic and probabilistic. The standard constraints are bivalent possibilistic, bivalent veristic and probabilistic. Standard constraints have a position of centrality in existing scientific theories. A generalized constraint, GC(X), is open if X is a free variable, and is closed if X is instantiated. A proposition is a closed generalized constraint. For example, "Lily is young," is a closed possibilistic constraint in which X=Age(Lily); r=blank; and R=young is a fuzzy set. Unless indicated to the contrary, a generalized constraint is assumed to be closed. A generalized constraint may be generated by combining, projecting, qualifying, propagating and counterpropagating other generalized constraints. The set of all generalized constraints together with the rules governing combination, projection, qualification, propagation and counterpropagation, constitutes the Generalized Constraint Language (GCL).

There is an important relationship between the concept of a generalized constraint and information. More specifically, a key idea in fuzzy logic is that of representing the information about a variable X , I(X) , as a generalized constraint on X , GC(X).The symbolic equation I(X)=GC(X) is the fundamental thesis of fuzzy logic.

Propositions

A proposition is a carrier of information. A consequence of the fundamental thesis is that the meaning of a proposition, p , is expressible as a generalized constraint. This is the meaning postulate of fuzzy logic. More specifically, the meaning of a proposition is expressible as a closed generalized constraint, while the meaning of a predicate is expressible as an open generalized constraint. Equivalently, if p is a proposition or a predicate then the meaning postulate may be stated as an assertion that the meaning of p may be represented/precisiated through translation of p into GCL. A very simple example of annotated translation is

Lily is young X/Age(Lily) is R/young,

implying that the constrained variable X is Age(Lily), the constraining relation, R , is young, and the constraint is possibilistic (r=blank). Equivalently, the meaning postulate implies that the meaning of a proposition or a predicate is defined by identifying the constrained variable, X , the constraining relation, R , and the modality of the constraint, r .

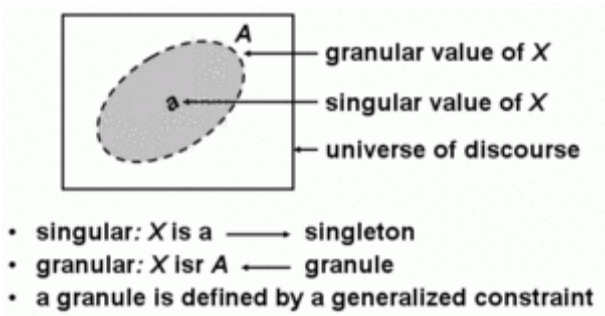

Figure 2.7 - Singular and granular values

There is a close connection between the concept of a generalized constraint and the concept of a granular value. More specifically, if X is a variable taking values in a universe of discourse, U , then a is a singular value of X if a is a singleton, implying that there is no uncertainty or imprecision about the value of X . If this is not the case, then a granular value of X , A , may be viewed as a representation of the state of knowledge about the value of X (Figure 5). For example, if X is unemployment, then is a singular value of X , and "high" is a granular value of X .

The concept of a generalized constraint on X serves to define the meaning of a granular value. Symbolically, A=GC(X). In the unemployment example, "high" is the label of a generalized constraint on unemployment - more specifically, a possibilistic constraint. In granular computing, the objects of computation are granular values which are defined as generalized constraints. Granular computing is rooted in (Zadeh 1979, 1986, 1997, 1998, 1999). The term Granular Computing was suggested by T.Y. Lin (Lin 1997). The text "Granular Computing" by A. Bargiella and W. Pedrycz is the first book on granular computing (Bargiela and Pedrycz, 2002).

Granular computing provides a basis for computing with words, (CW) or, more concretely, NL-Computation, that is, computation with information described in natural language (Zadeh 2006). Since a natural language is a system for describing perceptions, NL-Computation is closely related to computation with perception-based information. As an illustration, if my perception is that most Swedes are tall, then what is the average height of Swedes? Another example: Robert usually leaves office at about 6 pm. Usually it takes him about an hour to get home. What is the probability that Robert is home after about 7 pm? NL-capability is the capability of a theory to operate on information described in natural language or, equivalently, to operate on perception-based information. The importance of NL-capability derives from the fact that much of human knowledge is expressed in natural language.

NL-Computation involves two stages. In the first stage, the information which is described in a natural language is precisiated through translation into the Generalized Constraint Language. The result is granular information expressed as system of generalized constraints. The second stage involves granular computing. Finally, the result of granular computing is retranslated into natural language.

Extension principle

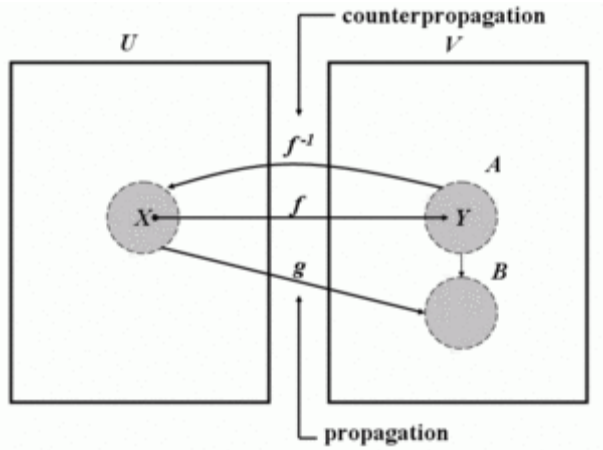

Figure 2.8 - Structure of extension principle

Deduction in fuzzy logic is governed by a collection of rules of deduction which, in the main, are rules that govern propagation and counter-propagation of generalized constraints. The principal rule is the extension principle. Extension principle has many versions. The simplest version (Zadeh 1965) is the following. Let f be a function from reals to reals, Y=f(X) . What we know is that X is A , where A is a fuzzy subset of the real line. Equivalently, what we know about X is its granular value, that is, its possibility distribution, A . What can be said about Y , that is, what is its granular value or, equivalently, its possibility distribution? In a more general form, (Zadeh 1975) X is A is replaced by f(X) is A (Figure 6). It is this form that is used in most practical applications. In a form that is used in fuzzy control, what is granulated is f , resulting in a granular function, f∗ , which is defined by a collection of fuzzy-if-then rules. A simple example is f∗ :

if X is small then Y is small

if X is medium then Y is large

if X is large then Y is small

More generally, the extension principle may be viewed as follows. Let Y=f(X) , where X is a real-valued variable. Assume that we can compute Y for singular values of fand X . Basically, the extension principle serves to extend the definition of Y to granular values of f and X .

The main tool for fuzzy logic is the notion of a fuzzy subset, since a vague predicate is interpreted by a fuzzy subset. Notice that in literature the name "fuzzy logic" also denotes a large series of topics based on an informal usage of the notion of a fuzzy subset, and which are usually devoted to applications.

As a matter of fact, fuzzy logic is an evolution and an enlargement of multi-valued logic since all the definitions and results in the literature on multi-valued logic are also considered in fuzzy logic. In particular, as in multi-valued logic, the starting point is a fixed valuation structure, i.e. a bounded lattice L equipped with suitable operations to interpret the logical connectives. The minimum 0 means '**False'**, the maximum 1 means '**True'**, the remaining elements are interpreted as intermediate truth values.

Definition. A standard algebra is an algebraic structure ([0,1], Θ, →, 0,1) where Θ is a continuous triangular norm, i.e. a continuous, associative, commutative, order preserving operation such that xΘ1 = 1 and → is the related residuation, i.e. x→y = sup{z | xΘz ≤ y}.

The main examples of standard algebras are obtained by assuming that Θ is the minimum (Zadeh logic), the usual product (product logic) or that xΘy = Max{x+y-1,0} (Łukasievicz logic). In addition, several authors consider also languages with logical constants to denote rational truth values. Once a valuation structure is fixed, the semantics of the corresponding propositional calculus is defined in a truth-functional way as usual. In first order fuzzy logic the semantics is defined as follows.

Definition. A fuzzy interpretation of a first order language is a pair (D,I) such that D is a nonempty set and I a map associating (as in the classical case) every n-ar operation name h with an n-ar operation in D and every constant c with an element I(c) in D. Moreover, I associates every n-ar predicate name r with an n-ar L-relation I(r) :D^n > L in D.

Then the only difference with classical logic is that the interpretation of an n-ar predicate symbol is an n-ar fuzzy relation in D. This enables us to represent properties which are "value" in nature. Given a fuzzy interpretation we can evaluate the formulas as follows where, given a term t whose variables are in $x_1,...,x_n$, we denote by I(t) the corresponding n-ar function we define as in classical logic.

Definition. Let (D,I) be a fuzzy interpretation, α a formula whose free variables are in $x_1,...,x_n$ and $d_1,...,d_n$ elements in D. Then we define the truth degree $Val(I,\alpha,d_1,...,d_n)$ by induction as follows :

$Val(I, r(t_1,...,t_p), d_1,...,d_n) = I(r)(I(t_1)(d_1,...,d_n), ..., I(t_p)(d_1,...,d_n))$

Val(I,α $\wedge$ β, $d_1,...,d_n$) = $Val(I,\alpha,d_1,...,d_n)\Theta Val(I,\beta,d_1,...,d_n)$

$Val(I,\alpha \rightarrow \beta, d_1,...,d_n) = Val(I,\alpha, d_1,...,d_n) \rightarrow Val(I,\beta,d_1,...,d_n)$

Val(I,$\forall$ $x_i\alpha$, $d_1,...,d_n$) = $Inf_{d\in D} Val(I,\alpha,d_1,...,d_{i-1},d,d_{i+1},...,d_n)$.

In the case there is a propositional constant c^* corresponding to a truth value c, we set

$Val(I, c^*,d_1,...,d_n) = c$.

Observe that in the case L is not complete it is possible that a quantified formula cannot be evaluated. We call safe an interpretation such that all the formulas are evaluated. As usual, if α is a closed formula, then its valuation does not depend on the elements $d_1,...,d_n$ and we write Val(I,α) instead of $Val(I,\alpha,d_1,...,d_n)$. More in general, given any formula α, we denote by Val(I, α) the valuation of the universal closure of α.

Fuzzy systems were initially implemented in Japan.

Interest in fuzzy systems was sparked by Seiji Yasunobu and Soji Miyamoto of Hitachi, who in 1985 provided simulations that demonstrated the feasibility of fuzzy control systems for the Sendai railway. Their ideas were adopted, and fuzzy systems were used to control accelerating, braking, and stopping when the line opened in 1987.

In 1987, Takeshi Yamakawa demonstrated the use of fuzzy control, through a set of simple dedicated fuzzy logic chips, in an "inverted pendulum" experiment. This is a classic control problem, in which a vehicle tries to keep a pole mounted on its top by a

hinge upright by moving back and forth. Yamakawa subsequently made the demonstration more sophisticated by mounting a wine glass containing water and even a live mouse to the top of the pendulum: the system maintained stability in both cases. Yamakawa eventually went on to organize his own fuzzy-systems research lab to help exploit his patents in the field.

Japanese engineers subsequently developed a wide range of fuzzy systems for both industrial and consumer applications. In 1988 Japan established the Laboratory for International Fuzzy Engineering (LIFE), a cooperative arrangement between 48 companies to pursue fuzzy research. The automotive company Volkswagen was the only foreign corporate member of LIFE, dispatching a researcher for a duration of three years.

Japanese consumer goods often incorporate fuzzy systems. Matsushita vacuum cleaners use microcontrollers running fuzzy algorithms to interrogate dust sensors and adjust suction power accordingly. Hitachi washing machines use fuzzy controllers to load-weight, fabric-mix, and dirt sensors and automatically set the wash cycle for the best use of power, water, and detergent.

Canon developed an autofocusing camera that uses a charge-coupled device (CCD) to measure the clarity of the image in six regions of its field of view and use the information provided to determine if the image is in focus. It also tracks the rate of change of lens movement during focusing, and controls its speed to prevent overshoot. The camera's fuzzy control system uses 12 inputs: 6 to obtain the current clarity data provided by the CCD and 6 to measure the rate of change of lens movement. The output is the position of the lens. The fuzzy control system uses 13 rules and requires 1.1 kilobytes of memory.

An industrial air conditioner designed by Mitsubishi uses 25 heating rules and 25 cooling rules. A temperature sensor provides input, with control outputs fed to an inverter, a compressor valve, and a fan motor. Compared to the previous design, the fuzzy controller heats and cools five times faster, reduces power consumption by 24%, increases temperature stability by a factor of two, and uses fewer sensors.

Other applications investigated or implemented include: character and handwriting recognition; optical fuzzy systems; robots, including one for making Japanese flower arrangements; voice-controlled robot helicopters (hovering is a "balancing act" rather similar to the inverted pendulum problem); control of flow of powders in film manufacture; elevator systems; and so on.

Work on fuzzy systems is also proceeding in the United State and Europe, although on a less extensive scale than in Japan.

The US Environmental Protection Agency has investigated fuzzy control for energy-efficient motors, and NASA has studied fuzzy control for automated space docking: simulations show that a fuzzy control system can greatly reduce fuel consumption.

Firms such as Boeing, General Motors, Allen-Bradley, Chrysler, Eaton, and Whirlpool have worked on fuzzy logic for use in low-power refrigerators, improved automotive transmissions, and energy-efficient electric motors.

In 1995 Maytag introduced an "intelligent" dishwasher based on a fuzzy controller and a "one-stop sensing module" that combines a thermistor, for temperature measurement; a conductivity sensor, to measure detergent level from the ions present in the wash; a turbidity sensor that measures scattered and transmitted light to measure the soiling of the wash; and a magnetostrictive sensor to read spin rate. The system determines the optimum wash cycle for any load to obtain the best results with the least amount of energy, detergent, and water. It even adjusts for dried-on foods by tracking the last time the door was opened, and estimates the number of dishes by the number of times the door was opened.

Research and development is also continuing on fuzzy applications in software, as opposed to firmware, design, including fuzzy expert systems and integration of fuzzy logic with neural-network and so-called adaptive "genetic" software systems, with the ultimate goal of building "self-learning" fuzzy-control systems [141-151].

In addition, the Japanese government joined forces with the big corporations to set up technology transfers. After founding the International Fuzzy Systems Association (IFSA) Japan Chapter in 1985 to support research in the area, several new industry support circles were formed:

Japan Society for Fuzzy Theory and Systems (SOFT)

Biomedical Fuzzy Systems Association (BMFSA)

Laboratory for International Fuzzy Engineering Research (LIFE)

Fuzzy Logic Systems Institute Iizuka (FLSI)

Center for Promotion of Fuzzy Logic at TITech

This resulted in the application of fuzzy logic in just about any area of intelligent control and data processing:

photo and video cameras to put photographer's expertise in their control

world's first car, by Mitsubishi, with all control system based on fuzzy logic; most other Japanese car manufacturers used fuzzy logic in some of their components

more than 350 patents by Omron Corp. in factory automation

many chemical and biological process and control optimization

In the early 1990s, major European companies realized that they had almost lost another key technology to the Japanese. Major efforts were made to produce numerous fuzzy logic based applications. With this, they launched more than 200 successful fuzzy logic enhanced mass market products which include home appliances that realize major savings in energy and water consumption with no added product costs as well as many automative applications. They also introduced an uncounted number of industrial automation and process control applications using fuzzy logic. This included chemical and biological process control, machinery equipment control, and intelligent sensors.

It was only in the 1990s when many US companies, who are in big competition with Europe and Asia, gained interest in fuzzy logic. This has made fuzzy logic come to full circle: US, Europe, Japan, Europe, US.

Nowadays the huge corporations GE, Fujitsu, Samsung, Siemens use fuzzy logic inside their manufacturer included healthcare products.

2.3.1 Fuzzy sets

In mathematics, fuzzy sets are sets whose elements have degrees of membership. Fuzzy sets were introduced by Lotfi A. Zadehand Dieter Klaua in 1965 as an extension of the classical notion of set. At the same time, Salii (1965) defined a more general kind of structures called L-relations, which he studied in an abstract algebraic context. Fuzzy relations, which are used now in different areas, such as linguistics (De Cock, et al., 2000), decision-making (Kuzmin, 1982) and clustering (Bezdek, 1978), are special cases of L-relations when L is the unit interval [0, 1].

In classical set theory, the membership of elements in a set is assessed in binary terms according to a bivalent condition - an element either belongs or does not belong to the set. By contrast, fuzzy set theory permits the gradual assessment of the membership of elements in a set; this is described with the aid of a membership function valued in the real unit interval [0, 1]. Fuzzy sets generalize classical sets, since the indicator functions of classical sets are special cases of the membership functions of fuzzy sets, if the latter only take values 0 or 1.[88] In fuzzy set theory, classical bivalent sets are usually called crisp sets. The fuzzy set theory can be used in a wide range of domains in which information is incomplete or imprecise, such as bioinformatics [89].

A fuzzy set is a pair (U, m) where U is a set and $m\colon U \to [0, 1]$.

For each $x \in U$, the value $m(x)$ is called the grade of membership of x in (U, m). For a finite set $U = \{x_1, \ldots, x_n\}$, the fuzzy set (U, m) is often denoted by $\{m(x_1)/x_1, \ldots, m(x_n)/x_n\}$.

Let $x \in U$. Then x is called not included in the fuzzy set (U, m) if $m(x) = 0$, x is called fully included if $m(x) = 1$, and x is called a fuzzy member if $0 < m(x) < 1$ The set $\{x \in U \mid m(x) > 0\}$ is called the support of (U, m) and the set $\{x \in U \mid m(x) = 1\}$ is called its kernel or core. The function m is called the membership function of the fuzzy set (U, m).

Sometimes, more general variants of the notion of fuzzy set are used, with membership functions taking values in a (fixed or variable) algebra or structure of a given kind; usually it is required that be at least a poset or lattice. These are usually called L-fuzzy sets, to distinguish them from those valued over the unit interval. The usual membership functions with values in [0, 1] are then called [0, 1]-valued membership functions. These kinds of generalizations were first considered in 1967 by Joseph Goguen, who was a student of Zadeh [141-170].

As an extension of the case of multi-valued logic, valuations ($\mu : V_o \to W$) of propositional variables (V_o) into a set of membership degrees (W) can be thought of as membership functions mapping predicates into fuzzy sets (or more formally, into an ordered set of fuzzy pairs, called a fuzzy relation). With these valuations, many-valued logic can be extended to allow for fuzzy premises from which graded conclusions may be drawn.[89,91]

This extension is sometimes called "fuzzy logic in the narrow sense" as opposed to "fuzzy logic in the wider sense," which originated in the engineering fields of automated control and knowledge engineering, and which encompasses many topics involving fuzzy sets and "approximated reasoning."[141-173]

Industrial applications of fuzzy sets in the context of "fuzzy logic in the wider sense" can be found at fuzzy logic.

A fuzzy number is a convex, normalized fuzzy set $\tilde{A} \subseteq \mathbb{R}$ whose membership function is at least segmentally continuous and has the functional value $\mu_A(x) = 1$ at precisely one element.

This can be likened to the funfair game "guess your weight," where someone guesses the contestant's weight, with closer guesses being more correct, and where the guesser "wins" if he or she guesses near enough to the contestant's weight, with the actual weight being completely correct (mapping to 1 by the membership function).

A fuzzy interval is an uncertain set $\tilde{A} \subseteq \mathbb{R}$ with a mean interval whose elements possess the membership function value $\mu_A(x) = 1$. As in fuzzy numbers, the membership function must be convex, normalized, at least segmentally continuous.[10]

The fuzzy relation equation is an equation of the form A · R = B, where A and B are fuzzy sets, R is a fuzzy relation, and A · R stands for the composition of A with R.

Let A be a non-empty set and P(A) be the power set of A . The set function Cr is known as credibility measure if it satisfies following condition

Axiom 1: $Cr\{A\} = 1$

Axiom 2: If B is subset of C, then, $Cr\{B\} \leq Cr\{C\}$

Axiom 3: $Cr\{B\} + Cr\{B^c\} = 1$

Axiom 4: $Cr\{\cup A_i\} = \sup_i(Cr(A_i))$, for any event A_i with $\sup_i Cr\{A_i\} < 0.5$

Cr{B} indicates how frequently event B will occur.

Credibility inversion theorem

Let A be a fuzzy variable with membership function u. Then for any set B of real numbers, we have

$$Cr\{A \in B\} = \frac{1}{2}\left(\sup_{t\in B} u(t) + 1 - \sup_{t\in B^c} u(t)\right)$$

Let A be a fuzzy variable. Then the expected value is

$$E[A] = \int_0^\infty Cr\{A \geq t\}\, dt - \int_{-\infty}^0 Cr\{A \leq t\}\, dt.$$

Let A be a fuzzy variable with a continuous membership function. Then its entropy is

$$H[A] = \int_{-\infty}^\infty S(Cr\{A \geq t\})\, dt.$$

Where

$$S(y) = -y \ln y - (1-y)\ln(1-y)$$

There are many mathematical constructions similar to or more general than fuzzy sets. Since fuzzy sets were introduced in 1965, a lot of new mathematical constructions

and theories treating imprecision, inexactness, ambiguity, and uncertainty have been developed. Some of these constructions and theories are extensions of fuzzy set theory, while others try to mathematically model imprecision and uncertainty in a different way (Burgin and Chunihin, 1997; Kerre, 2001; Deschrijver and Kerre, 2003).

The diversity of such constructions and corresponding theories includes:

1. interval sets (Moore, 1966),
2. L-fuzzy sets (Goguen, 1967),
3. flou sets (Gentilhomme, 1968),
4. Boolean-valued fuzzy sets (Brown, 1971),
5. type-2 fuzzy sets and type-n fuzzy sets (Zadeh, 1975),
6. set-valued sets (Chapin, 1974; 1975),
7. interval-valued fuzzy sets (Grattan-Guinness, 1975; Jahn, 1975; Sambuc, 1975; Zadeh, 1975),
8. functions as generalizations of fuzzy sets and multisets (Lake, 1976),
9. level fuzzy sets (Radecki, 1977)
10. underdetermined sets (Narinyani, 1980),
11. rough sets (Pawlak, 1982),
12. intuitionistic fuzzy sets (Atanassov, 1983),
13. fuzzy multisets (Yager, 1986),
14. intuitionistic L-fuzzy sets (Atanassov, 1986),
15. rough multisets (Grzymala-Busse, 1987),
16. fuzzy rough sets (Nakamura, 1988),
17. real-valued fuzzy sets (Blizard, 1989),
18. vague sets (Wen-Lung Gau and Buehrer, 1993),
19. Q-sets (Gylys, 1994)
20. shadowed sets (Pedrycz, 1998),
21. α-level sets (Yao, 1997),
22. genuine sets (Demirci, 1999),
23. neutrosophic sets (Smarandache, 1999),
24. soft sets (Molodtsov, 1999),
25. intuitionistic fuzzy rough sets (Cornelis, De Cock and Kerre, 2003)
26. blurry sets (Smith, 2004)
27. L-fuzzy rough sets (Radzikowska and Kerre, 2004),
28. generalized rough fuzzy sets (Feng, 2010)
29. rough intuitionistic fuzzy sets (Thomas and Nair, 2011),
30. soft rough fuzzy sets (Meng, Zhang and Qin, 2011)
31. soft fuzzy rough sets (Meng, Zhang and Qin, 2011)
32. soft multisets (Alkhazaleh, Salleh and Hassan, 2011)
33. fuzzy soft multisets (Alkhazaleh and Salleh, 2012)

2.3.2 Membership functions

The membership function of a fuzzy set is a generalization of the indicator function in classical sets. In fuzzy logic, it represents the degree of truth as an extension of valuation. Degrees of truth are often confused with probabilities, although they are conceptually distinct, because fuzzy truth represents membership in vaguely defined sets, not likelihood of some event or condition. Membership functions were introduced by Zadeh in the first paper on fuzzy sets (1965). Zadeh, in his theory of fuzzy sets, proposed using a membership function (with a range covering the interval (0,1)) operating on the domain of all possible values.

For any set X, a membership function on X is any function from X to the real unit interval $[0, 1]$.

Membership functions on X represent fuzzy subsets of X. The membership function which represents a fuzzy set $\tilde{A}$ is usually denoted by μ_A. For an element x of X, the value $\mu_A(x)$ is called the membership degree of x in the fuzzy set $\tilde{A}$. The membership degree $\mu_A(x)$ quantifies the grade of membership of the element x to the fuzzy set $\tilde{A}$. The value 0 means that x is not a member of the fuzzy set; the value 1 means that x is fully a member of the fuzzy set. The values between 0 and 1 characterize fuzzy members, which belong to the fuzzy set only partially.

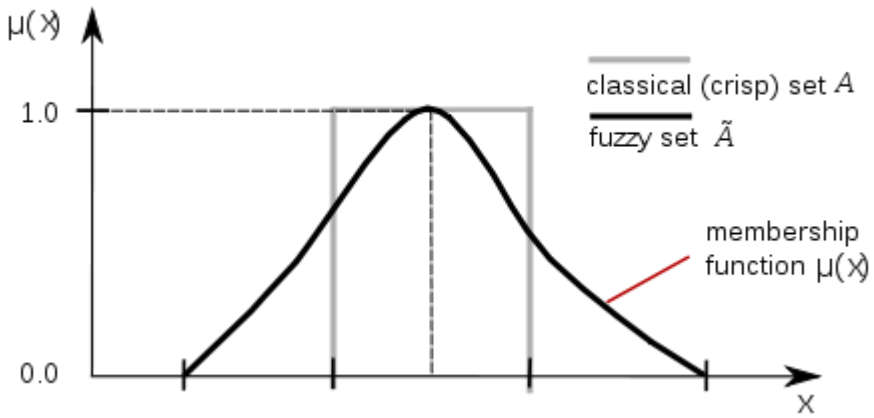

Figure 2.9 - Membership function of a fuzzy set

Sometimes, a more general definition is used, where membership functions take values in an arbitrary fixed algebra or structure L; usually it is required that L be at least aposet or lattice. The usual membership functions with values in [0, 1] are then called [0, 1]-valued membership functions.

One application of membership functions is as capacities in decision theory.

In decision theory, a capacity is defined as a function, ν from **S**, the set of subsets of some set, into $[0, 1]$, such that ν is set-wise monotone and is normalized (i.e. $\nu(\emptyset) = 0, \nu(\Omega) = 1)$. This is a generalization of the notion of a probability measure, where the probability axiom of countable additivity is weakened. A capacity is used as a subjective measure of the likelihood of an event, and the "expected value" of an outcome given a certain capacity can be found by taking the Choquet integral over the capacity.

Linguistic variable - the variable accepting values from a set of words or phrases of some natural or artificial language.

Linguistic variable - a set <b, T,X,G,M>, where

b - name of a linguistic variable;

T - a set of its values (basic a term set) representing names of indistinct variables on range of definition of X;

G - the syntactic procedure allowing to generate new terms. A set of T, G(T), where G(T) - a set of the generated terms, - expanded a term set;

M - the semantic procedure turning each term from G(T) into an indistinct variable.

Membership functions has next classification:

The entered definition of an indistinct set doesn't impose restrictions on a choice of function of accessory. However, in practice it is expedient to use analytical representation of function of accessory μ A x of an indistinct set of A with the elements x which are indistinctly possessing the property R defining a set. Typification of functions of accessory in the context of the solved technical task significantly simplifies the corresponding analytical and numerical calculations at application of methods of the theory of indistinct sets. Allocate the following standard functions of accessory:

The triangular functions of accessory which are used for a task of non-determination type: "it is approximately equal", "average value", "it is located in an interval", "it is similar to object", "it is similar regarding", etc.:

triangular and trapezoidal functions:

trimf x,a,b,c = 0 , x ≤ a ; x - a b - a , a ≤ x ≤ b ; c - x c - b , b ≤ x ≤ c ; 0 , c ≤ x ;
trapmf x,a,b,c,d = 0 , x ≤ a ; x - a b - a , a ≤ x ≤ b ; 1 , b ≤ x ≤ c ; d - x d - c , c ≤ x ≤d ;
0, d ≤ x ;

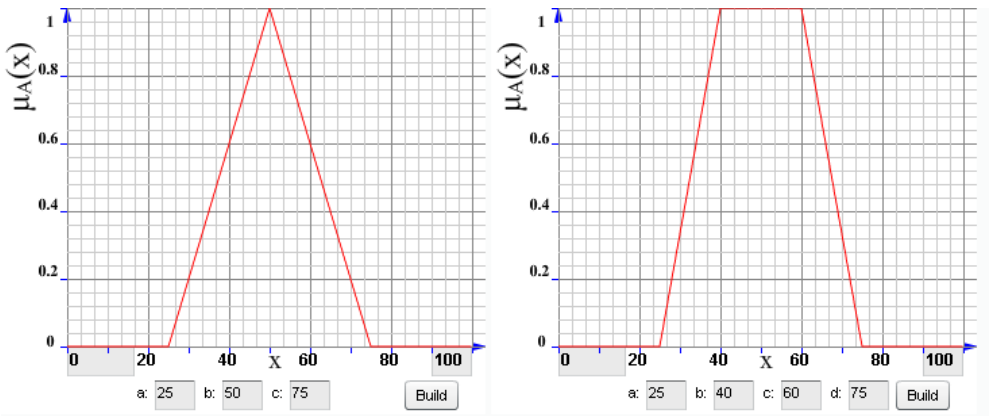

Figure 2.10 - Triangular and trapezoidal membership functions

The Z-shaped functions of accessory which are used for a task of non-determinant type: "small quantity", "small value", "insignificant size", "low level", etc.:

• square and harmonious Z-splines

zm f 1 x,a,b = 1 , x ≤ a ; 1 - 2 x - a b - a 2 , a < x ≤ a + b 2 ; 2 b - x b - a 2 , a + b 2 < x < b ; 0 , b ≤ x ; zm f 2 x,a,b = 1 , x < a ; 1 2 + 1 2 cos x - a b - a ; a ≤ x ≤ b ; 0, x > b ;

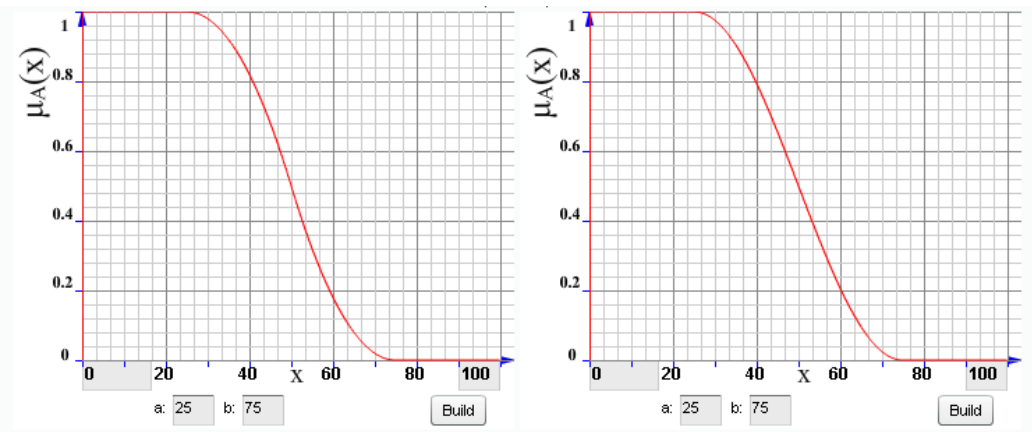

Figure 2.11 - Square and harmonious Z-splines

Z-sigmoidal and Z-linear functions

sigmf x,a,b = 1 1 + exp - a x - b, a < 0;
zlinemf x,c,d = 1 , - ∞ < x ≤ c ; d - x b - c , c < x ≤ d ; 0 , x > d ;

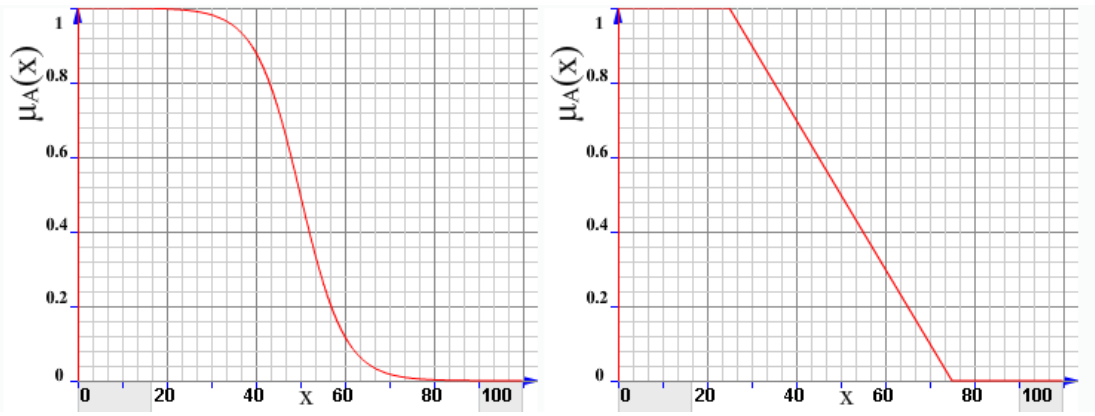

Figure 2.12 - Z-sigmoidal and Z-linear functions

The S-shaped membership functions which are used for non-determinant task type: "large number", "great value", "considerable size", "high level", etc.:

square and harmonious S-splines

sm f 1 x,a,b = 0 , x ≤ a ; 2 x - a b - a 2 , a < x ≤ a + b 2 ; 1 - 2 b - x b - a 2 , a + b 2 < x < b ; 1 , b ≤ x ;

sm f 2 x,a,b = 0 , x < a; 1 2 + 1 2 cos x - b b - a ; a ≤ x ≤ b ; 1, x > b;

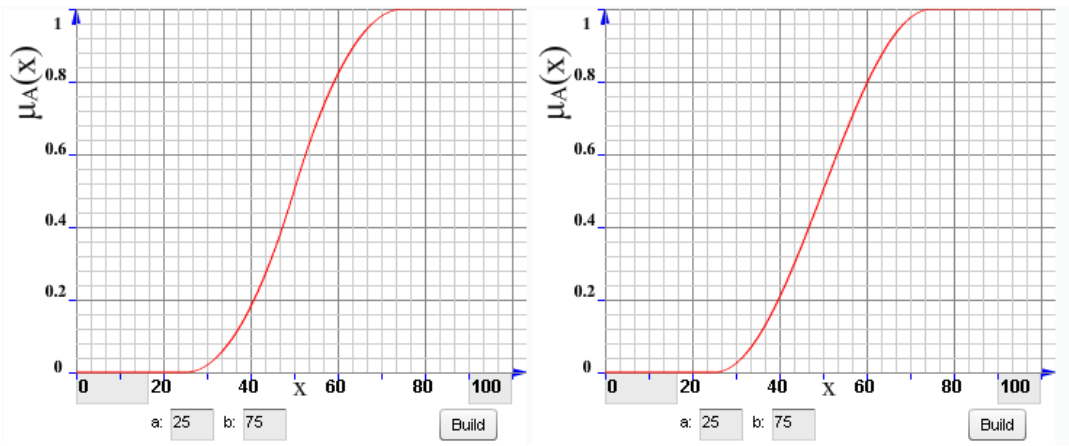

Figure 2.13 - Square and harmonious S-splines

S-sigmoidal and S-linear functions

sigmf x,a,b = 1 1 + exp - a x - b , a > 0 ; slinemf x,a,b = 0 , x ≤ a ; x - a b - a , a < x ≤ b ; 1 , x > b ;

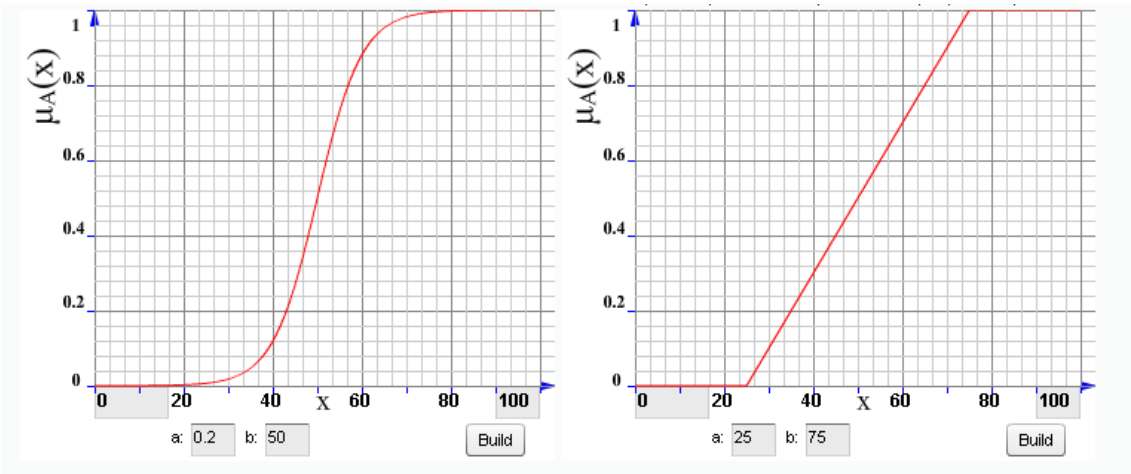

Figure 2.14 - S-sigmoidal and S-linear functions

The P-shaped functions of accessory which are used for non-determinant task type: "approximately ranging from and to", "it is approximately equal", "near", etc.:

bell-shaped and Gaussian functions

gbellmf x,a,b,c = 1 1 + x - c a 2b ; gaussmf x,σ,c = exp - x - c 2 2σ 2

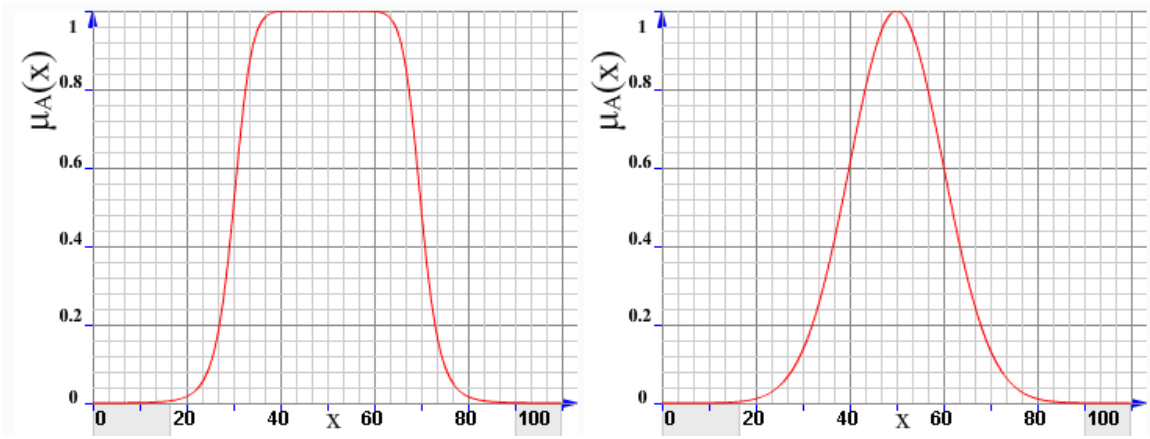

Figure 2.15 - Bell-shaped and Gaussian functions

There is a set of other functions of accessory of the indistinct sets set as compositions of above-mentioned basic functions (double Gaussian, double sigmoidalny, etc.) or as combinations on sites of increase and decrease (it sigmoidalno-is Gaussian, a spline - triangular, etc.).

Function of accessory μ A x is the some not probability subjective measure of an illegibility defined as a result of poll of experts about degree of compliance of an element x to the concept formalized by an indistinct set of A. Unlike a probability measure which is an assessment of the stochastic uncertainty dealing with ambiguity

of approach of some event in various timepoints, the indistinct measure is a numerical assessment of the linguistic uncertainty connected with ambiguity and a vagueness of categories of human thinking. At creation of function of accessory μ A x is associated with each indistinct set of A some property, a sign or attribute R which characterizes some set of objects of X. Than more the concrete object x ∈ X possesses this property R, especially is close to the corresponding value μ to A x. If the element x ∈ X definitely possesses this property R, μ A x = 1 if x ∈ X definitely doesn't possess this property R, μ A x = 0. There are straight lines and indirect methods of creation of functions of accessory.

Direct methods (methods of relative frequencies, parametrical, interval are most known) it is expedient to use for measurable properties, signs and attributes, such as the speed, time, temperature, pressure, etc. When using direct methods often it isn't required absolutely exact potochechny task μ to A x. As a rule, happens to record enough a type of function of accessory and characteristic points on which discrete representation of function of accessory is approximated by continuous analog - the most suitable standard function of accessory.

Indirect methods (the method of pair comparisons is most known) are used when there are no measurable properties of objects in the considered subject domain. Owing to specifics of the considered tasks at creation of indistinct systems of automatic control direct methods, as a rule, are applied. In turn, depending on number of the experts involved to poll both direct, and indirect methods share on single and group. The most rough estimate of characteristic points of function of accessory can be received by poll of one expert which simply sets for each value x ∈ the X corresponding value μ A x.

2.4 Soft computing

Soft calculations - the term entered the Back Lotfi in 1994 [88-89], designating set of inexact, approximate methods of the solution of the tasks which often don't have the decision for polynomial time. Such tasks arise in the field of biology, medicine, the humanities, robastny management, management.

The technology of soft calculations is intensively developed the last 25 years [91-96]. It is capable to solve the problems of management of poorly structured objects of management so actual for the general theory and practice of design of control systems.

The tools of technologies of soft calculations are based on indistinct systems (indistinct sets, fuzzy logic, indistinct regulators, etc.), models of indistinct neural networks, on genetic algorithms (and also including immune algorithms, algorithms of optimization on the basis of behavioural reactions of groups of animals, birds, ants, bees, etc.)

Methods of soft calculations well supplement each other, and are often shared.

Therefore creation of the systems working with uncertainty it is necessary to understand as a component of "soft" calculations.

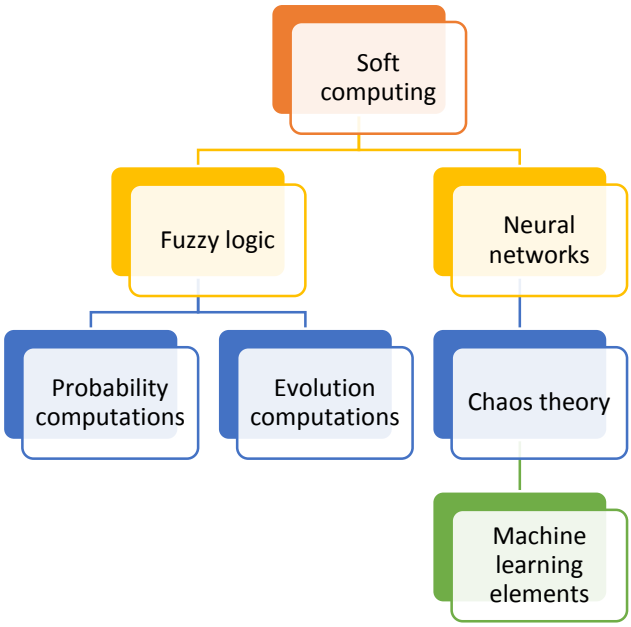

Figure 2.16 - Soft computing structure

In essence in 1970 L.Zade was created a new method of calculus mathematics which was supported by hardware (indistinct processors) which in a number of problem areas became more effective, than classical methods. Originally these areas were included into a perspective of artificial intelligence. Gradually a circle of these areas the direction of "computing intelligence" extended significantly and created. This direction enter now:

- fuzzy logic and sets theory;
- indistinct expert systems;
- systems of approximate calculations;
- theory of chaos;
- fractal analysis;
- nonlinear dynamic systems;
- hybrid systems (fuzzy indistinct or neurological, genetic-neural, Fuzzy geneticor logic genetic systems);
- the systems operated by data (neural networks, evolutionary calculation), artificial intelligence.

Soft calculations (SC) is not some separate methodology. More likely, it is consortium of computing methodologies which collectively provide bases for understanding, designing and development of intellectual systems. In this association the main SC components are fuzzy logic (FL), neurocalculations (NC), genetic calculations (GC) and probabilistic calculations (PC). Later this conglomerate included reasonings on the basis of certificates (evidential reasoning), networks of trust (belief networks), chaotic systems and sections of the theory of machine training. In comparison with traditional rigid calculations, soft calculations are more adapted for work with inexact, uncertain or partially true data / knowledge. The guideline of soft calculations is: "tolerance to inaccuracy, uncertainty and the partial validity for achievement of convenience of a manipulation, a robastnost, low cost of the decision and the best consent with reality".

In soft calculations that the methodologies making them are more synergetic and complementary is very important, than competing. Thus, in many cases of higher KMI it is possible to reach by sharing of FL, NC, GC and PC, than by their application separately. Moreover, there are many problems which can't be solved only by any one means: fuzzy logic, neurocalculations, genetic calculations or probabilistic reasonings. It calls in question positions of those who publicly declares that its favourite tools, whether it be FL, NC, GC or PC, can solve all problems. In process of distribution of soft calculations the number of adherents of such unilateral points of view will be steadily reduced. Each of the making methodologies has many opportunities for its use within soft calculations. The fuzzy logic is the cornerstone of work methods with inaccuracy, granular structure (granulated) information, confidants рассужденияй and that is the most important, calculations with words (Computing with Words). Neurocalculations reflect ability to training, adaptation and identification. In case of genetic calculations, it is about opportunity to systematize casual search and to reach optimum value of characteristics. Probabilistic calculations provide base for management of uncertainty and carrying out the reasonings proceeding from certificates.

Systems in which FL, NC, GC and PC are used in some combination, are called as hybrid systems. The most known systems of this type are so-called neuro and indistinct systems. We start building also indistinct and genetic systems, neuro and genetic systems and neuro and indistinct and genetic systems.

According to L. Zade, finally the majority of systems with high KMI will be hybrid systems. In the future the wide circulation of intellectual systems will have deep influence on ways by means of which intellectual systems are designed, made and interact.

The term fuzzy logic is used in two various meanings. In narrow sense, the fuzzy logic is the logical system which is expansion of multiple-valued logic. However, even for fuzzy logic in narrow sense, the list of the main operations very much differs both on spirit, and according to the contents from the list of the main operations for systems multiple-valued the logician.

In the broadest sense, which prevails today, the fuzzy logic is equivalent theories of indistinct sets, i.e. classes with inexact, indistinct borders [61-64]. Thus, the fuzzy logic understood in narrow sense is the section of fuzzy logic in a broad sense.

The important characteristic of fuzzy logic is that any theory of T can be a fazzifitsirovan (fuzzified) and is therefore generalized by replacement of concept of an accurate set in T concept of an indistinct set. In such a way it is possible to come to indistinct arithmetics, indistinct topology, indistinct probability theory, indistinct management, the indistinct analysis of decisions .A prize from a fazzifikation is the big community and the best compliance of model of reality. However with indistinct numbers it is more difficult to operate, than with accurate numbers. Moreover, values of the majority of indistinct concepts depend on a context and/or the appendix. It is that price which needs to be paid for the best consent with reality.

2.5 Fuzzy logic software

In this section is presented detailed list for fuzzy logic software packages:

1. MatLab Fuzzy logic toolbox

Fuzzy Logic Toolbox™ provides functions, apps, and a Simulink® block for analyzing, designing, and simulating systems based on fuzzy logic. The product guides you through the steps of designing fuzzy inference systems. Functions are provided for many common methods, including fuzzy clustering and adaptive neurofuzzy learning.

The toolbox lets the model complex system behaviors using simple logic rules, and then implement these rules in a fuzzy inference system. User can use it as a stand-alone fuzzy inference engine. Alternatively, user can use fuzzy inference blocks in Simulink and simulate the fuzzy systems within a comprehensive model of the entire dynamic system.

Fuzzy logic toolbox key features:

a) Fuzzy Logic Design app for building fuzzy inference systems and viewing and analyzing results;

b) Membership functions for creating fuzzy inference systems;

c) Support for AND, OR, and NOT logic in user-defined rules;

d) Standard Mamdani and Sugeno-type fuzzy inference systems;

e) Automated membership function shaping through neuroadaptive and fuzzy clustering learning techniques;

f) Ability to embed a fuzzy inference system in a Simulink model;

g) Ability to generate embeddable C code or stand-alone executable fuzzy inference engines.

Fuzzy Inference System Modeling:

Build Mamdani systems using membership functions.

Adaptive Neuro-Fuzzy Modeling:

Build Adaptive Neuro-Fuzzy Inference Systems (ANFIS), train Sugeno systems using neuro-adaptive learning

Data Clustering:

Find clusters in input-output data using C-means or subtractive clustering.

Simulation:

Simulate systems in Simulink

Deployment:

Deploy standalone applications or embed systems in external applications.

2. Wolfram Mathematica Fuzzy logic

Fuzzy Logic 2.0.2 requires Mathematica 5.0-5.2 and is available for all Mathematica platforms.

"This is the most useful computational package for the use and study of fuzzy logic by practicing professionals and students." Timothy J. Ross, author of Fuzzy Logic with Engineering Applications and editor-in-chief of Journal of Intelligent and Fuzzy Systems.

Fuzzy Logic is a collection of notebooks and packages that are designed to introduce fuzzy set theory and fuzzy logic in the Mathematica environment. The

packages provided in Fuzzy Logic, combined with Mathematica, provide a powerful tool for studying fuzzy logic and for developing fuzzy applications. The notebooks provided with this package demonstrate how the various fuzzy logic functions are used, and they contain many worked examples showing how this package can be used in real-world applications

3. Pyfuzzy is a framework to work with fuzzy sets and process them with operations of fuzzy logic based on Python language.

4. GNU Octave fuzzy-logic-toolkit mostly MATLAB-compatible fuzzy logic toolkit:

Package Version: 0.4.4
Last Release Date: 2014-06-26
Package Author: L. Markowsky
Package Maintainer: L. Markowsky
License: GPLv3+.

5. Fuzzy Logic for Dart

This is a module for fuzzy logic in [Dart]. It takes some inspiration from the FCL (Fuzzy Control Language) IEC 1131-7 specification, but otherwise strives to be a 'Dart-y' way to create and work with fuzzy rules. The goal of this project is to make it extremely easy to implement fuzzy logic when creating:

Artificial intelligence in Web-based games.

Intelligent user experience in websites.

6. R language package sets includes fuzzy logic, the ”sets” package provides several fuzzy logic families. A concrete fuzzy logic is selected by calling fuzzy_logic with a character string specifying the family name, and optional parameters. Let us refer to $N(x) = 1-x$ as the standard negation, and, for a t-norm T, let $S(x, y) = 1-T(1-x, 1-y)$ be the dual (or complementary) t-conorm. Available specifications and corresponding families are as follows, with the standard negation used unless stated otherwise.

7. Bioconductor version: Release (3.1).

This package is an extension to CellNOptR. It contains additional functionality needed to simulate and train a prior knowledge network to experimental data using constrained fuzzy logic (cFL, rather than Boolean logic as is the case in CellNOptR). Additionally, this package will contain functions to use for the compilation of multiple optimization results (either Boolean or cFL). Author: M. Morris, T. Cokelaer, current version 1.10.0.

8. Scikit-fuzzy (a.k.a. skfuzzy): Fuzzy logic toolbox for Python.

This package implements many useful tools for projects involving fuzzy logic, also known as grey logic.Author: Joshua Warner, current version 0.1.3.

9. Rigel corporation’s Fuzzy Logic LabPac. This package has been put together at a discount for those interested in Fuzzy Logic applications using the 8051 family of microcontrollers. Detailed information on the hardware, software, and books may be found on the web site.

The R-515JC is a six-layer board with separate VCC and Ground planes intended for demanding industrial applications. Ideal for data logging or mixed mode

communications. This board is the newest in Rigel's expanding line of 8051 controllers. It's low cost and flexibility also make it ideal as a training platform. The R-515JC has four serial ports, one is a dedicated RS-232 port, one a synchronous serial port, and two which can be configured for RS-232 or RS-422 / RS-485. The R-515JC also has CAN, (Controller Area Network) with the physical layer on-board.

rFLASH Fuzzy Logic Applications Software Helper, is a code generator which creates a set of subroutines and tables in the MCS-51 assembly language to implement Fuzzy Logic Control applications. The user writes a Control Task Description File (CTDF) for the input to rFLASH. The CTDF consists of five types of statements: inputs, outputs, terms, rules, and options. No in-depth knowledge of fuzzy logic control is necessary. The CTDF may be written with any ASCII editor. rFLASH has minimal requirements of the computer's resources. A rFLASH Simulator is included. The rFLASH Simulator generates outputs from given inputs on the PC. The simulator may be used to test several inputs and fine-tune the terms or rules accordingly.

Reads51 (RIGEL's Embedded Applications Development System) Reads51 v4.10 combines a IDE, a SmallC-compatible 8051 compiler, an absolute assembler, a relative assembler, a linker/locator, and an editor, with Reads51 v3.x and the RchipSim in one easy to use IDE.

10. jFuzzyLogic is an open source fuzzy logic library implementing industry standards to simplify fuzzy systems developments. jFuzzyLogic is a fuzzy logic package. As you might have guessed, it is written in Java. jFuzzyLogic implements Fuzzy control language (FCL) specification IEC 61131 part 7, as well as a complete library that will greatly simplify your fuzzy logic development or research work. There are 2 versions the full version for desktop and web app and the **core** version is used mostly on mobile applications or applications where resources are limited and graphics capabilities are not required

11. perl-AI-Fuzzy an extension package for Fuzzy logic.

12. fuzzylite is a free and open-source fuzzy logic control library programmed in C++ for multiple platforms (Windows, Linux, Mac, iOS, Android). Its goal is to allow you to easily create fuzzy logic controllers in a few steps utilizing object-oriented programming without requiring any third-party libraries.

jfuzzylite is the same fuzzylite library, but programmed entirely in Java without requiring any third-party libraries.

QtFuzzyLite is an entirely new Qt-based graphic user interface for fuzzylite. Its goal is to allow you to visually design your fuzzy logic controllers and interact with them in real time. QtFuzzyLite is now a commercial and closed-source application whose objective is to raise funds to continue the development of the fuzzylite family of products, all of which will always remain free and open source.

Chapter 2 conclusions

In this chapter were described situations types and situational management system kinds, also detailed shown formal methods classification, fuzzy logic determination and it's advantages for this tasks.

Fuzzy logic is a relatively new paradigm which may radically impact complex systems security. It can be used in formal methods, in trusted system analysis and design, in measuring the security of systems, and in representing the imprecise human world of policies and inference. The implications are challenging and complicated.

Fuzzy set theory and fuzzy logic have been successfully applied to industrial control problems, delivering performance levels similar to those obtained by expert human operators [85-90]. Fuzzy methods have also been used as a technique for uncertainty management in some commercial expert systems [91-105]. Fuzzy set theory, and related theories such as possibility theory [105-115], have been suggested as an alternative analytical tool in the social sciences. The elasticity inherent in fuzzy set theory has been seen as providing a more flexible tool for quantitative analysis, particularly in areas of human choice and decision making

3 DIAGNOSIS PREDICTION MODEL

In this work key features of development of intellectual system of the situational room intended for support of decision-making by the doctor when diagnosing patients with cardiological diseases are considered. In this work some approaches to classification are considered, the analysis and a choice of approach which is most effective for the solution of this task is carried out. For establishment of the diagnosis the approach based on use of the indistinct qualifier is offered. Comparison of algorithms of an indistinct conclusion of Mamdani and Takagi - Sugeno is carried out. In the course of development of the indistinct qualifier key parameters of entrance indicators are picked up, the set of rules of indistinct system is created, functions of accessory on the basis of a method of expert classification are defined. Results of classification of diagnoses when using indistinct system are estimated. Main objective of development of medical indistinct control systems of situations, or systems of decision-making, the desire to improve quality of treatment and to reduce quantity of medical errors - system or casual is. In particular, systems of support of decisions would be actual during the work of the unskilled personnel, for example, of the paramedic in rural areas or in a situation when the doctor has no enough time in details to consider the possible diagnosis of the patient. Also, often the doctor has difficulties with statement of the diagnosis when diagnosing atypical analyses of patients. The systems of support of decisions developing with 1970kh years when the first system such - MYCIN was developed help to solve all these problems, it intended for diagnosing of infectious diseases. As the area of medicine and health care is extensive, as subject domain the cardiology and cardiovascular diseases which are in the lead in the Republic of Kazakhstan by lethal outcomes quantity was chosen. In general heart troubles - the main problem of world health care. According to the forecast of WHO, by 2030 according to forecasts about 25 million people will die of cardiovascular diseases, mainly, from heart troubles and a stroke. 12 million people die every year of the coronary heart disease (CHD) and a stroke.

3.1 Possibility model and Probability model

It is shown that for the solution of many problems of medical diagnostics naturally application not of probabilistic, but possibility model of the analysis and interpretation of the data obtained as with use of modern medical technologies, and reflecting health and a condition of the patient, professional experience and intuition of the doctor. The possibility model of symptomatology of a disease characterizing indistinct communication between the simptomatiyny description of a condition of the patient and his real state in which diagnostic criteria are defined by groups of values of signs (symptoms) ranged on values of their opportunities at this disease is constructed. In possibility model of diagnostics the optimum decisive rule minimizes opportunity or (and) inevitability of losses at statement of the diagnosis. When modeling medical objects it is necessary in practice to face the illegibility and uncertainty of their description connected with incompleteness and unauthenticity of knowledge, accident

and inaccuracy of data, subjective approach to their description. Insufficient efficiency of probabilistic methods of modeling of similar objects is connected first of all with the impossibility of empirical creation of their stochastic models caused by variability in time of characteristics of health of the patient and symptoms of a disease, and unformalized and in many cases subjective character of symptoms of a disease. Probabilistic model of stochastic object, it is unpredictable evolving in time, empirically it is impossible to construct, its possibility model at known restrictions on nature of evolution of probabilistic model can be restored, and is exact and on the basis of almost probably final number of supervision. If to add to it that the possibility model and not stochastic object can be constructed empirically on the basis of expert opinions, preference of possibility modeling of medical diagnostics in which are used as the "accurate" data received as a result of application of modern medical technologies, and the unformalized data reflecting a subjective self-assessment, intuition and experience of the doctor becomes obvious.

International classification of diseases of the 10th revision (MKB-10) has 22 code classes for most of known diseases. As it is a huge data set, in Ph.D. thesis will be shown cardiology disease classes next diseases: insult and myocardical infarct.

According to Barmagambetova's report among leaders in mortality from IBS in 2012 it should be noted the RK following areas:

1. Akmola area-163,74 cases on 100 thousand population
2. Pavlodar region-158,18 cases on 100 thousand population
3. East Kazakhstan region-155,17 cases on 100 thousand population
4. North Kazakhstan-147,16 cases on 100 thousand population
5. Zhambyl area-115,48 cases on 100 thousand population

Dynamics of spread of cardiovascular diseases to RK was considered by N. A. Taubaldinova in work "A current state of prevalence of cardiovascular diseases". Dynamics of distribution of cardiovascular diseases looks the following an coronary heart disease trouble (445,6 cases on 100 thousand population), cerebral-vascular diseases (189,0), a sharp myocardial infarction on the third place (53,6).

The analysis of incidence of coronary heart disease in a section of areas showed such picture according to 2011:

- Zhambyl area-846,2 cases on 100 thnd. the population
- North Kazakhstan area-504,1
- Almaty region-462,2
- South Kazakhstan area-445,9
- Atyrau area-434,0

Cerebral-vascular diseases meet at the population of the North Kazakhstan area (305,5) more often, then in Zhambyl (285,4), Pavlodar (277,0), West Kazakhstan (217,5) and Kostanay (200,4) areas.

The highest levels of a sharp myocardial infarction had the population of the North Kazakhstan area (137,7 cases on 100 thousand population), the East Kazakhstan region (105,9), Akmola (89,9), Karaganda (85,4) and the Pavlodar (58,3) areas.

It is formalized, the problem of diagnostics sounds as follows: at these results of 4 types of analyses to carry the diagnosis of the patient to four classes: the patient is

healthy, repeated research is necessary, medicine treatment is necessary or surgery is necessary

Let X - a set of descriptions of objects, Y - a set of numbers (or names) classes. There is an unknown dependence - display y^*: X → Y which values are known only on objects of the final training selection of Xm = { (x1, y1),…, (xm, ym) }. It is required to construct algorithm, a: X → Y capable to classify any object of x∈X. Display f is called as a sign: X → Df, where Df - a set of admissible values of a sign. If are set priznakif1, …, fn, a vector x = (f1(x), …, fn(x)) is called as the priznakovy description of object of x∈X. Is admissible to identify descriptions with objects. Thus a great number of X = _ (f_1) × … × D _ (f_n) call D symptom's space.

Depending on a set of Df signs share on the following types:

binary sign: Df = {0,1}; nominal priznak:df-pointed set; serial sign: Df the-pointed ordered set;

quantitative sign: Df-set of real numbers. Often applied tasks meet polytypic signs, not everyone is suitable for their decision methods.

There are some main approaches to the solution of a problem of classification. We will consider the following approaches:

- the metric;
- the probabilistic;
- structural - linguistic.

The problem of a choice of approach to recognition in a question of classification of medical data is considered in many foreign and domestic works as separate type of a problem of classification of that medical data contain a large number of random and systematic errors, are data with high dimension, a zashumlennost and missing data. Also, medical data often possess a large number of classes to which it is necessary to carry elements of our set.

We will consider metric approach to recognition of data.

The problem of classification in this case is formulated as follows: Let the X-set of descriptions of objects, Y - a set of answers (identifiator of classes); Some training selection of X ℓ = (x_i, y_i) _ Is known (l_i); At classification by a metric way the compactness hypothesis is meant: similar objects, as a rule, lie in one class. Function of distance is set: X \X → [0, ∞). For example, as a metrics the Euclidean distance can serve: $\rho(u,x_j) = \sqrt{\sum_{i=1}^{n}(u_i - x_{j_i})^2}$ where $u = (u_1, \ldots, u_n)$, $x_i = (x_{j_1}, \ldots, x_{j_n})$ symptoms descriptions of objects. However the distance isn't obliged to be a metrics - the inequality of a triangle is sometimes broken. The metric klassifikatsiyaprosta in realization - exists a large number of the methods based on metric approach - a method main a component, a method of the next neighbors and many others. Other plus of metric approach is that results of classification are interpreted: using a paradigm of CBR (case based-reasoning), the qualifier not only does the decision on object belonging to a class, but also explains why the qualifier made such choice. The example of such logical conclusion - "Object of X is carried to a class C because the close object of the training selection of X belonged to the same class'".

This approach isn't applicable for the solution of our task of the following reasons: metric algorithms aren't sensitive to emissions and the metric qualifier gives poor quality of classification; secondly, operations go with indistinct data as weight of the questionnaire are based on answers - the patient answers questions of quality of life where the accurate distance between categories "Seldom" and "Often" doesn't exist, we can't use the metric qualifier.

Probabilistic approach.

In a probabilistic problem definition it is considered that the set "object, class" steam of $X \times Y$ is probabilistic space with an unknown measure of P. There is a final training selection of supervision of $Xm = \{ (x1, y1),\ldots, (xm, ym) \}$, P generated according to a probability measure. It is required to construct algorithm of $a: X \rightarrow Y$ capable to classify any object of $x \in X$.

The main method of classification in a probabilistic problem definition, and the most frequent used in practice for the analysis of medical data is the method of Bayesian networks (or its simplification - the naive Bayesian qualifier). Bayesian networks are the directed acyclic columns to which each top there corresponds the casual variable, and arches of the count code the relations of conditional independence between these variables. Tops can represent variables of any types, to be the weighed parameters, the hidden variables or hypotheses. The naive Bayesian qualifier uses Bayes's formula of $P (X \mid C) = \prod (i=1) ^n \langle\langle P (X\_i \mid C) \rangle\rangle$ for correlation of object of $X = (X1., X)$ to a class C. The object is classified to a class with the maximum probability of accessory. The naive Bayesian qualifier is simple in realization and is effective at observance of some conditions for a problem of classification and selection. Besides, an important factor is the interpretiruyemost of solutions of the Bayesian qualifier - the qualifier can offer explanations on the basis of what arguments this or that class [5] was chosen. Shpigelyalter in 1993 developed the expert system for diagnosing of heart failure at babies founded on Bayesian networks. Thus the accuracy of classification made 65.5%. After that Shpigelyalter tried to create expert system on the basis of the naive Bayesian qualifier and in this case classification accuracy only increased and made 67.3% This way of classification the training selection demands very big. Besides, one of the main necessary conditions of an optimality of use of the naive Bayesian qualifier is balance of the training selection.

Structural and linguistic approach is based on the description of structure of a class by means of specialized formal language which alphabet is made by production elements and structures, and also the operations and compositions over them set by grammar of language. Such approach assumes that the structure and nature of communications between elements of all subjects to recognition of objects submit to certain, in advance known regularities.

This approach uses decisive rules of a look "If … that …" with different scales. On the basis of these rules using various methods of a conclusion, consequents - levels of confidence in implementation of rules gather, and then consequents are aggregated, and on the basis of collected data the general conclusion is drawn.

Systems which are trained on the basis of such rules, possess the useful properties most suitable for a problem of classification of medical data: rules are intuitively clear

for doctors who could use such system, and also such rules repeat logic of doctors. Also, such systems possess property of uniformity, that is all knowledge is expressed in the same format in what they are stored in real life. However at the moment there are no such systems which could correct the rules. Their low efficiency belongs to shortcomings of such systems during the work with noisy data, and also the low speed of training.

Formulation of a problem of indistinct classification.

Problem of indistinct classification of data is the problem of creation of display of a vector (A1, A2, … An) to a vector (to M1,M2, … Mk) where, (Ai) - a vector of real numbers, and Mk- belonging to the classes C1, … Sk on which indistinct sets break.

The task of medical diagnostics is set as a problem of classification in which it is required to make the decision on object accessory - the patient - to one of the M classes of diseases. The condition of the patient is estimated by the doctor by results of the conducted researches, analyses, and also testing at which the patient answers questions of existence and degree of expressiveness of various symptoms. Within a problem of classification we will consider symptoms the signs describing object. Each sign can accept various values. For example, the sign "number of leukocytes" accepts quantitative values, a sign "fatigue" - the values in a rang scale expressing fatigue degree. At a grade level of the algorithm of possibility classification recommending this or that diagnosis of a disease it is necessary to find such values of signs which are characteristic for each class. In fact it is diagnostic criteria of diseases.

In many cases in the presence of the interdependent data possessing natural variability and an illegibility there is an ambiguity of interpretation of a simptomatiyny picture of a disease of different experts, and the clinical assessment of a disease is interfaced to difficulties.

For establishment of the diagnosis the approach based on use of the indistinct qualifier is offered. Comparison of algorithms of an indistinct conclusion of Mamdani and Takagi - Sugeno is carried out. The qualifier of definition of the diagnosis is realized on the basis of system of an indistinct conclusion of Mamdani. In the course of development of the indistinct qualifier by experts key parameters of entrance indicators are picked up, the set of rules of indistinct system is created, functions of accessory on the basis of a method of expert classification are defined.

The symptoms groups an illness belonging to different diagnoses represent certain areas which form some indistinct clusters.

Let consider fuzzy logic methods medical diagnostics at quantitative parameters values:

A) A={A1,A2…Aj,…Am } is Set of possible diagnoses in the considered symptomatology or medicine area

B) X={X1,X2..Xi,Xn} Set of symptoms i.e. patient condition parameters

C) Linguistic terms based on each from these parameters and ranges on their measurement

D) Indistinct sets (fuzzy sets) based on each linguistic interval and their function accessory to all state parameters and each of diagnoses

E) the knowledge matrix defining the Fuzzy logical rules, conclusion, types and mathematical formulas for the applied operators

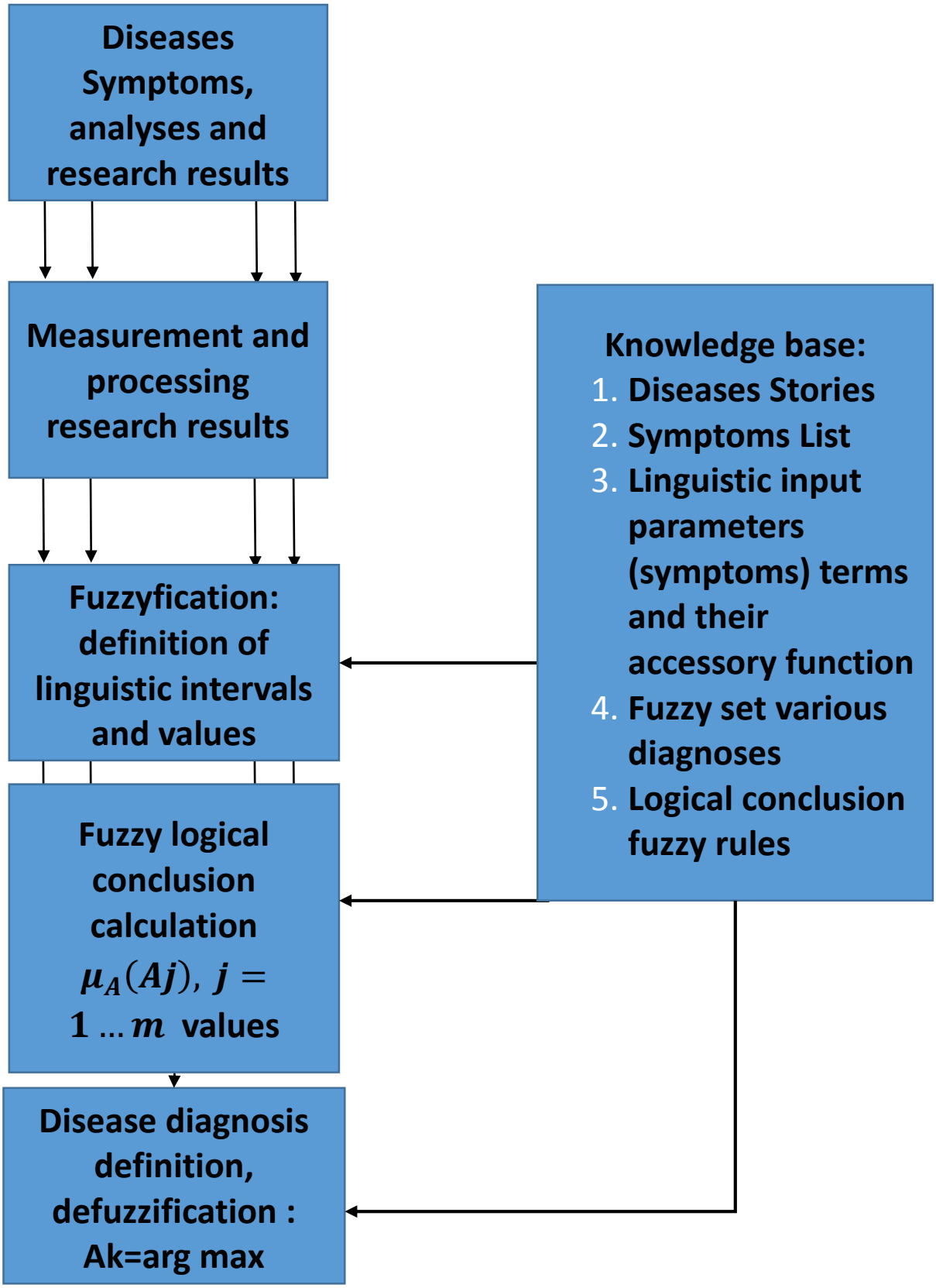

Figure 3.1 - Decision algorithm

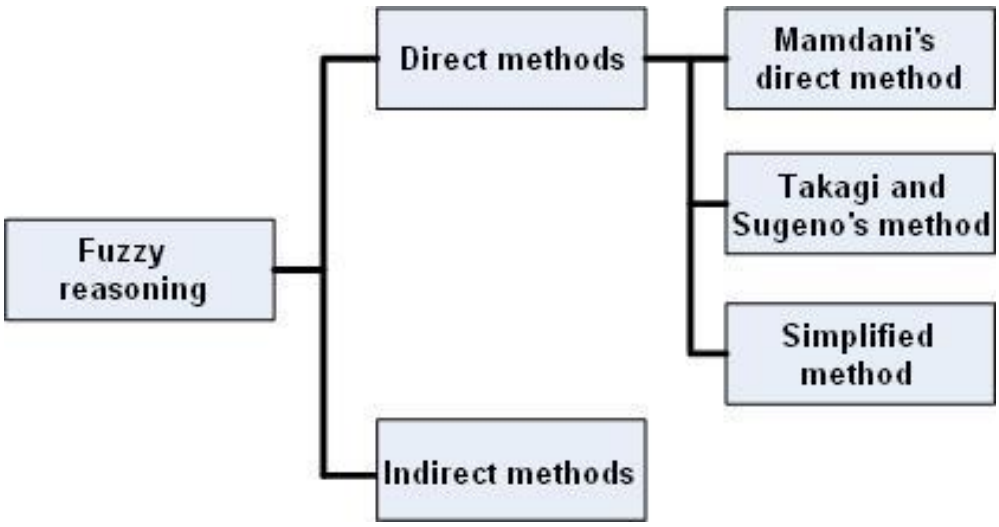

Figure 3.2 - Fuzzy reasoning methods

The most popular FLC systems are: Mamdani, Tsukamoto, Sugeno and Larsen which work with crisp data as inputs. An extension of the Mamdani model in order to work with interval inputs is presented in (Liu et al., 2005) , where the fuzzy sets are represented by triangular fuzzy numbers and the firing level of the conclusion is computed as the product of firing levels from the antecedent. Other extensions and applications of the standard FLC systems were proposed in (Iancu, 2009a;b; Iancu, Colhon & Dupac, 2010; Iancu, Constantinescu & Colhon, 2010; Iancu & Popirlan, 2010).

3.2 Mamdani method

Mamdani's fuzzy inference method is the most commonly seen fuzzy methodology. Mamdani's method was among the first control systems built using fuzzy set theory. It was proposed in 1975 by Ebrahim Mamdani [100-105] as an attempt to control a steam engine and boiler combination by synthesizing a set of linguistic control rules obtained from experienced human operators. Mamdani's effort was based on Lotfi Zadeh's 1973 paper on fuzzy algorithms for complex systems and decision processes
[85-89]. Although the inference process described in the next few sections differs somewhat from the methods described in the original paper, the basic idea is much the same.

Mamdani-type inference, as defined for the toolbox, expects the output membership functions to be fuzzy sets. After the aggregation process, there is a fuzzy set for each output variable that needs defuzzification.

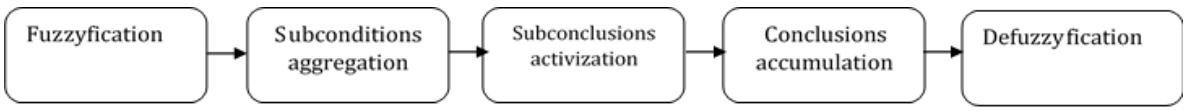

Figure 3.3 - Mamdani’s direct method

Fuzzyfication:created base of rules and array are entrance data A = { a1..., an }. This array contains values on all entrance variables. The purpose of this stage is obtaining values of the validity for all subconditions from base of rules. For each of subconditions there is a bi value = μ (ai). Thus, the set of bi values (i = turns out 1. n).

Subcondition aggregation: $c_j = \min\{b_i\}$, (i = 1..n)

Subconclusions activization: $d_i = c_i * \omega_i$, where i =1..r. Then to the subconclusion, the set Di is compared to each i with new accessory function. Its value is defined at least from di and value of term accessory function from the subconclusion

μ'i (x) = by min { di, μi (x) }. Where: μ'i (x) - the "intensified" function of accessory;

μi (x) - function of accessory of a term; di - degree the validity for i subconclusion.

Conclusions accumulation: $E_i = \bigcup_j D_j$ (i = 1..s). Association two indistinct sets is the third indistinct set with the following function of accessory: μ'i (x) = max { μ1 (x), μ2 (x) }, where μ1 (x), μ2 (x) - functions of accessory of the united sets

Defuzzification: $y_i = \frac{\int_{min}^{max} x * \mu_i(x)dx}{\int_{min}^{max} \mu_i(x)dx}$ μi (x) - function of accessory of the corresponding indistinct set of Ei; Min and Max - borders of a universum of indistinct variables;

yi - result of a defuzzyfication.

Intuitive, Widespread acceptance, Well suited to human input.

Mamdani's method is useful when there is a determined number of variables.

In Mamdani’s model the fuzzy implication is modeled by Mamdani’s minimum operator, the conjunction operator is min, the t-norm from compositional rule is min and for the aggregation of the rules the max operator is used. In order to explain the working with this model of FLC will be considered the example from (Rakic, 2010) where a simple two-input one-output problem that includes three rules is examine.

According to MKB-10 illness of cardiology treat diseases of the blood circulatory systems (100-199).

As our diagnoses of cardiology the stroke (cerebral vascular diseases) and a myocardial infarction were taken.

Annually in the world more than 30 million cases of a stroke are registered. Though the brain blow was always the noticeable cause of heavy suffering or sudden death, the problem of a stroke became especially actual recently. The annual risk of a stroke in age group of 45-54 years makes 0,1%, 55-63 - 0.8%, 65-74 - 1%, is more senior than 80 years of-5%

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For a stroke for correct primary statement of the diagnosis we will determine input and output parameters and functions of accessory.

Input linguistic parameters, with the set upper and lower bound (figure 6-9):

1. The smile - an indistinct set of the second sort, can accept parameters equal (symmetric), asymmetric, curve, direct.

2. The speech of the patient - accurate, indistinct, faltering, unclear.

3. The movement of extremities of the patient - normal, the left extremities, the right extremities as the stroke as a rule influences one party of part of a body.

4. The patient's pressure - low, normal, high.

The output variable is the forecast of risk of a stroke.

Determine “Smile” input parameter

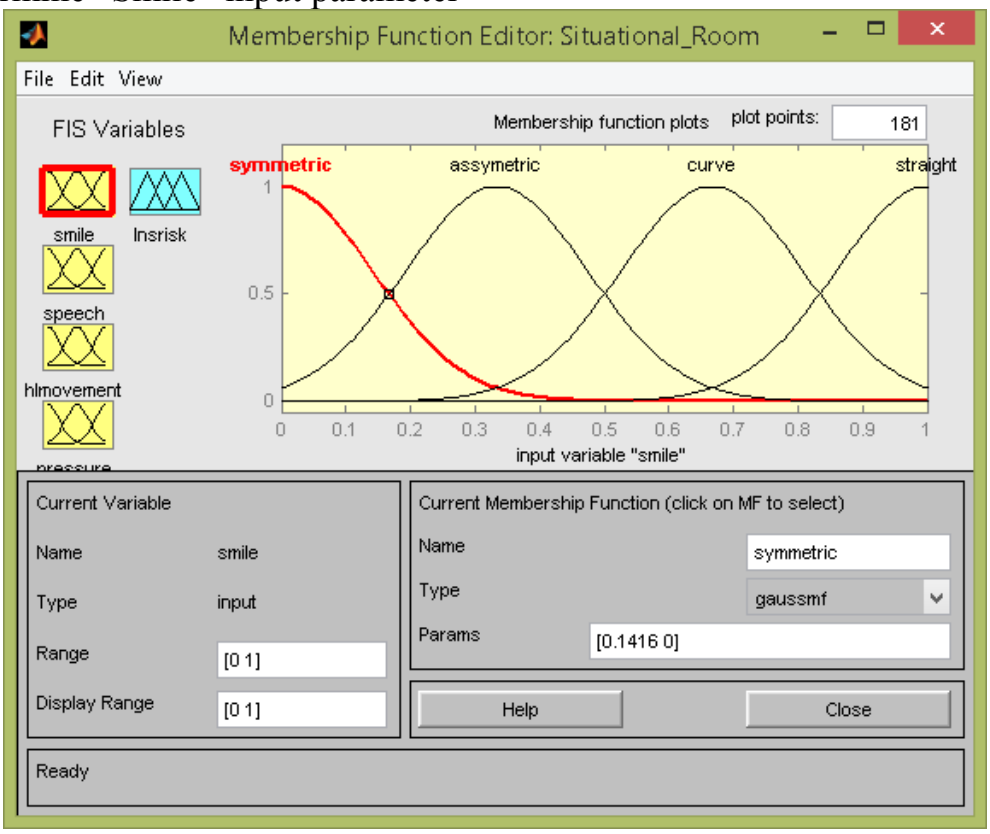

Figure 3.4 - Determine “smile” input parameter
via Gaussian membership function

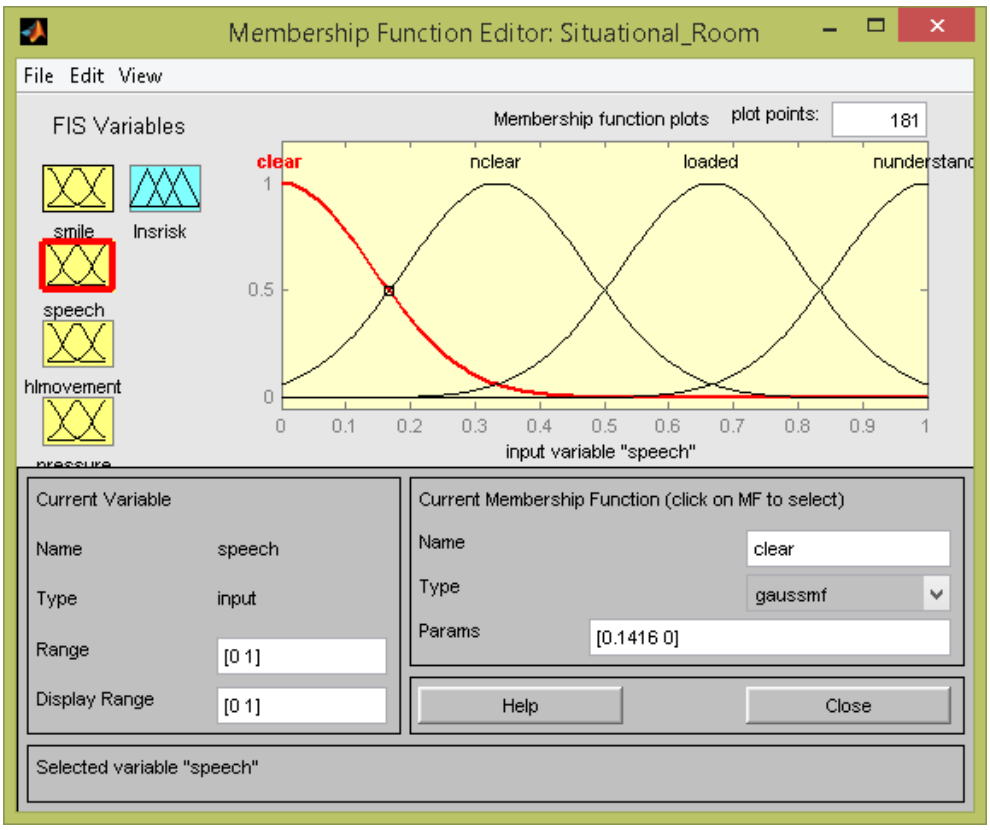

Figure 3.5 - Determine “speech” input parameter via Gaussian membership function

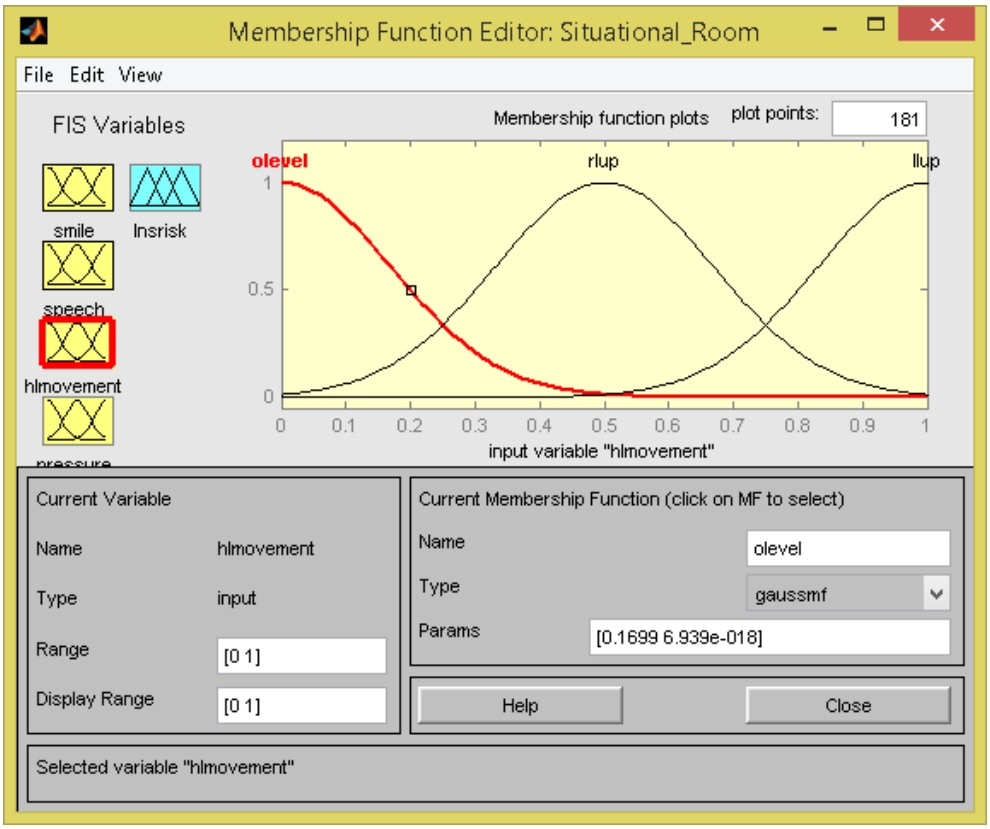

Figure 3.6 - Determine “hlmovement” input parameter via Gaussian membership function

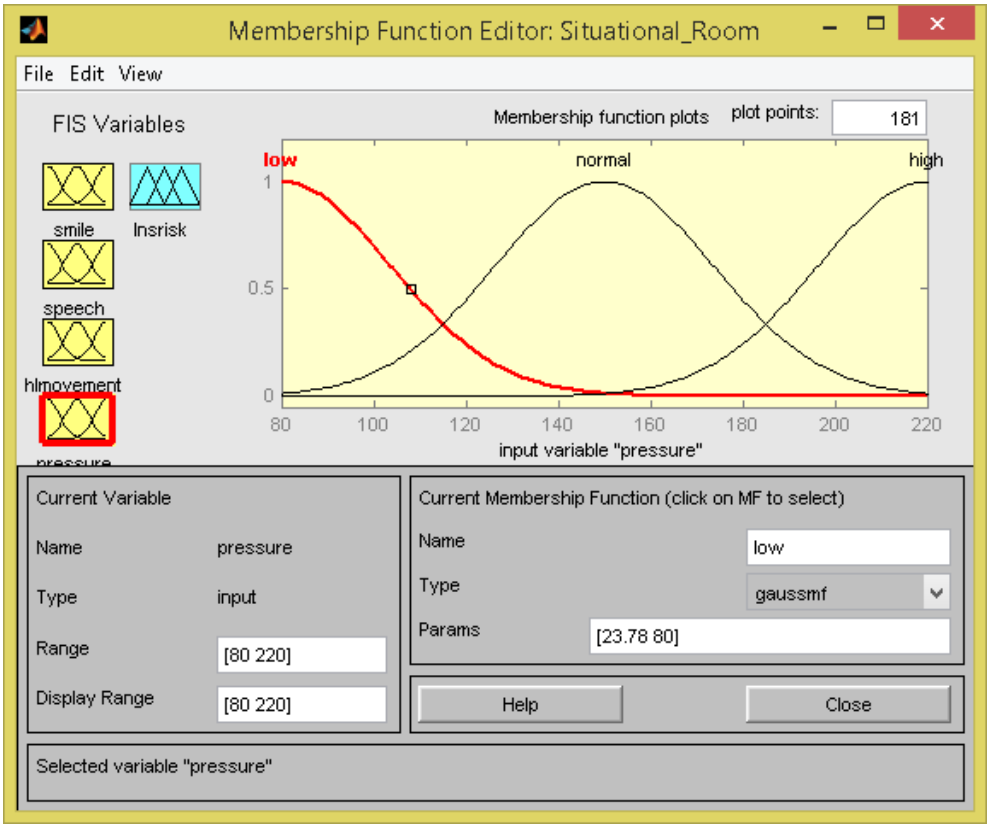

Figure 3.7 - Determine “hlmovement” input parameter via Gaussian membership function

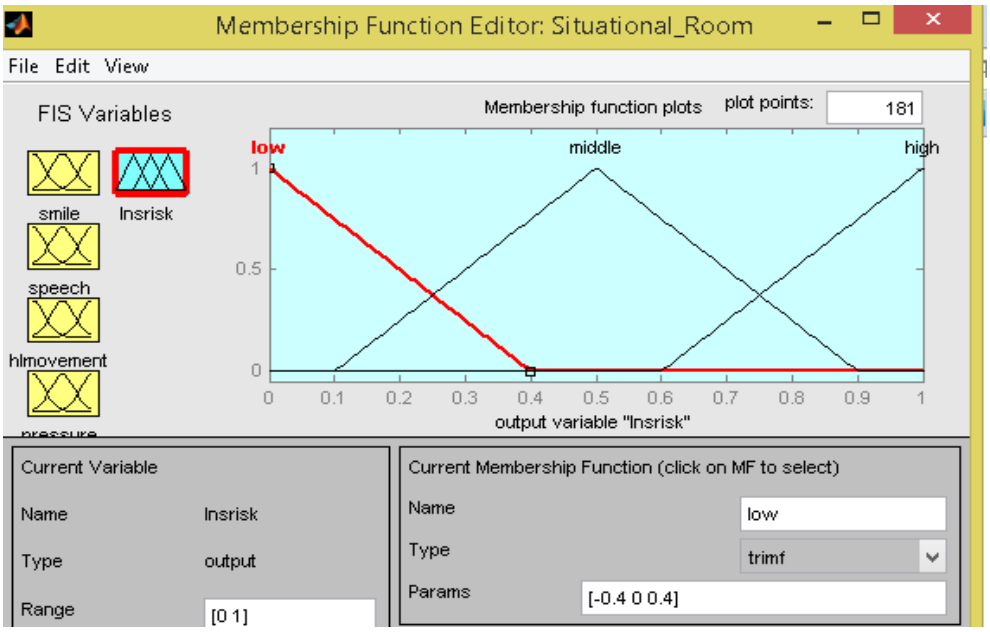

Figure 3.8 - Determine output parameter insult risk Membership functions to input parameters are Gaussian, for output - triangular.

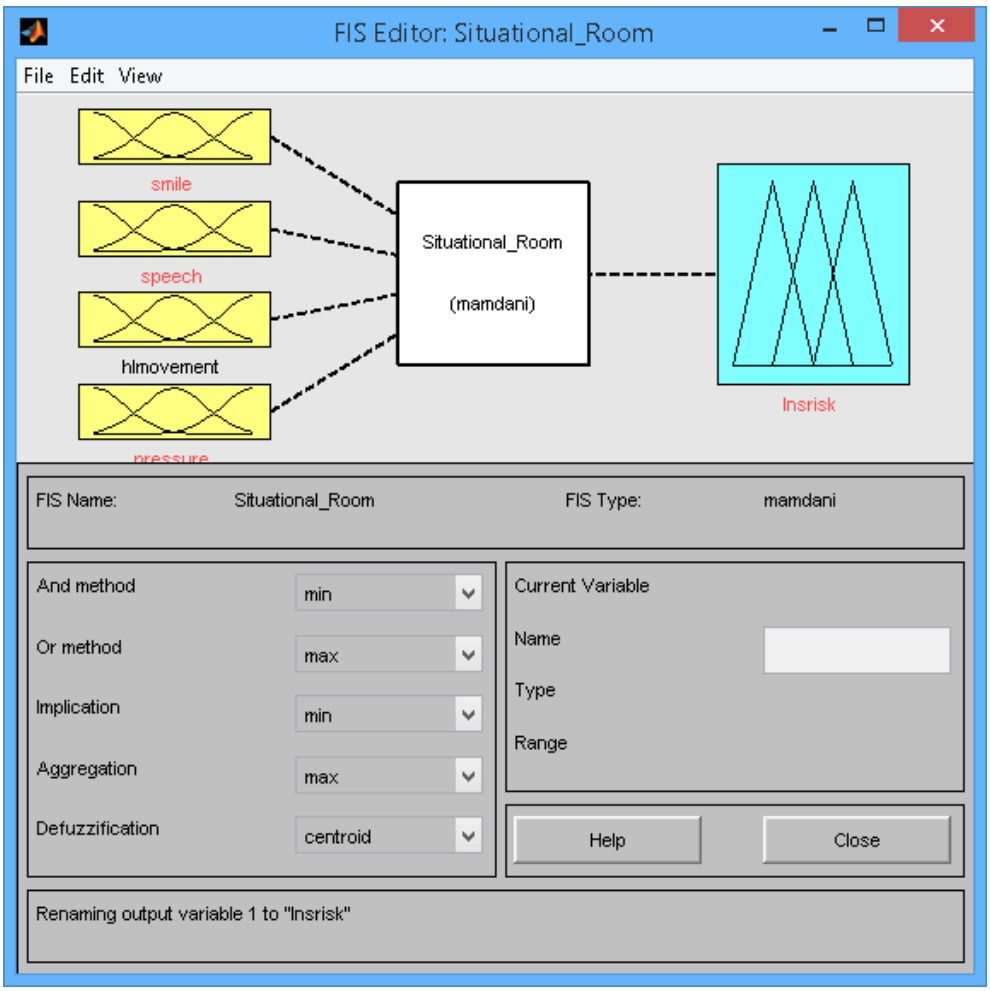

Figure 3.9 - Scheme of input and output parameters of indistinct system

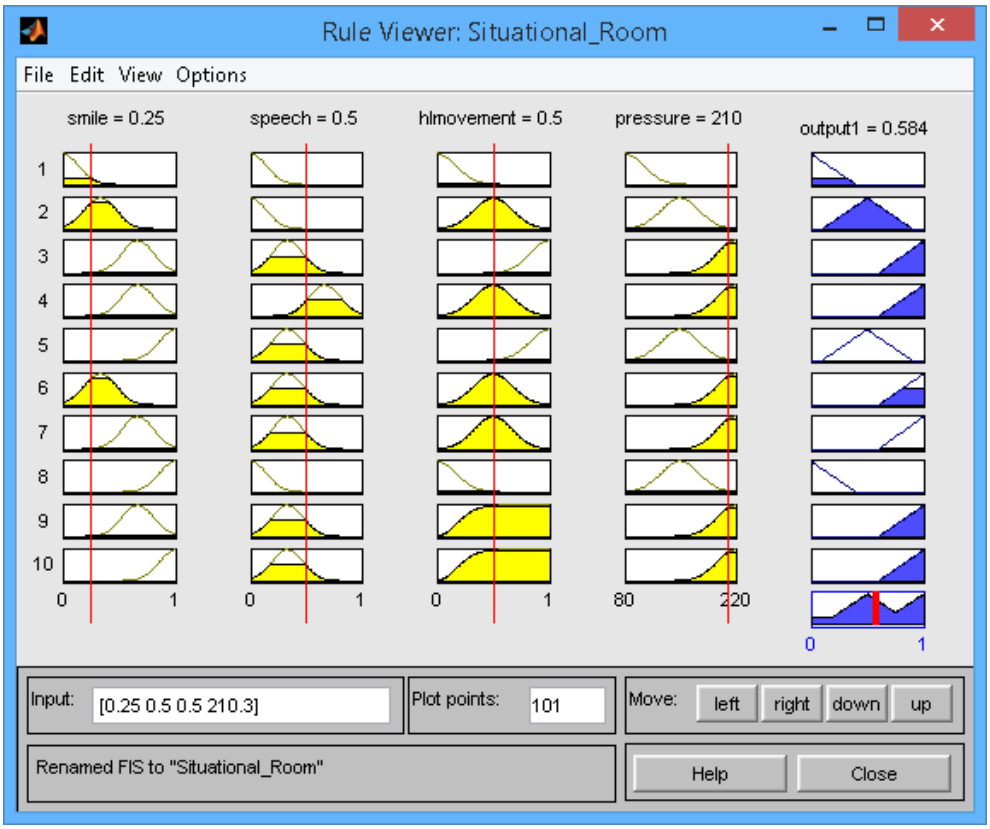

Figure 3.10 - Scale Measurements on Insult Risk on the basis of decisive rules

3.3 Takagi-Sugeno method

The main difference between Mamdani and Sugeno is that the Sugeno output membership functions are either linear or constant.

A typical rule in a Sugeno fuzzy model has the form:

If Input 1 = x and Input 2 = y, then Output is $z = ax + by + c$

For a zero-order Sugeno model, the output level z is a constant $(a=b=0)$.

The output level z_i of each rule is weighted by the firing strength w_i of the rule.

For example, for an AND rule with Input 1 = x and Input 2 = y, the firing strength is $wi=AndMethod(F1(x),F2(y))$ where $F_{1,2}(.)$ are the membership functions for Inputs 1 and 2.The final output of the system is the weighted average of all rule outputs, computed as

$Output = \frac{\sum_{i=1}^{N} w_i z_i}{\sum_{i=1}^{N} w_i}$, where N is the rules number .

Sugeno fuzzy method advantages computationally efficient, works well with linear techniques (e.g., PID control), works well with optimization and adaptive techniques.

has guaranteed continuity of the output surface.

well suited to mathematical analysis.

A Sugeno rule operates as shown in the following diagram:

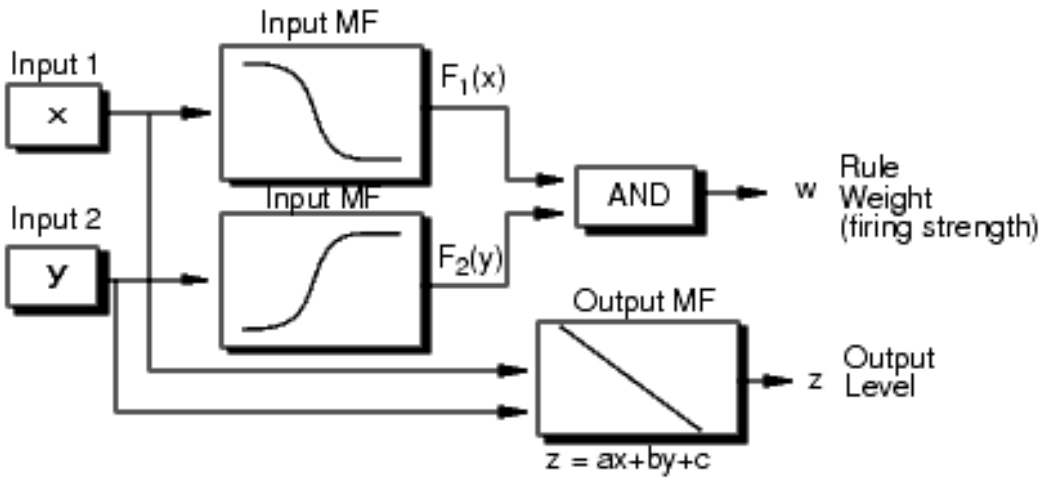

Figure 3.11 - Sugeno rule operations

By Takagi-Sugeno method:

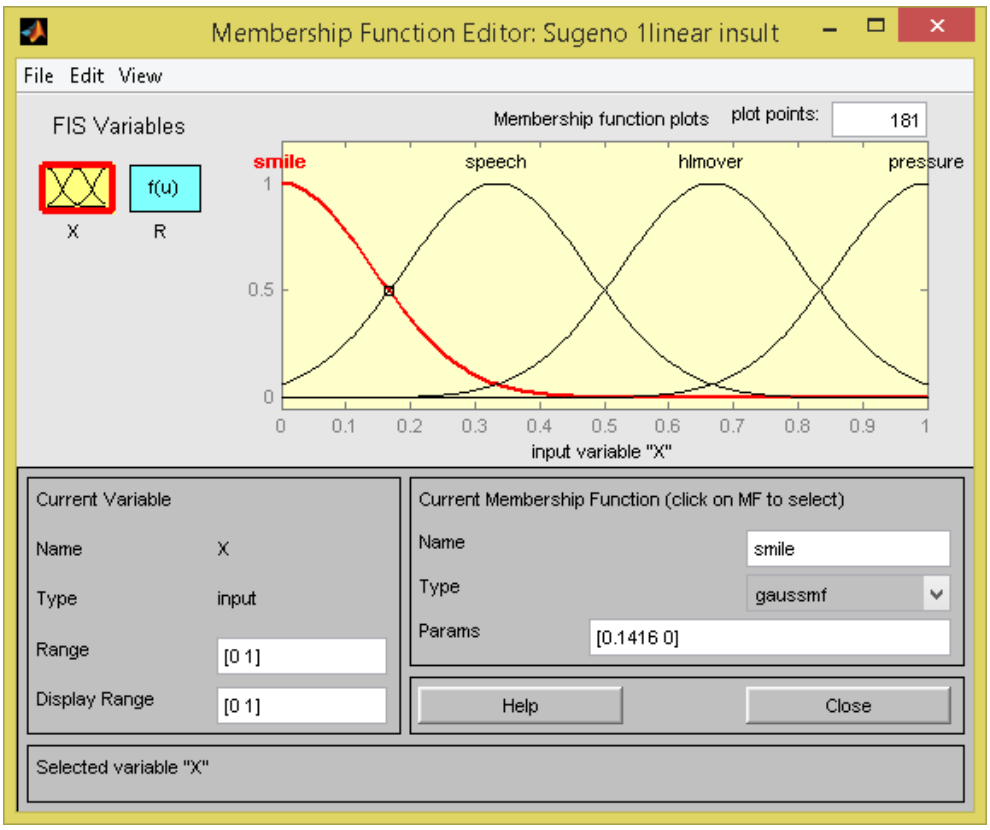

Figure 3.12 - Input parameters for indistinct system on Takagi-Sugeno's method

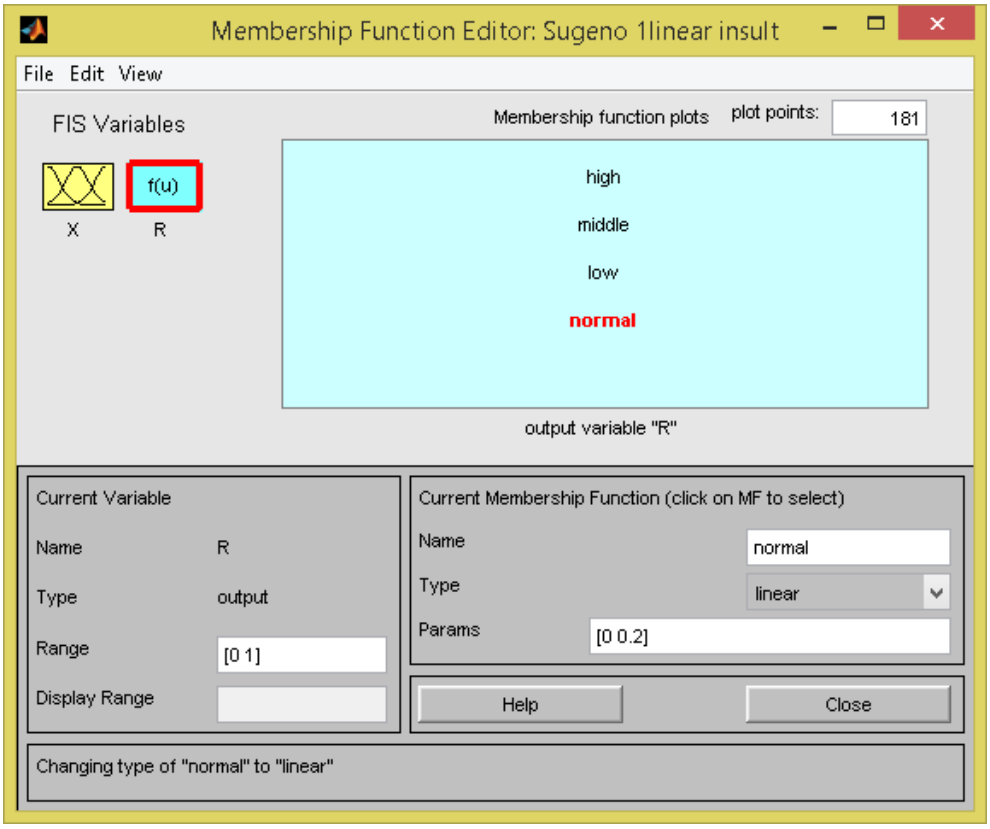

Figure 3.13 - Output parameter and membership function on Takagi-Sugeno's method for insult risk prediction

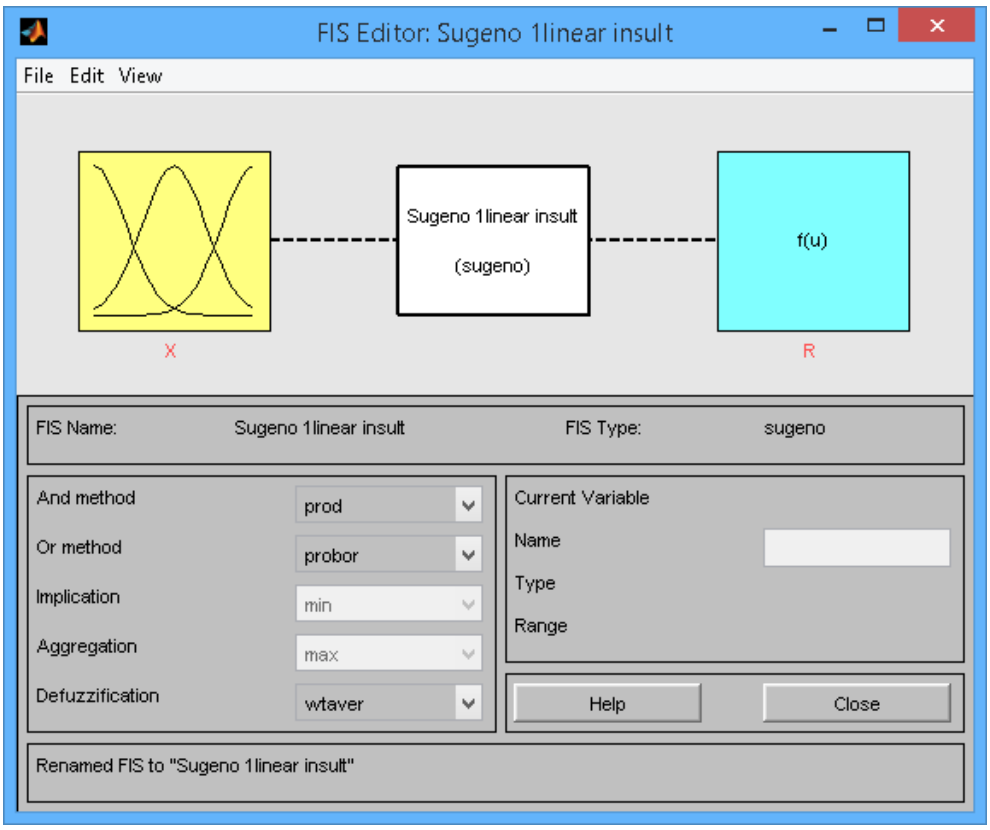

Figure 3.14 - Output parameter and membership function on Takagi-Sugeno's method for insult risk prediction

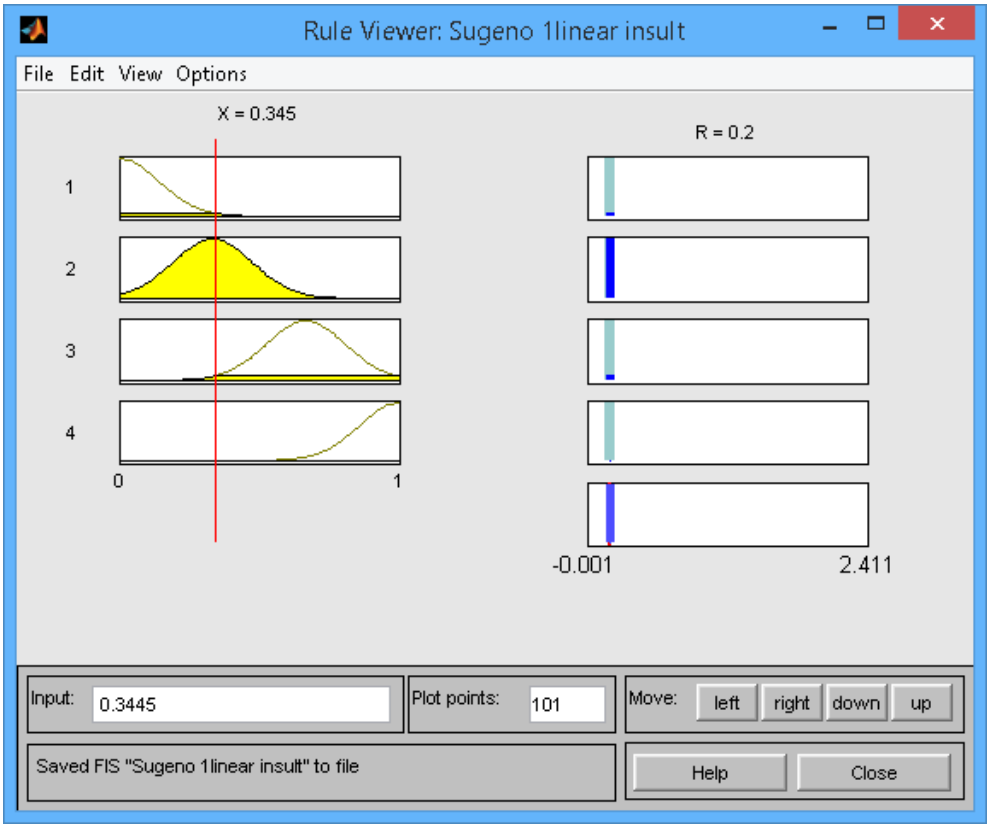

Figure 3.15 - Scale of decisive rules for a stroke on Takagi-Sugeno's method

3.4 Clusterization algorithms

Data clustering is the process of dividing data elements into classes or clusters so that items in the same class are as similar as possible, and items in different classes are as dissimilar as possible. Depending on the nature of the data and the purpose for which clustering is being used, different measures of similarity may be used to place items into classes, where the similarity measure controls how the clusters are formed. Some examples of measures that can be used as in clustering include distance, connectivity, and intensity.

In hard clustering, data is divided into distinct clusters, where each data element belongs to exactly one cluster. In fuzzy clustering (also referred to as soft clustering), data elements can belong to more than one cluster, and associated with each element is a set of membership levels. These indicate the strength of the association between that data element and a particular cluster. Fuzzy clustering is a process of assigning these membership levels, and then using them to assign data elements to one or more clusters.

One of the most widely used fuzzy clustering algorithms is the Fuzzy C-Means (FCM) Algorithm (Bezdek 1981). The FCM algorithm attempts to partition a finite collection of n elements $X = \{\mathbf{x}_1, ..., \mathbf{x}_n\}$ into a collection of c fuzzy clusters with respect to some given criterion. Given a finite set of data, the algorithm returns a list of c cluster centres $C = \{\mathbf{c}_1, ..., \mathbf{c}_c\}$ and a partition matrix $W = w_{i,j} \in [0, 1],\ i = 1, ..., n,\ j = 1, ..., c$, where each element w_{ij} tells the degree to which element $\mathbf{x}_i$ belongs to cluster $\mathbf{c}_j$. Like the K-means clustering, the FCM aims to minimize an objective function:

$$\arg\min_{C} \sum_{i=1}^{n} \sum_{j=1}^{c} w_{ij}^{m} \left\| \mathbf{x}_i - \mathbf{c}_j \right\|^2 ,$$

where:

$$w_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\|\mathbf{x}_i - \mathbf{c}_j\|}{\|\mathbf{x}_i - \mathbf{c}_k\|} \right)^{\frac{2}{m-1}}}.$$

This differs from the *k*-means objective function by the addition of the membership values w_{ij} and the fuzzifier $m \in R$, with $m \geq 1$. The fuzzifier m determines the level of cluster fuzziness. A large m results in smaller memberships w_{ij} and hence, fuzzier clusters. In the limit $m = 1$, the memberships w_{ij} converge to 0 or 1, which implies a crisp partitioning. In the absence of experimentation or domain knowledge, m is commonly set to 2.

In fuzzy clustering, every point has a degree of belonging to clusters, as in fuzzy logic, rather than belonging completely to just one cluster. Thus, points on the edge of a cluster, may be *in the cluster* to a lesser degree than points in the center of cluster. An overview and comparison of different fuzzy clustering algorithms is available.[1]

Any point *x* has a set of coefficients giving the degree of being in the *k*th cluster $w_k(x)$. With fuzzy *c*-means, the centroid of a cluster is the mean of all points, weighted by their degree of belonging to the cluster:

$$c_k = \frac{\sum_x w_k(x)^m x}{\sum_x w_k(x)^m}.$$

The degree of belonging, $w_k(x)$, is related inversely to the distance from x to the cluster center as calculated on the previous pass. It also depends on a parameter m that controls how much weight is given to the closest center. The fuzzy c-means algorithm is very similar to the k-means algorithm:[2]

1. Choose a number of clusters.
2. Assign randomly to each point coefficients for being in the clusters.
3. Repeat until the algorithm has converged (that is, the coefficients' change between two iterations is no more than ε, the given sensitivity threshold):

a. Compute the centroid for each cluster, using the formula above.

b. For each point, compute its coefficients of being in the clusters, using the formula above.

The algorithm minimizes intra-cluster variance as well, but has the same problems as k-means; the minimum is a local minimum, and the results depend on the initial choice of weights.

Using a mixture of Gaussians along with the expectation-maximization algorithm is a more statistically formalized method which includes some of these ideas: partial membership in classes.

Another algorithm closely related to Fuzzy C-Means is Soft K-means.

Fuzzy c-means has been a very important tool for image processing in clustering objects in an image. In the 70's, mathematicians introduced the spatial term into the FCM algorithm to improve the accuracy of clustering under noise

Fuzzy clustering by Local Approximation of Memberships (FLAME) is a data clustering algorithm that defines clusters in the dense parts of a dataset and performs cluster assignment solely based on the neighborhood relationships among objects. The key feature of this algorithm is that the neighborhood relationships among neighboring objects in the feature space are used to constrain the memberships of neighboring objects in the fuzzy membership space.

The FLAME algorithm is mainly divided into three steps:

1. Extraction of the structure information from the dataset:

Construct a neighborhood graph to connect each object to its K-Nearest Neighbors (KNN);

Estimate a density for each object based on its proximities to its KNN;

Objects are classified into 3 types:

1.Cluster Supporting Object (CSO): object with density higher than all its neighbors;

2.Cluster Outliers: object with density lower than all its neighbors, and lower than a predefined threshold;

3.the rest.

2. Local/Neighborhood approximation of fuzzy memberships:

1. Initialization of fuzzy membership:

1.Each CSO is assigned with fixed and full membership to itself to represent one cluster;

2.All outliers are assigned with fixed and full membership to the outlier group;

3.The rest are assigned with equal memberships to all clusters and the outlier group;

2. Then the fuzzy memberships of all type 3 objects are updated by a converging iterative procedure called *Local/Neighborhood Approximation of Fuzzy Memberships*, in which the fuzzy membership of each object is updated by a linear combination of the fuzzy memberships of its nearest neighbors.

3. Cluster construction from fuzzy memberships in two possible ways:

1. One-to-one object-cluster assignment, to assign each object to the cluster in which it has the highest membership;

One-to-multiple object-clusters assignment, to assign each object to the cluster in which it has a membership higher than a threshold. The Local/Neighborhood Approximation of Fuzzy Memberships is a procedure to minimize the Local/Neighborhood Approximation Error (LAE/NAE) defined as the following:

$$E(\{\boldsymbol{p}\}) = \sum_{\boldsymbol{x}\in\boldsymbol{X}} \left\| \boldsymbol{p}(\boldsymbol{x}) - \sum_{\boldsymbol{y}\in\mathcal{N}(\boldsymbol{x})} w_{\boldsymbol{xy}} \boldsymbol{p}(\boldsymbol{y}) \right\|^2$$

where $\boldsymbol{X}$ is the set of all type 3 objects, $\boldsymbol{p}(\boldsymbol{x})$ is the fuzzy membership vector of object $\boldsymbol{x}$, $\mathcal{N}(x)$ is the set of nearest neighbors of $\boldsymbol{x}$, and $w_{\boldsymbol{xy}}$ with $\sum_{\boldsymbol{y}\in\mathcal{N}(\boldsymbol{x})} w_{\boldsymbol{xy}} = 1$ are the coefficients reflecting the relative proximities of the nearest neighbors.

The NAE can be minimized by solving the following linear equations with unique solution which is the unique global minimum of NAE with value zero:

$$p_k(\boldsymbol{x}) - \sum_{\boldsymbol{y}\in\mathcal{N}(\boldsymbol{x})} w_{\boldsymbol{xy}} p_k(\boldsymbol{y}) = 0, \quad \forall \boldsymbol{x} \in \boldsymbol{X}, \quad k = 1, ..., M$$

where M is the number of CSOs plus one (for the outlier group). The following iterative procedure can be used to solve these linear equations:

$$\boldsymbol{p}^{t+1}(\boldsymbol{x}) = \sum_{\boldsymbol{y}\in\mathcal{N}(\boldsymbol{x})} w_{\boldsymbol{xy}} \boldsymbol{p}^{t}(\boldsymbol{y})$$

The FCM (Fuzzy C-Means) algorithm is one of the most widely used fuzzy clustering algorithms. This technique was originally introduced by Professor Jim Bezdek in 1981. The FCM algorithm attempts to partition a finite collection of elements $X=\{x_1, x_2, ..., x_n\}$ into a collection of c fuzzy clusters with respect to some given criterion. Given a finite set of data, the algorithm returns a list of c cluster centers V, such that $V = v_i$, i =1, 2, ... , c and a partition matrix *U* such that $U = u_{ij}$, i =1, ..., c, j =1,..., n, where u_{ij} is a numerical value in [0, 1] that tells the degree to which the element $\mathbf{x_j}$ belongs to the i-th cluster.

The following is a linguistic description of the FCM algorithm, which is implemented *Fuzzy Logic*. The functions that implement this algorithm can be found in the *Clustering.m* file.

Step 1: Select the number of clusters c ($2 \le c \le n$), exponential weight μ ($1 < \mu < \infty$), initial partition matrix U^0, and the termination criterion ϵ. Also, set the iteration index l to 0.

Step 2: Calculate the fuzzy cluster centers $\{v_i^l \mid i=1, 2, ..., c\}$ by using U^l.

Step 3: Calculate the new partition matrix U^{l+1} by using $\{v_i^l \mid i=1, 2, ..., c\}$.

Step 4: Calculate the new partition matrix $\Delta = \|U^{l+1} - U^l\| = \max_{i,j} |u_{ij}^{l+1} - u_{ij}^l|$. If $\Delta > \epsilon$, then set l = l + 1 and go to step 2. If $\Delta \leq \epsilon$, then stop.

Fuzzy Logic Toolbox command line function fcm starts with an initial guess for the cluster centers, which are intended to mark the mean location of each cluster. The initial guess for these cluster centers is most likely incorrect. Additionally, fcm assigns every data point a membership grade for each cluster. By iteratively updating the cluster centers and the membership grades for each data point, fcm iteratively moves the cluster centers to the right location within a data set. This iteration is based on minimizing an objective function that represents the distance from any given data point to a cluster center weighted by that data point's membership grade.

The command line function fcm outputs a list of cluster centers and several membership grades for each data point. You can use the information returned by fcm to help you build a fuzzy inference system by creating membership functions to represent the fuzzy qualities of each cluste r.

C-means algorithm for disease risk determination was designed on PHP for 2500 and 10000 points.

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Point Object ( [r] => 173.336069311 [g] => 85.9461262905 [b] => 85.4613336668 )
**************************************************
points:10000
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Point Object ( [r] => 23 [g] => 102 [b] => 91 ) Array ( [0] => 0.322098209086 [1] => 0.0358243406868 [2] => 0.566024925007 [3] => 0.0760525252205 )
Point Object ( [r] => 99 [g] => 57 [b] => 188 ) Array ( [0] => 0.992443582112 [1] => 0.00266498117545 [2] => 0.00157383007962 [3] => 0.00331760663322 )
Point Object ( [r] => 226 [g] => 53 [b] => 221 ) Array ( [0] => 0.285664252139 [1] => 0.36482093238 [2] => 0.0512288208242 [3] => 0.298285994657 )
Point Object ( [r] => 99 [g] => 91 [b] => 28 ) Array ( [0] => 0.0798844382731 [1] => 0.0334699962381 [2] => 0.424259352722 [3] => 0.462386212767 )
Point Object ( [r] => 90 [g] => 235 [b] => 50 ) Array ( [0] => 0.0165546998837 [1] => 0.0392719137795 [2] => 0.917185334749 [3] => 0.0269880515873 )
Point Object ( [r] => 123 [g] => 173 [b] => 64 ) Array ( [0] => 0.00682360779854 [1] => 0.0162260480054 [2] => 0.948182588263 [3] => 0.0287677559328 )
Point Object ( [r] => 210 [g] => 227 [b] => 26 ) Array ( [0] => 0.0543767177455 [1] => 0.270465058893 [2] => 0.374047156264 [3] => 0.301111067097 )
Point Object ( [r] => 227 [g] => 177 [b] => 178 ) Array ( [0] => 0.0125635453938 [1] => 0.948284490979 [2] => 0.011776454899 [3] => 0.0273755087277 )
Point Object ( [r] => 76 [g] => 20 [b] => 221 ) Array ( [0] => 0.918582224701 [1] => 0.0287170398789 [2] => 0.0193755093918 [3] => 0.0333252260283 )
Point Object ( [r] => 136 [g] => 152 [b] => 51 ) Array ( [0] => 0.0219771726699 [1] => 0.0404657131587 [2] => 0.708383034215 [3] => 0.229174079957 )
Point Object ( [r] => 105 [g] => 156 [b] => 133 ) Array ( [0] => 0.125581911354 [1] => 0.195044684591 [2] => 0.627906818946 [3] => 0.0514665851093 )
Point Object ( [r] => 176 [g] => 235 [b] => 171 ) Array ( [0] => 0.0133170052997 [1] => 0.940488273206 [2] => 0.0307539113033 [3] => 0.0154408101905 )
Point Object ( [r] => 129 [g] => 226 [b] => 204 ) Array ( [0] => 0.043416126635 [1] => 0.878085352041 [2] => 0.0591016920304 [3] => 0.0193968292937 )
Point Object ( [r] => 114 [g] => 89 [b] => 59 ) Array ( [0] => 0.0661606960424 [1] => 0.023355191712 [2] => 0.201150796979 [3] => 0.709333315267 )
Point Object ( [r] => 123 [g] => 159 [b] => 59 ) Array ( [0] => 0.0100549354238 [1] => 0.0176889377171 [2] => 0.915034563019 [3] => 0.0572215638397 )
Point Object ( [r] => 153 [g] => 46 [b] => 212 ) Array ( [0] => 0.735555576618 [1] => 0.117731674557 [2] => 0.027623698009 [3] => 0.119089050816 )
Point Object ( [r] => 197 [g] => 20 [b] => 204 ) Array ( [0] => 0.421855807543 [1] => 0.18984987579 [2] => 0.0478971272943 [3] => 0.340397189373 )
Point Object ( [r] => 204 [g] => 228 [b] => 145 ) Array ( [0] => 0.0165891900948 [1] => 0.902290114817 [2] => 0.045160764461 [3] => 0.0359599306268 )
Point Object ( [r] => 146 [g] => 69 [b] => 145 ) Array ( [0] => 0.458478224239 [1] => 0.0620922355152 [2] => 0.0284941070966 [3] => 0.450935433149 )
Point Object ( [r] => 132 [g] => 185 [b] => 62 ) Array ( [0] => 0.011990038054 [1] => 0.0396261749861 [2] => 0.895930159521 [3] => 0.0524536274384 )
Point Object ( [r] => 164 [g] => 54 [b] => 198 ) Array ( [0] => 0.629466678084 [1] => 0.15522060332 [2] => 0.0308675924404 [3] => 0.184445126156 )
Point Object ( [r] => 62 [g] => 211 [b] => 197 ) Array ( [0] => 0.232078440866 [1] => 0.415277502441 [2] => 0.306617884892 [3] => 0.0460261718015 )
Point Object ( [r] => 213 [g] => 105 [b] => 188 ) Array ( [0] => 0.108470393901 [1] => 0.661016828652 [2] => 0.0295333784525 [3] => 0.200979398994 )
```

Figure 3.16 C-means algorithm for disease risk prediction (10000 points)

Chapter 3 Conclusions

In this chapter detailed described fuzzy logic approach and possibilities, mathematical model for diagnosis prediction based on Mamdani, Sugeno fuzzy inference methods, also presented c-means solution for this task.

In next chapter 4 will be described detailed mobile module and test scenario.

4 MOBILE MODULE AND TESTING SCENARIO

MissionMode Situation Center

Even the best business continuity and IT disaster recovery plans can falter in execution without the right executional support tools. Many companies rely on everyday tools like email, voicemail, and Excel spreadsheets to communicate and project manage disruptive events. Unfortunately, these systems weren't built for critical incident management and often make navigating the rough waters of an unplanned business event more difficult than it has to be.

MissionMode Situation Center was specifically designed to support the end-to-end business continuity lifecycle; from planning to early warning system tracking, risk assessment and response. It enables you to pre-populate your organization's BCM plans, templates, contact lists, and more into an easy-to-use collaborative incident management platform that speeds communication, tracks progress, and simplifies project management. MissionMode provides a common operating picture across all departments. Our staff can see at a glance the status of any incident and make better-informed decisions. - Airport Manager, Birmingham Airport

By appointing a business continuity team and drafting plans to address potential disruptive events, you've taken the first big step to sustainable operational readiness. Now arm your team with the tools they need for maximum efficiency. MissionMode's easy-to-use Situation Center simplifies your response to any type of crisis. It's a streamlined incident management and crisis communications system-a virtual command center that reduces the time and cost of returning to normal business activity. When a crisis occurs, the Situation Center puts you in complete control.

Situation Center Advantages

- Enables anytime, anywhere collaboration
- Straightforward and simple to use
- Includes team and individual task checklists
- Includes a robust mass communication platform
- Creates a common operating picture
- Online forms management
- Innovative mobile app
- Centralized document repository handles all file types
- Includes integration toolkit

MissionMode's full Situation Center Suite is available via mobile app. Whether you need to send or receive emergency notifications or are launching a new Situation Room for an event that's unfolding, our mobile incident management applications will allow you to access our full feature set on the go.

Notification Center Mobile™.

Notification creators easily launch alerts with just a few taps on the screen. Customized templates ensure that the right people are reached with the right message. Quickly communicate with any number of people within minutes-anywhere, anytime.

Situation Center Mobile ™.

The power of our web-based incident management application in the palm of your hand. Using tablets and smartphones, your teams collaborate, communicate, manage tasks, access plans andother documents, and send alerts. Straightforward and easy to use.

Earshot™

Go far beyond ordinary mass notification. Establisha dialogue using rich, 2-way messages, forms, photos and location-based services. EarShot is used for detecting potential crises, gathering eyewitness intelligence, reporting safety and security issues, communicating with field personnel, and much more.

a. Mobile module based on Android platform

To manage quick the situations it's better to work inside real-time systems better to use mobile module which allows quick response and time optimization.

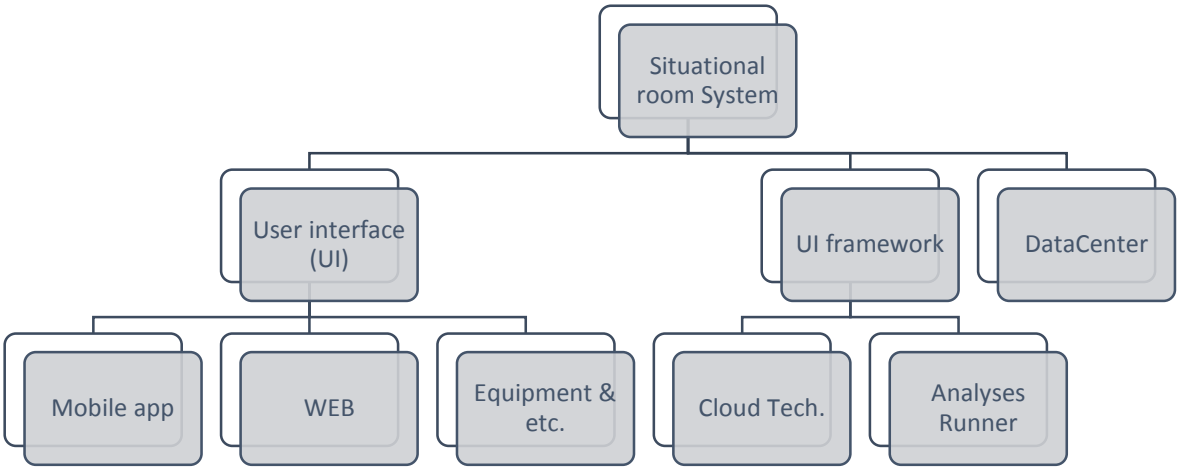

Figure 4.1 - Situational room scheme

4.1 Platform overview

According to the analytical company VisionMobile which experts interrogated over 10 thousand developers from 137 countries, 70% of all founders of programs use as the main the Android operating system whereas 51% give preference to iOS. Thus a certain percent develops applications at once for two platforms. By the way, the share of founders of Windows applications of Phone in comparison with last year increased from 21% to 28%.

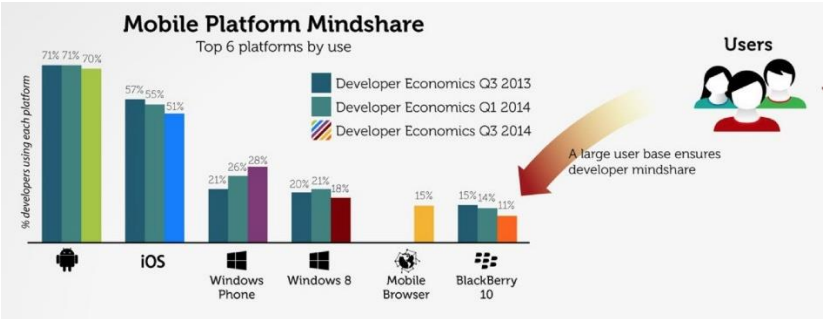

Figure 4.1.a

And here is how, according to experts, the picture in the world market of operating systems looks. For iOS doesn't exceed 16%.

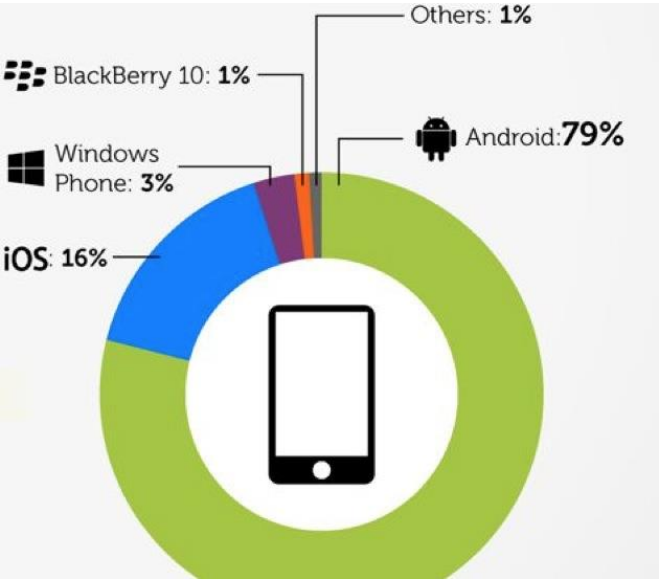

Figure 4.1.b

Android versions spread dynamics: April, 2015

Version	Codename	API	Distribution
2.2	Froyo	8	0.4%
2.3.3 - 2.3.7	Gingerbread	10	6.4%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	5.7%
4.1.x	Jelly Bean	16	16.5%
4.2.x		17	18.6%
4.3		18	5.6%
4.4	KitKat	19	41.4%
5.0	Lollipop	21	5.0%
5.1		22	0.4%

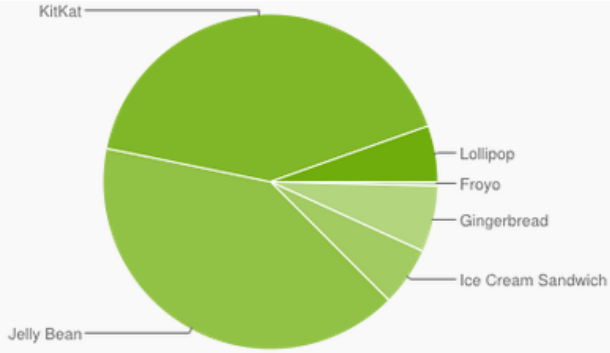

Figure 4.2 Android versions distribution worldwide April, 2015

4.2 Framework selection

For development of mobile appendices most rasprostrannenymi environments of development of Eclipse with support of a plug-in AndroidDeveloperTool and the environment of development of Android Studio. We will consider each of them.

Eclipse -the free integrated environment of development of modular cross-platform appendices. Eclipse Foundation develops and supported. The most known appendices on Eclipse Platform basis -various "Eclipse IDE" for development ON in a set of languages (for example, the most popular "Java IDE" supported initially isn't necessary on what - or the closed expansions, uses standard open API for access to Eclipse Platform.

Originally Eclipse was developed by IBM firm as the successor of the environment of development of IBM VisualAge, in quality of the corporate IDE standard for development in different languages for the IBM platforms. According to data of IBM, design and development cost 40 million dollars [28]. The initial code was completely open and made available how Eclipse was transferred for further development independent from IBM community.

In Eclipse 3.0 (2003) specifications of the service OSGi platform as architecture of the environment of execution were chosen. From version 3.0 Eclipse I ceased to be the monolithic IDE supporting expansions, an itself became a set of expansions. The framework of OSGi and SWT/JFace on which basis the following layer -RCP is developed (Rich Client Platform, a platform for development of full client appendices) are the cornerstone. RCP forms a basis not only for Eclipse, but also for others RCP-prilozheny, for example Azureus and File Arranger. The following layer -the Eclipse representing itself a set of the RCP expansions -editors, panels, prospects, the CVS module and the Java Development Tools (JDT) module.

Table 4.1 -Eclipse releases

Release	Data	Platform version	Project
Luna	6 June 2014	4.4	Luna
Kepler	26 June 2013	4.3	Kepler
Juno	27 June 2012	3.8 и 4.2	Juno
Indigo	22 June 2011	3.7	Indigo
Helios	23 June 2010	3.6	Helios
Galileo	24 June 2009	3.5	Galileo
Ganymede	25 June 2008	3.4	Ganymede
Europa	29 June 2007	3.3	Europa
Callisto	30 June 2006	3.2	Callisto
Eclipse	28 June 2005	3.1	Classic
Eclipse	28 June 2004	3.0	Classic

Basis of Eclipse is the platform of the expanded client (RCP -from English. rich client platform). It is made by the following components:

- Platform kernel (loading of Eclipse, start of modules);
- OSGi (standard environment of delivery of sets (English. bundles));
- SWT (the ported tools of widgets);
- JFace (file buffers, work with the text, text editors);
- Working Eclipse environment (panels, editors, projections, masters).

GUI is written to Eclipse with use of the SWT tools. The last, in difference from Swing (which independently emulates graphic elements of management), uses graphic components of this operational system. The user Eclipse interface also depends on an intermediate layer of GUI called by JFace which simplifies creation of the user interface which is based on SWT. Flexibility of Eclipse is provided for the account of the connected modules thanks to what development not only on Java, but also in other languages, such as C/C ++ is possible, Perl, Groovy, Ruby, Python, PHP, Erlang, Zonnon, etc.

Eclipse supports the following architecture and systems:

- Android (ARM);
- AIX (PPC/Motif);
- FreeBSD (x86, x86-64/GTK 2);
- HP-UX (HP9000/Motif);
- Linux (x86, x86-64, PPC, IA-64/GTK 2, x86/Motif);
- Mac OS X (x86, x86-64, PPC/ Cocoa);
- OpenSolaris (x86, x64, SPARC/ GTK 2);
- Solaris 8 (SPARC/GTK 2, Motif);
- QNX (x86/Photon);
- Microsoft Windows (Win32, Win64).

Android Studio.

Rather new environment of development of Android of appendices which is based on the Intellij IDEA platform of the JetBrains company (authors of IntellijIdea, PhpStorm, AppCode, ReSharper) which was announced at the world Google I conference \O 2013. Is in a stage of active development, additions come out almost each two weeks. Na figure 4.3 the supported development environments for the main platforms are displayed.

Platform	Package	Size	MD5 Checksum
Windows	android-studio-bundle-132.893413-windows.exe	484345454 bytes	14cbf0109a822688f4e2f886c0b0c85a
Mac OS X	android-studio-bundle-132.893413-mac.dmg	463332508 bytes	0cd4ac59864890f7de57314bcc7ea5aa
Linux	android-studio-bundle-132.893413-linux.tgz	487694946 bytes	9f1306100314b03ff5b691b94f154501

Figure 4.3 Supported frameworks for base platforms

4.3 Database Scheme

Databases are logically modelled storage spaces for all kinds of different information (data). Each database, other than schema-less ones, have a model, which provide structure for the data being dealt with. Database management systems are applications (or libraries) which manage databases of various shapes, sizes, and sorts.

Relational Database Management Systems.

Relational Database Systems implement the relational model to work with the data. Relational model shapes whatever information to be stored by defining them as related entities with attributes across tables (i.e. schemas).

These type of database management systems require structures (e.g. a table) to be defined in order to contain and work with the data. With tables, each column (e.g. attribute) holds a different type (e.g. data type) of information. Each record in the database, uniquely identified with keys, translates to a row that belongs to a table, with each row's series of attributes being represented as the columns of a table -- all related together, as defined within the relational model.

Relations And Data Types.

Relations can be considered as mathematical sets that contain series of attributes which collectively represent the database and information being kept. This type of identification and collection method allow relational databases to work the way they do.

When defining a table to insert records, each element forming a record (i.e. attribute) must match the defined data type (e.g. an integer, a date etc.). Different relational database management systems implement different data types -- which are not always directly interchangeable.

Working with and through constraints, like the one we have just explained, is common with relational databases. In fact, constraints form the core of the relations.

Popular And Important Relational Databases.

In this article, we are going to introduce three major and important open-source relational database management systems that have helped to shape the world of application development.

SQLite: A very powerful, embedded relational database management system.

MySQL: The most popular and commonly used RDBMS.

PostgreSQL: The most advanced, SQL-compliant and open-source objective-RDBMS.

Table 4.2- Supported Data Types

Data type	point	int numbers	non int numbers	time/date	text	other types
SQLite	Null, bool	integer	real	-	text	blob
MySQL	bool	tinyint, smallint, mediumint, integer, bigint	float, double, double precision, real / decimal, numeric	date, datetime, timestamp, time, year	char, varchar, tinytext, text, mediumtext, longtext	tinyblob, blob, mediumblob, longblob
PostgreSQL	Boolean, cidr	bigint, bigserial, integer, numeric [(p, s)], smallint, serial	double precision, real,	date, interval [fields] [(p)], time [(p)] with/out time zone, timestamp [(p)] [with/out time zone]	bit [(n)], bit varying [(n)], character varying [(n)], character [(n)], text	box, bytea, inet, macaddr, circle, line, lseg, path, point, polygon, money, tsquery, tsvector, xml

SQLite

SQLite is an amazing library that gets embedded inside the application that makes use of. As a self-contained, file-based database, SQLite offers an amazing set of tools to handle all sorts of data with much less constraint and ease compared to hosted, process based (server) relational databases.

When an application uses SQLite, the integration works with functional and direct calls made to a file holding the data (i.e. SQLite database) instead of communicating through an interface of sorts (i.e. ports, sockets). This makes SQLite extremely fast and efficient, and also powerful thanks to the library's underlying technology.

Advantages of SQLite.

File based:

The entire database consists of a single file on the disk, which makes it extremely portable.

Standards-aware:

Although it might appear like a "simple" DB implementation, SQLite uses SQL. It has some features omitted (RIGHT OUTER JOIN or FOR EACH STATEMENT), however, some additional ones are baked in.

Great for developing and even testing:

During the development phase of most applications, for a majority of people it is extremely likely to need a solution that can scale for concurrency. SQLite, with its rich feature base, can offer more than what is needed for development with the simplicity of working with a single file and a linked C based library.

Disadvantages of SQLite.

No user management:

Advanced databases come with the support for users, i.e. managed connections with set access privileges to the database and tables. Given the purpose and nature of SQLite (no higher-levels of multi-client concurrency), this feature does not exist.

Lack of possibility to tinker with for additional performance:

Again by design, SQLite is not possible to tinker with to obtain a great deal of additional performance. The library is simple to tune and simple to use. Since it is not complicated, it is technically not possible to make it more performant than it already, amazingly is.

When To Use SQLite.

Embedded applications:

All applications that need portability, that do not require expansion, e.g. single-user local applications, mobile applications or games.

Disk access replacement:

In many cases, applications that need to read/write files to disk directly can benefit from switching to SQLite for additional functionality and simplicity that comes from using the *Structured Query Language*(SQL).

Testing:

It is an overkill for a large portion of applications to use an additional process for testing the business-logic (i.e. the application's main purpose: functionality).

When Not To Use SQLite.

Multi-user applications:

If you are working on an application whereby multiple clients need to access and use the same database, a fully-featured RDBM (e.g. MySQL) is probably better to choose over SQLite.

Applications requiring high write volumes:

One of the limitations of SQLite is the *write* operations. This DBMS allows only one single write*operating to take place at any given time, hence allowing a limited throughput.

MySQL

MySQL is the most popular one of all the large-scale database servers. It is a feature rich, open-source product that powers a lot of web-sites and applications online. Getting started with MySQL is relatively easy and developers have access to a massive array of information regarding the database on the internet.

Advantages of MySQL

Easy to work with: MySQL can be installed very easily. Third-party tools, including visual ones (i.e. GUIs) make it extremely simple to get started with the database.

Feature rich: MySQL supports a lot of the SQL functionality that is expected from a RDBMS -- either directly or indirectly.

Secure: A lot of security features, some rather advanced, are built in MySQL.

Scalable and powerful: MySQL can handle *a lot* of data and furthermore it can be used "at scale", if needed be.

Speedy: Giving up some standards allows MySQL to work very efficiently and cut corners, thus providing speed gains.

Disadvantages of MySQL

Known limitations: By design, MySQL does not intend to do everything and it comes with functional limitations that some state-of-the-art applications might require.

Reliability issues: The way certain functionality gets handled with MySQL (e.g. references, transactions, auditing etc.) renders it a little-less reliable compared to some other RDBMSs.

Stagnated development: Although MySQL is still technical an open-source product, there are complaints regarding the development process since its acquisition. However, it should be noted that there are some MySQL-based, fully-integrated databases that add value on top of the standard MySQL installations (e.g. MariaDB).

When To Use MySQL

Distributed operations: When you need more than what SQLite can offer, including MySQL to your deployment stack, just like any stand-alone database server, brings a lot of operational freedom together with some advanced features.

High security: MySQL's security features provide reliable protection for data-access (and use) in a simple way.

Web-sites and web-applications: A great majority of web-sites (and web-applications) can simply work on MySQL despite the constraints. This flexible and somewhat scalable tool is easy to use and easy to manage -- which proves very helpful in the long run.

Custom solutions: If you are working on a highly specific and extremely custom solution, MySQL can tag along easily and go by your rules thanks to its rich configuration settings and operation modes.

When Not To Use MySQL

SQL compliance: Since MySQL does not [try to] implement the full SQL standard, this tool is not completely SQL compliant. If you might need integration with such RDBMSs, switching from MySQL will not be easy.

Concurrency: Even though MySQL and some storage engines perform really well with *read* operations, concurrent *read-writes* can be problematic.

Lack of features: Again, depending on the choice of the database-engine, MySQL can lack certain features, such as the full-text search.

id	timedate	organ_name
1	2015-05-02 05:20:11	Кровь
2	2015-05-02 05:20:11	Сердце
3	2015-05-02 05:20:11	Печень
4	2015-05-02 05:20:11	Желудок
5	2015-05-02 05:20:11	Легкие
6	2015-05-02 05:20:11	Почки
7	2015-05-02 05:20:11	Кишечник
8	2015-05-02 05:20:11	Мозг
9	2015-05-02 05:20:11	Глаза

Figure 4.4 Database table “Body part” classificator

id	timedate	analis_name	organ_id
1	2015-05-02 05:42:53	Общий анализ крови	1
2	2015-05-02 05:42:53	Биохимический анализ крови	1
3	2015-05-03 00:45:23	Иммунологический анализ крови	1
4	2015-05-03 00:45:23	Гармони́ческий ана́лиз	1
5	2015-05-03 00:48:07	Скрининговый анализ крови	1
6	2015-05-03 01:01:45	ЭКГ	2
7	2015-05-03 01:01:45	УЗИ	2
8	2015-05-03 01:02:11	МРТ	2
9	2015-05-03 01:05:56	Печеночный анализ крови	3
10	2015-05-03 01:05:56	Общий анализ мочи	3
11	2015-05-03 01:07:47	Тимолова проба	3
12	2015-05-03 01:09:31	Коагулограмма крови	3

Figure 4.5 Table Analysis

id	timedate	parametr_id	gender	min_value	max_value	other
1	2015-05-02 12:58:41	1	male	130	160	г/л
2	2015-05-02 12:58:41	1	female	120	140	г/л
3	2015-05-02 12:58:41	2	male	4	5.1	10^12 г/л
4	2015-05-02 12:58:41	2	female	3.7	4.7	10^12 г/л
23	2015-05-02 15:50:13	3	male	0.85	1.15	г/л
5	2015-05-02 12:58:41	4	male	180	320	10^9 г/л
6	2015-05-02 12:58:41	4	female	180	320	10^9 г/л
7	2015-05-02 12:58:41	5	male	1	10	мм/ч
8	2015-05-02 12:58:41	5	female	2	15	мм/ч
9	2015-05-02 12:58:41	6	male	4	9	10^9 г/л
10	2015-05-02 12:58:41	6	female	4	9	10^9 г/л
11	2015-05-02 12:58:41	10	male	3	5	ммоль/л
12	2015-05-02 12:58:41	10	female	3	5	ммоль/л
13	2015-05-02 12:58:41	11	male	3	17	мкмоль/л
14	2015-05-02 12:58:41	11	female	3	17	мкмоль/л
15	2015-05-02 12:58:41	12	male	20	41	Ед/л

Figure 4.6 Parameters norms for male/female person

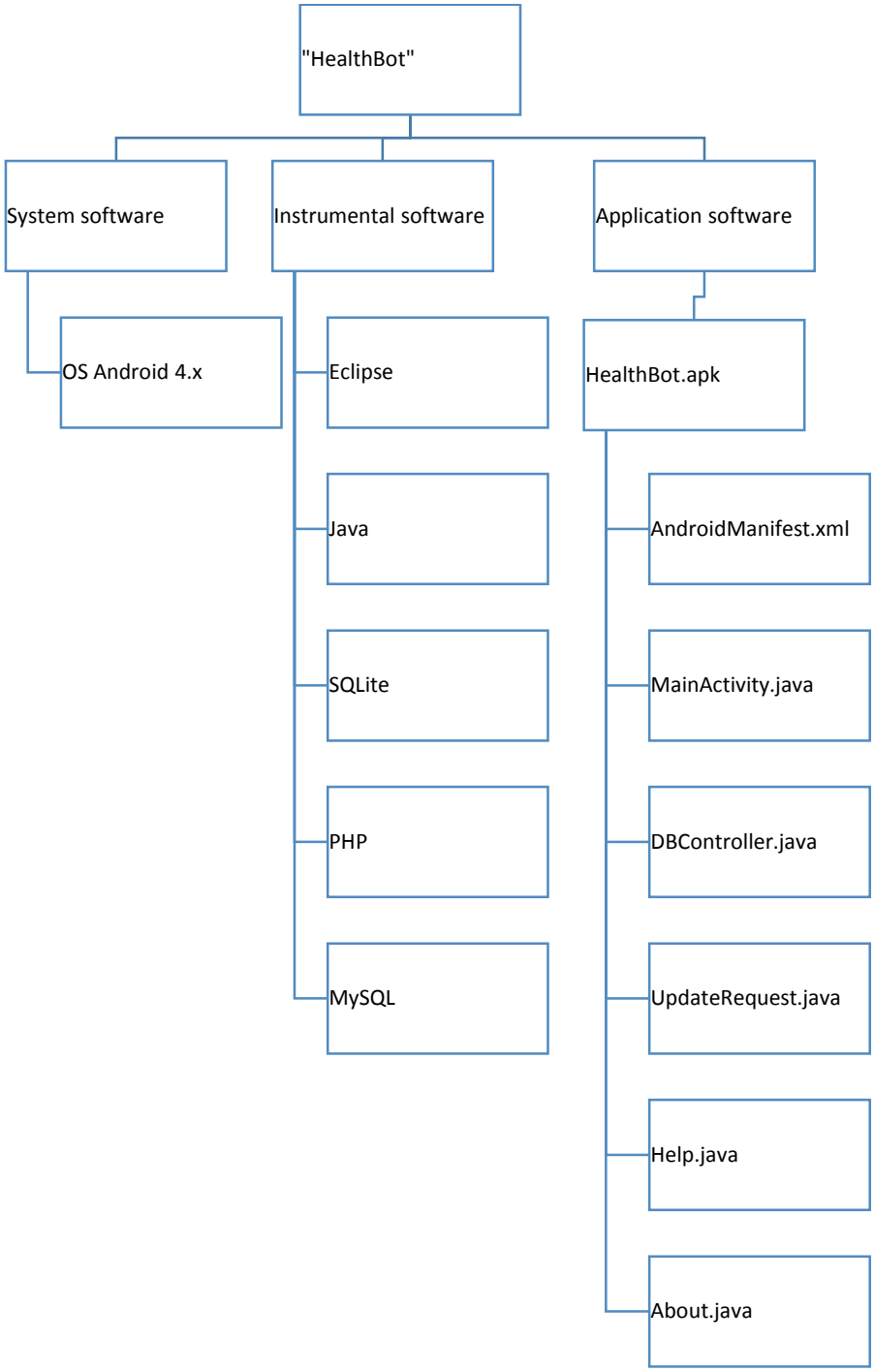

Figure 4.7 Mobile module scheme

Mobile module “HealthBot” for Healthcare situational center consists from next: Main activity, see Figure 4.8, Menu, requests history, about module, see figure 4.9.

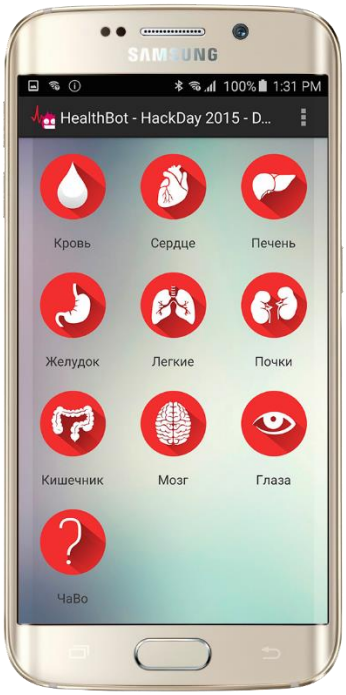

Figure 4.8 HealthBot main activity

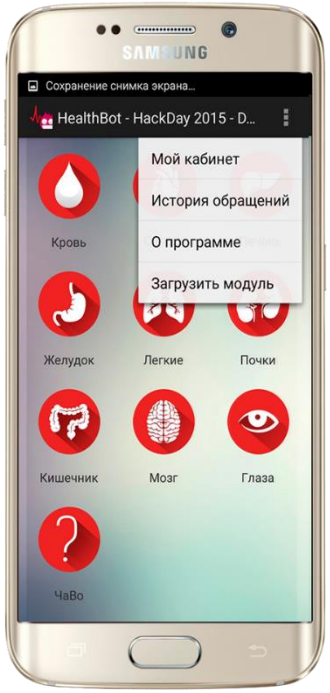

Figure 4.9 Module menu activity

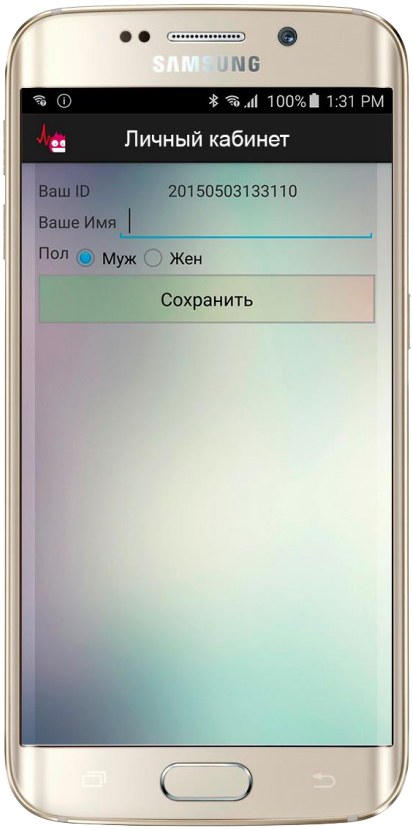

Figure 4.10 Personnel cabinet

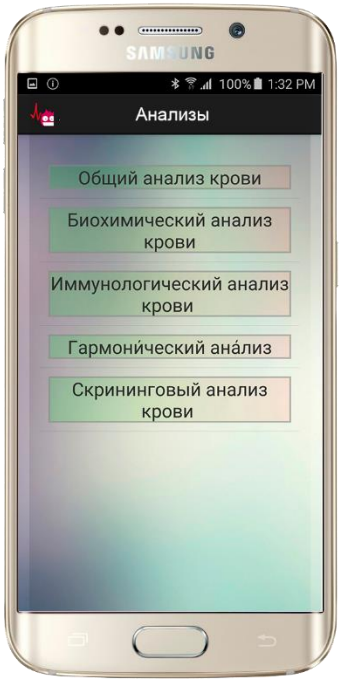

Figure 4.5 Blood analysis activity

Mobile module for diagnosis prediction based on Mamdani, Sugeno, C-means algorithm was developed in Eclipse ADT. Was tested on Android OS Lollipop 5.0, 5.1 on the next hardware: Samsung Galaxy S6 Edge (screen attached below), Samsung

Galaxy S2, HTC Dualsim 816 4 core, HTC Dual sim 310 2 core (Android v. 4.4 KitKat)

4.4 Empirical scenario

```
Centers:4
Point Object ( [r] => 78.8280194709 [g] => 168.176230035 [b] => 171.373448454 )
Point Object ( [r] => 85.3319697638 [g] => 82.4067932155 [b] => 83.7477979709 )
Point Object ( [r] => 175.883212251 [g] => 87.5952488425 [b] => 170.270230877 )
Point Object ( [r] => 169.525358432 [g] => 180.135343331 [b] => 81.9916765475 )
**********************************************
Center0:602
Center1:615
Center2:633
Center3:650

Points:2500
0 Point Object ( [r] => 61 [g] => 123 [b] => 147 ) Array ( [0] => 0.777518222938 [1] => 0.174064964833 [2] => 0.0301572170131 [3] => 0.0182595952162 )
1 Point Object ( [r] => 159 [g] => 215 [b] => 92 ) Array ( [0] => 0.00898879740936 [1] => 0.00375773298637 [2] => 0.00390275327549 [3] => 0.983350716329 )
2 Point Object ( [r] => 105 [g] => 204 [b] => 45 ) Array ( [0] => 0.0902889743862 [1] => 0.104514298736 [2] => 0.02474313174 [3] => 0.780453595138 )
3 Point Object ( [r] => 90 [g] => 88 [b] => 132 ) Array ( [0] => 0.0733224766122 [1] => 0.849015671301 [2] => 0.0616011208347 [3] => 0.0160607312518 )
4 Point Object ( [r] => 219 [g] => 164 [b] => 174 ) Array ( [0] => 0.0911432914777 [1] => 0.0330479991655 [2] => 0.593283639806 [3] => 0.28252506955 )
5 Point Object ( [r] => 201 [g] => 116 [b] => 186 ) Array ( [0] => 0.00868565600654 [1] => 0.00444712590088 [2] => 0.975935297642 [3] => 0.0109319204506 )
6 Point Object ( [r] => 101 [g] => 115 [b] => 109 ) Array ( [0] => 0.063298475958 [1] => 0.869323948965 [2] => 0.0321745384576 [3] => 0.0352030366199 )
7 Point Object ( [r] => 167 [g] => 125 [b] => 191 ) Array ( [0] => 0.0341193790367 [1] => 0.00858155358049 [2] => 0.941917913163 [3] => 0.0153811542203 )
8 Point Object ( [r] => 67 [g] => 91 [b] => 190 ) Array ( [0] => 0.615240545117 [1] => 0.186592539588 [2] => 0.170019005713 [3] => 0.0281479095832 )
9 Point Object ( [r] => 179 [g] => 80 [b] => 51 ) Array ( [0] => 0.0394367315033 [1] => 0.423881620474 [2] => 0.201396303415 [3] => 0.335285344607 )
10 Point Object ( [r] => 46 [g] => 121 [b] => 155 ) Array ( [0] => 0.797336054303 [1] => 0.15449456643 [2] => 0.0306390222667 [3] => 0.0175303570003 )
11 Point Object ( [r] => 173 [g] => 45 [b] => 134 ) Array ( [0] => 0.0137034854699 [1] => 0.0657807056517 [2] => 0.900367818794 [3] => 0.0201479900845 )
12 Point Object ( [r] => 30 [g] => 130 [b] => 102 ) Array ( [0] => 0.278951459652 [1] => 0.652191504984 [2] => 0.0271486974362 [3] => 0.0417083379283 )
13 Point Object ( [r] => 55 [g] => 200 [b] => 170 ) Array ( [0] => 0.98619204894 [1] => 0.00501625200561 [2] => 0.00332615989961 [3] => 0.0054655391552 )
14 Point Object ( [r] => 168 [g] => 184 [b] => 99 ) Array ( [0] => 0.000519562480358 [1] => 0.000310415342372 [2] => 0.000450372026516 [3] => 0.998719650151 )
15 Point Object ( [r] => 107 [g] => 149 [b] => 196 ) Array ( [0] => 0.945997293296 [1] => 0.00964879809964 [2] => 0.0351025124487 [3] => 0.00925139615542 )
16 Point Object ( [r] => 57 [g] => 230 [b] => 76 ) Array ( [0] => 0.449698824054 [1] => 0.157321649739 [2] => 0.0430358262306 [3] => 0.349943699976 )
17 Point Object ( [r] => 147 [g] => 162 [b] => 181 ) Array ( [0] => 0.554325813204 [1] => 0.032958285868 [2] => 0.300899835029 [3] => 0.111816065899 )
18 Point Object ( [r] => 102 [g] => 210 [b] => 36 ) Array ( [0] => 0.100962855738 [1] => 0.120879293 [2] => 0.0289841158285 [3] => 0.749173735433 )
19 Point Object ( [r] => 56 [g] => 153 [b] => 97 ) Array ( [0] => 0.423069604448 [1] => 0.460914404599 [2] => 0.0289494569569 [3] => 0.0870665339961 )
20 Point Object ( [r] => 87 [g] => 180 [b] => 198 ) Array ( [0] => 0.993526871344 [1] => 0.00163332095658 [2] => 0.00281253937826 [3] => 0.002027268321 )
21 Point Object ( [r] => 223 [g] => 118 [b] => 224 ) Array ( [0] => 0.0474947488669 [1] => 0.020290411917 [2] => 0.887552156725 [3] => 0.0446626824907 )
22 Point Object ( [r] => 121 [g] => 128 [b] => 118 ) Array ( [0] => 0.21837933688 [1] => 0.41561340916 [2] => 0.156321789464 [3] => 0.209685464496 )
```

Chapter 4 Conclusions

In chapter 4 is shown architecture and structure of mobile module, defined database solution, shown prototype of mobile module tested on HackDay 2015.

Mobile module will allow to doctor, patient or medical staff solve issue faster and put correct diagnosis based on analysis.

It'll be more helpful in integration ambulance data, polyclinic database and first aid clinics databases as at present time they are distributed and not structured with replication processes.

CONCLUSION

On the provided research basis we developed the fuzzy logic system, which includes the following properties:

On the basis of fuzzy logic formal methods we developed the efficient model that predicts risk of the disease based on fuzzy input sets. The model can take into several parameters

algorithmic terms, followed by unified modelling language specification.

1.The model of an indistinct logical conclusion for definition of the patient diagnosis is constructed. This indistinct model differs in use of the improved and added functionality of the structure uniting in itself indistinct algorithm, collecting and the data analysis, results assessment on modeling, the knowledge base and parameters control algorithm on indistinct model that allows to provide output parameters and to improve model accuracy.

2. Detailed approach to an indistinct model assessment on the patient diagnosis which differs in usage statistical data on indistinct model results, implementation model decisive rules concerning their conclusions, the knowledge base for decisive rules combinations that objectivity allows to carry out estimates at redefinition on indistinct model input parameters are presented.

3. The probabilistic algorithm for indistinct model parameters task the diagnosis statement is optimized.

4. Test experiment was made on unstructured data clusters (2500 and 10000 data points, c-means algorithm).

All of the goals are solved completely. The obtained results can be used and integrated in such systems like ENSZ, EISZ, etc.

In the future we would like to extend our research in order to

Perform multi disease application according fuzzy logic.

Also we want to add some more features into our application, in particular we want to make a complex system for educational and evaluation purposes with appropriate animations of virtual characters. As an alternative approach other methods, models and algorithms can be used in the future.

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74. Приказ № 12 от 08.01.2013 г. «Об утверждении Правил оплаты за оказанные медицинские услуги в рамках гарантированного объема бесплатной медицинской помощи, осуществляемые за счет средств республиканского бюджета».
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APPENDIX A

МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ имени М.В. ЛОМОНОСОВА (МГУ)

ФАКУЛЬТЕТ ВЫЧИСЛИТЕЛЬНОЙ МАТЕМАТИКИ И КИБЕРНЕТИКИ

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05.07.13 № 191-13/102-03
На № _____

Куатбаевой Акмарал Алихановне

Свидетельство

Настоящим свидетельством подтверждается, что Куатбаева Акмарал Алихановна в период с 24 июня по 6 июля 2013 г. прошла обучение по программе Международной Летней Суперкомпьютерной Академии, которая проходила на базе факультета Вычислительной Математики и Кибернетики Московского Государственного университета имени М.В. Ломоносова. Объем учебной программы составил 100 академических часов.

Руководитель учебной программы
Летней суперкомпьютерной академии,
чл.-корр. РАН, профессор Вл.В.Воеводин

APPENDIX B


ORT PUBLISHING NGO PREMIER

CERTIFICATE

This is to certify that

Kuatbayeva Akmaral

has participated successfully in the 1st Conference

Science progress in European countries: new concepts and modern solutions,

held in Stuttgart, Germany, Mart 29-30, 2013

Conference Co-Chair


ORT PUBLISHING NGO PREMIER

CERTIFICATE

This is to certify that

Kuatbayeva Akmaral Alikhanovna

has participated successfully in the 1st Conference

Applied Sciences and technologies in the United States and Europe: common challenges and scientific findings,

held in New York, USA, June 29-30, 2013

Conference Co-Chair

APPENDIX C

Девятая Международная Азиатская школа-семинар
"Проблемы оптимизации сложных систем"
15-25 августа 2013
Алматы

СЕРТИФИКАТ

Настоящим сертификатом подтверждается, что

Куатбаева Акмарал Алихановна

принимала участие в работе
Девятой Международной Азиатской школы-семинара
"Проблемы оптимизации сложных систем",
где она выступила с докладом на тему:

«Бюджетные программы повышения квалификации государственных служащих с привлечением иностранных преподавателей»

Руководители школы:

д.ф.-м.н., профессор **В.К. Попков** (ИВМиМГ СО РАН)

д.ф.-м.н., профессор, член-корр. НАН РК **М.Н. Калимолдаев** (ИПИУ МОН РК)

APPENDIX D

МОСКОВСКИЙ
ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ
им. М. В. ЛОМОНОСОВА
(МГУ)

МЕХАНИКО-МАТЕМАТИЧЕСКИЙ
ФАКУЛЬТЕТ

СПРАВКА

Оргкомитет международной конференции «Спектральная теория и дифференциальные уравнения», посвящённой 100-летию Б.М.Левитана, Москва, 23-27 июня 2014 г., подтверждает, что

Куатбаева Акмарал

принимала участие в конференции и сделала доклад

"Генетический алгоритм в когнитивном моделировании и управлении развитием ситуаций в здравоохранении".

Заместитель председателя
оргкомитета

А. А. Шкаликов

119991 Москва, Ленинские горы, д. 1. Телефон: +7-495-939-55-40, факс: +7-495-939-55-40

APPENDIX E

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ
РЕСПУБЛИКИ КАЗАХСТАН
Актюбинский региональный государственный
университет им. К.Жубанова

К.ЖҰБАНОВ АТЫНДАҒЫ АҚТӨБЕ ӨҢІРЛІК МЕМЛЕКЕТТІК УНИВЕРСИТЕТІ

СЕРТИФИКАТ

вручается
Куатбаевой А.А., Болатхановой Ж.А.,
Кажикаримовой С.А.
за активное участие в работе Международной
научно-практической интернет-конференции

СОВРЕМЕННЫЕ АКТУАЛЬНЫЕ ПРОБЛЕМЫ
ЕСТЕСТВЕННЫХ НАУК

которая состоялась
с 18 по 27 декабря 2014 года

Ректор К.К. Кенжебаев

Актобе - 2014

APPENDIX F

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Certificate of Attendance

This is to certify that

Akmaral Kuatbayeva

has attended a workshop on:

"Implementing mobile learning in Kazakhstan: Combining British experience and Kazakhstan possibilities"

February 11-13, 2015, Almaty, Kazakhstan

Assylbek Kozhakhmetov
Almaty Management University

John Traxler
University of Wolverhampton

APPENDIX G

State standards of the Republic of Kazakhstan in the field of information technologies

№	Обозначение стандарта	Наименование стандарта	Тип носителя
	35.020	**Информационные технологии (ИТ) в целом**	
1	СТ РК 34.005-2002	Информационная технология. Основные термины и определения - Введен впервые	Электронный
2	СТ РК 34.007-2002	Информационная технология. Телекоммуникационные сети. Основные термины и определения	Электронный
3	СТ РК 34.015-2002	Информационная технология. Комплекс стандартов на автоматизированные системы. ТЗ на создание АС - Введен впервые	
4	СТ РК 34.020-2006	Защита информации. Технические средства защиты информации. Имитаторы излучения. Общие технические требования - Введен впервые	Бумажный
5	СТ РК 34.021-2006	Защита информации. Технические средства защиты информации. Генераторы пространственного зашумления. Общие технические требования - Введен впервые	Бумажный

6	СТ РК 1184-2003	Качество служебной информации. Термины и определения - Введен впервые	Бумажный
7	СТ РК ИСО\МЭК 27001-2007	Информационная технология. Методы и средства обеспечения безопасности. Системы управления информационной безопасности. Требования -Введен впервые	Электронный, бумажный
8	СТ РК ГОСТ Р 50739-2006	Средства вычислительной техники. Защита от несанкционированного доступа к информации. Общие технические требования - Введен впервые	Бумажный
9	СТ РК ГОСТ Р 51275-2006 (ГОСТ Р 51275-99, IDT)	Средства вычислительной техники. Защита от несанкционированного доступа к информации. Общие технические требования.	Бумажный
10	СТ РК ГОСТ 52292-2007	Электронный обмен информацией. Термины и определения	Бумажный
11	СТ РК ГОСТ Р МЭК60950-2005	Безопасность оборудования информационных технологий - Введен впервые	Бумажный
	35.040	**Наборы знаков и кодирование информации**	
12	СТ РК 5.0-2005	Единая система классификации и	Бумажный

		кодирования технико-экономической и социальной информации. Основные положения - Введен впервые	
13	СТ РК 5.1-2007	Порядок разработки государственных классификаторов технико-экономической и социальной информации - Введен взамен 5.1-92	Бумажный
14	СТ РК 5.2-2005	Единая система классификации и кодирования технико-экономической и социальной информации. Положение о ведении государственных классификаторов технико-экономической информации - Введен взамен СТ РК 5.2-99	Бумажный
15	СТ РК 5.3-2005	Государственная система технического регулирования Республики Казахстан. Система классификации и кодирования технико-экономической информации. Порядок ведения реестра государственных классификаторов технико-экономической информации - Введен впервые	Бумажный
16	СТ РК 6.0-2005	Система штрихового кодирования продукции.	Бумажный

		Основные положения - Введен взамен СТ РК 6.0-96	
17	СТ РК 6.1-2005	Система штрихового кодирования продукции. Требования к символике "2 из 5 чередующийся" - Введен взамен СТ РК 6.1-98	Бумажный
18	СТ РК 34.014 - 2002	Информационная технология. Комплекс стандартов на автоматизированные системы. Автоматизированные системы. Термины и определения - Введен впервые	Бумажный
19	СТ РК 34.017-2005	Информационные технологии. Электронное издание. Электронное учебное издание - Введен впервые	Бумажный
20	СТ РК 34.023-2006	Информационная технология. Методика оценки соответствия информационных систем требованиям безопасности - Введен впервые	Бумажный
21	СТ РК 34.024-2006	Защита информации. Автоматизированные системы в защищенном исполнении. Общие технические требования - Введен впервые	Бумажный
22	СТ РК 34.025-2006	Защита информации. Порядок создания автоматизированных	Бумажный

		систем в защищенном исполнении. Общие положения - Введен впервые	
23	СТ РК 1048-2002	Информационная технология. 8-битовая кодовая таблица казахского алфавита - Введен взамен РСТ КазССР 920-92	Бумажный
24	СТ РК 1073-2007	Средства криптографической защиты информации. Общие технические требованияВеден взамен СТ РК 1073-2002	Бумажный
25	СТ РК 1087-2002	Единая система программной документации. Руководство пользователя. Требования к составу, содержанию и оформлению - Введен впервые	Бумажный
26	СТ РК 1089-2002	Единая система программной документации. Программа и методика испытаний. Планирование проведения испытаний программного обеспечения - Введен впервые	Бумажный
27	СТ РК 1090-2002	Единая система программной документации. Спецификация требований к программному	Бумажный

		обеспечению - Введен впервые	
28	СТ РК 1238-2004	Система штрихового кодирования продукции. Правила размещения штриховых кодов EAN на потребительских товарах и транспортных упаковках- Введен взамен ПР РК 50.6.1-96	Бумажный
29	СТ РК 1694-2007	Средства защиты телефонных аппаратов от утечки информации за счет акустоэлектрических преобразований и высокочастотного навязывания	Бумажный
30	СТ РК 1697-2007	Защита информации. Средства защиты технических сркдства от утечки информации по цепям электропитания	Бумажный
31	СТ РК 14516-2007	Технологии информационные. Методы обеспечения защиты. Использование и управление услугами доверенной третьей стороной. Общие требования	Бумажный
32	СТ РК ГОСТ Р ИСО/МЭК 15408-1-2006	Информационная технология. Методы и средства обеспечения безопасности. Критерии оценки безопасности информационных технологий. Часть 1.	Бумажный

		Введение и общая модель - Введен впервые	
33	СТ РК ГОСТ Р ИСО/МЭК 15408-2-2006	Информационная технология. Методы и средства обеспечения безопасности. Критерии оценки безопасности информационных технологий. Часть 2. Функциональные требования безопасности - Введен впервые	Бумажный
34	СТ РК ГОСТ Р ИСО/МЭК 15408-3-2006	Информационная технология. Методы и средства обеспечения безопасности. Критерии оценки безопасности информационных технологий. Часть 3. Требования доверия к безопасности - Введен впервые	Бумажный
35	СТ РК ГОСТ Р ИСО\МЭК 15419-2007	Автоматическая идентификация. Кодирование штриховое. Цифровой системы создания изображений и печати символов штрихового кода. Общие требования к испытаниям - Введен впервые	Бумажный
36	СТ РК ИСО/МЭК ТО 15443-1-2007	Технологии информационные. Методы защиты. Структура обеспечения безопасности информационных	Бумажный

		технологий. Часть 1. Общие требования	
37	СТ РК ИСО/МЭК ТО 15443-22007	Технологии информационные. Методы защиты. Структура обеспечения безопасности информационных технологий. Часть 2. Методы обеспечения	Бумажный
38	СТ РК ИСО/МЭК 10118-1-2006	Информационная технология. Методы защиты информации Хэш-функции. Часть 1. Общие положения.	Бумажный
39	СТ РК ИСО/МЭК 10118-2-2006	Информационная технология. Методы защиты информации Хэш-функции. Часть 2. Хэш-функции, использующие n-битовый блок шифрования	Бумажный
40	СТ РК ИСО/МЭК 10118-3-2006	Информационная технология. Методы защиты информации Хэш-функции. Часть 3. Специализированные Хэш-функции.	Бумажный
41	СТ РК ИСО/МЭК 10118-4-2006	Информационная технология. Методы защиты информации Хэш-функции. Часть 4. Хэш-функции, использующие модульную арифметику.	Бумажный
42	СТ РК ИСО/МЭК СТ РК ИСО/МЭК 14888-1-2006	Информационная технология. Методы защиты информации. Цифровые подписи с	Бумажный

		приложением. Часть 1. Общие положения - Введен впервые	
43	СТ РК ИСО/МЭК 14888-2-2006	Информационная технология. Методы защиты информации. Цифровые подписи с приложением. Часть 2. Механизмы основанные на идентичности - Введен впервые	Бумажный
44	СТ РК ИСО/МЭК 14888-3-2006	Информационная технология. Методы защиты информации. Цифровые подписи с приложением. Часть 3. Механизмы основанные на сертификате - Введен впервые	Бумажный
45	СТ РК ИСО/МЭК 17799-2006	Информационная технология. Методы обеспечения защиты свод правил по управлению защитой информации.	Бумажный
46	СТ РК ИСО/МЭК 18028-4-2007	Технологии информационные. Методы обеспечения защиты. Защита сети от информационных технологий.Часть 4. Защита удаленного доступа	Бумажный
	35 080	Документация на разработку программного обеспечения	
47	СТ РК 34.003 - 2002	Информационная технология. Номенклатура показателей качества баз	Бумажный

		данных информационных систем - Введен впервые	
48	СТ РК 34.004 - 2002	Информационная технология. Методы определения базовых значений показателей качества программного обеспечения - Введен впервые	Бумажный
49	СТ РК 34.008 - 2002	Информационная технология. Статистический анализ программных средств - Введен впервые	Электронный
50	СТ РК 34.009 - 2002	Информационная технология. Динамический анализ программных средств - Введен впервые	Электронный
51	СТ РК 34.010 - 2002	Информационная технология. Сертификация программных средств. Порядок проведения экспертизы программной документации. - Введен впервые	Электронный
52	СТ РК 34.011 - 2002	Информационная технология. Технологические факторы, определяющие работоспособность программных средств - Введен впервые	Электронный
53	СТ РК 34.012 - 2002	Информационная технология. Сертификация программных средств. Типовая методика оценка	Электронный

		качества программной документации - Введен впервые	
54	СТ РК 34.016 - 2004	Технические и программные средства дистанционного обучения. Общие технические требования - Введен впервые	Бумажный
55	СТ РК 34.018-2005	Информационная технология. Оценка программной продукции. Характеристики качества и руководства по их применению - Введен впервые	Бумажный
56	СТ РК 34.019-2005	Информационная технология. Процессы жизненного цикла программных средств - Введен впервые	Электронный
57	СТ РК 34.027-2006	Информационная технология. Классификация программных средств - Введен впервые	Бумажный
58	СТ РК 1695-2007	Информационная безопасность. Аттестация объектов информатизации и средств вычислительной техники. Общие требования -Введен впервые	Бумажный
59	СТ РК 1699-2007	Системы контроля и управления доступом	Бумажный
60	СТ РК 1700-2007	Техническая защита информации в служебных помещениях	Бумажный

61	СТ РК 1701-2007	Техническая защита информации в средствах вычислительной техники, автоматизированных информационных системах и сетях от утечки посредством побочных электромагнитных излучений и наводок. Общие технические требования	Бумажный
62	СТ РК ИСО/МЭК 6592-2002	Информационная технология. Руководство по документированию компьютерных прикладных систем - Введен впервые	Бумажный, электронный
63	СТ РК ГОСТ Р ИСО/МЭК 12119-2006	Информационная технология. Пакеты программ. Требования к качеству и тестированию.	Бумажный
64	СТ РК ГОСТ Р ИСО/МЭК 14764-2006	Информационная технология. Сопровождение программных средств - Введен впервые	Бумажный
65	СТ РК ГОСТ Р ИСО/МЭК 15026-2006	Информационная технология. Уровни целостности систем и программных средств - Введен впервые	Бумажный
66	СТ РК ИСО/МЭК ТО 15504-1-2002	Информационная технология. Оценка разработки программных средств. Часть 1. Общие понятия и вводное руководство	Бумажный

67	СТ РК ИСО/МЭК ТО 15504-2-2002	Информационная технология. Оценка разработки программных средств. Часть 2. Базовая модель процессов и их зрелость	Бумажный
68	СТ РК ИСО/МЭК ТО 15504-3-2002	Информационная технология. Оценка разработки программных средств. Часть 3. Проведение оценки	Бумажный
69	СТ РК ИСО/МЭК ТО 15504-4-2002	Информационная технология. Оценка разработки программных средств. Часть 4. Руководство по применению оценки	Бумажный
70	СТ РК ГОСТ Р ИСО/МЭК 15026-2006 (ГОСТ Р ИСО/МЭК 15910-2002, IDT)	Информационная технология. Процесс создания документации пользователя программного средства.	Бумажный
71	СТ РК ГОСТ Р 51188-2007	Защита информации. Испытания программных средств на наличие компьютерных вирусов	Бумажный
72	СТ РК ГОСТ Р ИСО/МЭК ТО 16326-2006	Программная инженерия. Руководство по применению СТ РК 34.019 при управлении проектом - Введен впервые	Бумажный
	35.100	**Взаимосвязь открытых систем**	
73	СТ РК 1178-2003	Защита информационной системы Государственного фонда	Бумажный

		стандартов от несанкционированного доступа. Общие технические требования - Введен впервые	
	35.100.70	**Прикладной уровень**	
74	СТ РК ГОСТ Р ИСО/МЭК 7498-1-2006	Информационная технология. Взаимосвязь открытых систем. Базовая эталонная модель - Часть 1. Базовая модель - Введен впервые	Бумажный
75	СТ РК ГОСТ Р ИСО/МЭК 7498-2-2006	Информационная технология. Взаимосвязь открытых систем. Базовая эталонная модель.	Бумажный
		Часть 2. Архитектура защиты информации - Введен впервые	
	35.160	**Микропроцессорные системы**	
76	СТ РК 34.002 - 2002	Информационная технология. Машины вычислительные электронные персональные. Требования к составу и правилам оценки характеристик качества - Введен впервые	Электронный
	35.240	**Применение информационных технологий**	Электронный
77	СТ РК 34.001 - 2002	Информационная технология. Сертификация баз данных. Методы обнаружения орфографических ошибок	

		в текстовых данных - Введен впервые	
78	СТ РК 34.022-2006	Защита информации. Требования к проектированию, установке, наладке, эксплуатации и обеспечению безопасности информационных систем	Бумажный
79	СТ РК 1698-2007	Защита информации. Защита информации от технических разведок и от ее утечки по техничеким каналам на объекте средств вычислительной техники	Бумажный

APPENDIX H

STANDARDS ON ELECTRONIC HEALTH CARE

IN THE REPUBLIC OF KAZAKHSTAN

1. The order on the approval of technical documentation concerning electronic health care.

2. The order of the Minister of Health of the Republic of Kazakhstan of April 22, 2014 No. 210 "About entering of additions into the order of the deputy. The Minister of Health of the Republic of Kazakhstan of February 10, 2014 No. 75 "About the approval of technical documentation concerning electronic health care".

3. Structure of working subgroups on standardization of electronic health care.

4. The plan of measures on standardization of electronic health care

5. Basic standards of electronic health care.

6. Standard requirements to the electronic passport of health.

7. Standard requirements to electronic medical record.

8. Standard requirements to identification of the operating parties of health care used in systems of electronic health care.

9. Technical requirements to interaction (transmission of messages) with information systems of e-health care.

10. Regulations on ensuring information security.

11. Standard requirements to the uniform qualifier of medicines, products of medical appointment and medical equipment.

12. Standard requirements to realization and regulation of the electronic directions.

13. Regulations of interaction of interested parties, for the purpose of ensuring interoperability of information systems and management of information streams.

14. Qualifier of laboratory researches.