# THE LECTURE 8

COLLECTIONS

## LIST OF COLLECTIONS

- Array
- System.Collections
- Hashtables
- Stack, Queue
- SortedList
- Collection Interfaces
- System.Collections.Generic
- List<T>

## ARRAY

- Array is a data structure that contains several variables of the same type.

```
type [ ] arrayName;
```

- Array has the following properties:
  - array can be **Single-dimensional**, **Multidimensiona**l or **Jagged**.
  - The default value of **numeric** array elements are set to **zero**, and **reference** elements are set to **null**.
  - Arrays are **zero indexed**: an array with **n** elements is indexed from **0** to **n-1**.
  - Array elements can be of **any type**, including an array type.
- Array types are reference types derived from the abstract base type **Array**. It implements **IEnumerable** and **IEnumerable<(Of <(T>)>)**, for using in **foreach**

# ARRAY. EXAMPLES

create →

element access →

number of elements →

```
int[] a = new int[5];
int [,] myMatrix=new int [6,8];

a[0] = 17;
a[1] = 32;
int x = a[1];

int l = a.Length;
```

default to `false` →

default to `0` →

set to given values →

```
bool[] a = new bool[10];

int[]  b = new int[5];

int[]  c = new int[5] { 48, 2,
55, 17, 7 };

int [] ages={5,6,8,9,2,0};
```

## ARRAY. EXAMPLES

- Multidimensional arrays:

```
string [ , ] names = new string[5,4];
```

- Array-of-arrays (jagged):

```
byte [ ][ ] scores = new byte[ 5 ][ ];
for ( int i = 0; i < scores.Length; i++)
{
    scores[i] = new byte[4];
}
```

- Three-dimensional rectangular array:

```
int [  ,  ,  ] buttons = new int [ 4, 5, 3];
```

## ARRAY. BENEFITS. LIMITATIONS

- **Benefits of Arrays**:
  - **Easy** to use: arrays are used in almost every programming language
  - **Fast** to change **elements.**
  - **Fast** to **move** through elements: Because an array is stored continuously in memory, it's **quick** and easy to cycle through the elements one-by-one from start to finish in a loop.
  - You can specify the type of the elements: When you create an array, you can **define** the **datatype**.
- **Limitations of Arrays**:
  - Fixed size: Once you have created an array, it will not automatically items onto the end.
  - Inserting elements mid-way into a filled array is difficult.

## SYSTEM.COLLECTIONS. ARRAYLIST

- **System.Collections** namespace
- **ArrayList**, **HashTable**, **SortedList, Queue, Stack**:
  - A collection can contain an **unspecified** number of members.
  - Elements of a collection do not have to share the same **datatype**.
  - An object's **position** in a collection can **change** whenever a change occurs in the whole, herefore, the position of a specific object in the collection can vary.

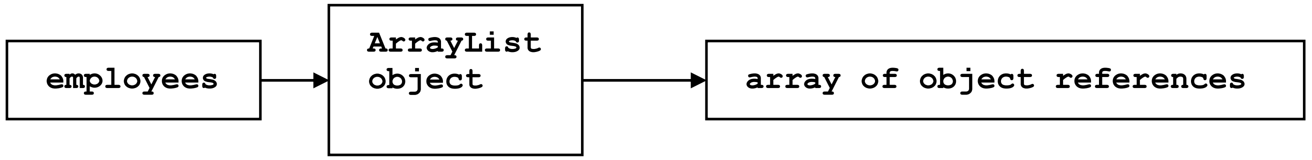
## ARRAYLIST

- `ArrayList` is a **special array** that provides us with some functionality over and above that of the standard Array.
- We can dynamically resize it by simply adding and removing elements.

**create `ArrayList` to store `Employees`** →

```
using System.Collections;

class Department
{
  ArrayList employees = new ArrayList();
  ...
}
```



# ARRAYLIST SERVICES

**add new elements** →

**remove** →

**containment testing** →

→

**control of memory**
**in underlying array** →

```
public class ArrayList : IList, ICloneable
{
  int  Add    (object value) // at the end
  void Insert(int index, object value) ...

  void Remove   (object value) ...
  void RemoveAt(int     index) ...
  void Clear    () ...

  bool Contains(object value) ...
  int  IndexOf (object value) ...

  object this[int index] { get... set.. }

  int  Capacity { get... set... }
  void TrimToSize() //minimize memory
  ...
}
```

## ARRAYLIST. BENEFITS AND LIMITATION

- **Benefits** of `ArrayList:`
  - Supports automatic **resizing.**
  - **Inserts** elements:An ArrayList starts with a collection containing no elements.
  - Flexibility when **removing elements**.
  - **Easy** to use.
- **Limitation** of `ArrayLists:`
  - There is **one major limitation** to an `ArrayList:` **speed**.
  - The flexibility of an `ArrayList` comes at a cost, and since memory allocation is a very expensive business the fixed structure of the simple array makes it a lot faster to work with.

# STACK

- `Stack`: last-in-first-out

create `Stack` to store sequence of method calls →

```
using System.Collections;

class Trace
{
   Stack callChain = new Stack();
   ...
}
```

```
Stack s = new Stack();

s.Push("aaa");
s.Push("bbb");

string t = (string)s.Peek();

string u = (string)s.Pop();
...
```

add → `s.Push("aaa"); s.Push("bbb");`

examine → `string t = (string)s.Peek();`

remove → `string u = (string)s.Pop();`

## QUEUE

- Queue: first-in-first-out

create Queue
to store events →

```
using System.Collections;

class Watcher
{
  Queue events = new Queue();
  ...
}
```

```
Queue q = new Queue();

q.Enqueue("aaa");
q.Enqueue("bbb");
q.Enqueue("ccc");

string s = (string)q.Peek();

string t = (string)q.Dequeue();
```

add → q.Enqueue

examine → q.Peek

remove → q.Dequeue

## HASHTABLE

- Represents a collection of **key/value pairs** that are organized based on the hash code of the key.
- The objects used as keys must override the **GetHashCode** method and the **Equals** method.

- **Benefits** of Hashtable:
  - **Non-numeric indexes** allowed. **Key** can be numeric, textual, or even in form of a date. But can't be null reference.
  - Easy **inserting** elements.
  - Easy **removing** elements.
  - Fast **lookup**.

create →

```
Hashtable ages = new Hashtable();
```

add →

```
ages["Ann"] = 27;
ages["Bob"] = 32;
ages.Add("Tom", 15);
```

update →

```
ages["Ann"] = 28;
```

retrieve →

```
int a = (int)ages["Ann"];
```

## HASHTABLE

- **Limitations** of Hashtable:
  - **Performance** and **speed**: `Hashtable` objects are **slower to update** but **faster to use** in a look-up than `ArrayList` objects.
  - **Keys** must be **unique**: An array automatically keeps the index values unique. In a `Hastable` we must monitor the key uniqueness.
  - No useful **sorting**: The items in a `Hashtable` are **sorted internally** to make it easy to find objects very quickly. It's not done by keys or values, the items may as well not be sorted at all.

```
Hashtable ages = new Hashtable();

ages["Ann"] = 27;
ages["Bob"] = 32;
ages["Tom"] = 15;

foreach (DictionaryEntry entry in ages)
{
  string name = (string)entry.Key;
  int    age  = (int)   entry.Value;
  ...
}
```

enumerate entries →

get key and value →

## SORTEDLIST

- Represents a collection of **key/value pairs** that are **sorted** by the keys
- Are accessible by **key** and by **index**.
- A SortedList object internally maintains two arrays to store the elements of the list
- Use the new keyword when creating the object. Each adding item is automatically inserted in the correct position in the list, according to a specific IComparer implementation .

```
SortedList stlShippers = new SortedList();

stlShippers["cp"]="Canada Post";

stlShippers["fe"]="Federal Express";

stlShippers["us"]="United State Postal Service";

foreach (DictionaryEntry de in stlShippers)

{

    Console.WriteLine("Key = {0}, Value = {1}", de.Key, de.Value);

}
```

## LIST<T>

- **List generic** class:

```
 [SerializableAttribute]
public class List<T> : IList<T>, ICollection<T>,
    IEnumerable<T>, IList, ICollection, Ienumerable
```

- The **List class** is the generic **equivalent** of the **ArrayList** class. It implements the `IList` generic interface using an array whose size is dynamically increased as required.
- The List class **uses** both an equality comparer and an ordering comparer.
- Methods such as **Contains**, **IndexOf**, **LastIndexOf**, and **Remove** use an equality comparer for the list elements.
- If type **T** implements the `IEquatable` generic interface, then the equality comparer **is the Equals method** of that interface; otherwise, the default equality comparer is `Object.Equals(Object).`

## LIST<T>

- Methods such as **BinarySearch** and **Sort** use an ordering comparer for the list elements.
- The List is not guaranteed to be sorted. You must sort the List before performing operations (such as BinarySearch) that require the List to be sorted.
- Elements in this collection can be accessed using an integer index. Indexes in this collection are zero-based.
- List accepts a **null** reference **as a valid** value for reference types and allows duplicate elements.