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Arrays

Processing Sequences of Elements

C# Advanced

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Declaring and Creating Arrays

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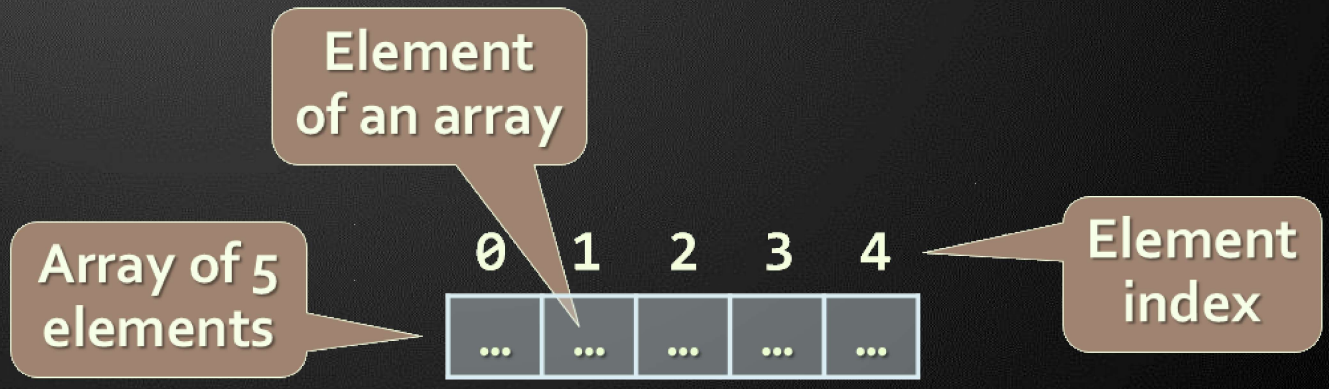
What are Arrays?

- An array is a sequence of elements
  - All elements are of the same type
  - The order of the elements is fixed
  - Has fixed size (Array.Length)



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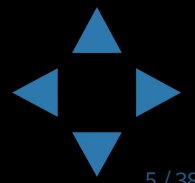
Declaring Arrays

- Declaration defines the type of the elements
- Square brackets [] mean array
- *Examples*:
  - Declaring an array of integers:

```
int[] myIntArray;
```

  - Declaring an array of strings:

```
string[] myStringArray;
```

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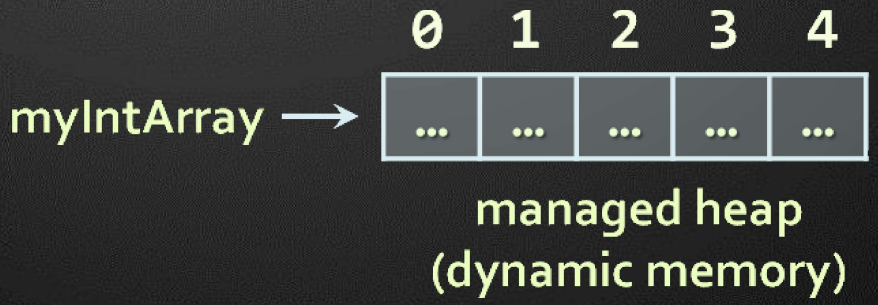
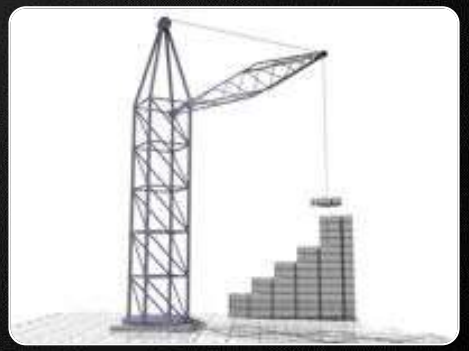
Creating Arrays

- Use the operator new
  - Specify array length
- *Example* creating (allocating) array of 5 integers:

```
myIntArray = new int[5];
```



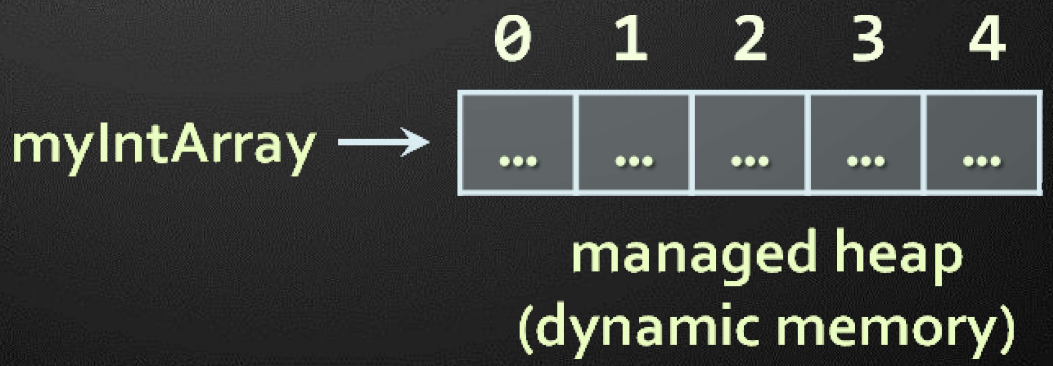


Telerik Academy Creating and Initializing Arrays

- Creating and initializing can be done together:

```
myIntArray = {1, 2, 3, 4, 5};
```

- The new operator is not required when using curly brackets initialization



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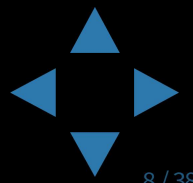
Creating Array – *Example*

- Creating an array that contains the names of the days of the week

```
string[] daysOfWeek =
{
    "Monday",
    "Tuesday",
    "Wednesday",
    "Thursday",
    "Friday",
    "Saturday",
    "Sunday"
};
```

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Days of Week

Demo

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Accessing Array Elements

Read and Modify Elements by Index

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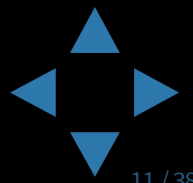
How to Access Array Element?

- Array elements are accessed using the square brackets operator [ ] (indexer)
  - Array indexer takes element's index as parameter
  - The first element has index `0`
  - The last element has index `Length-1`
- Array elements can be retrieved and changed by using the [ ] operator



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Reversing an Array – *Example*

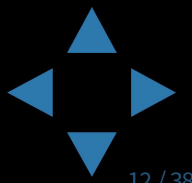
- Reversing the contents of an array

```
int[] array = new int[] {1, 2, 3, 4, 5};

// Get array size
int length = array.Length;

// Declare and create the reversed array
int[] reversed = new int[length];

// Initialize the reversed array
for (int index = 0; index < length; index++)
{
    reversed[length-index-1] = array[index];
}
```

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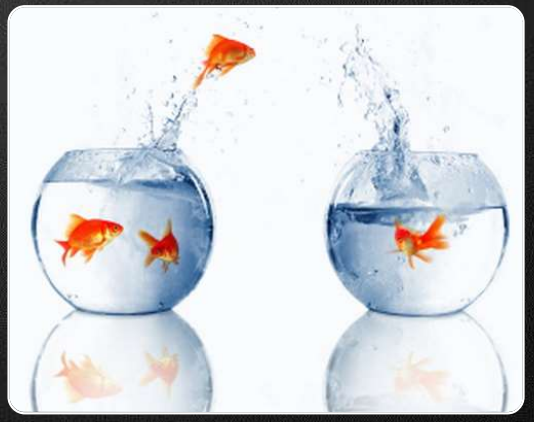
Reversing an Array

Demo



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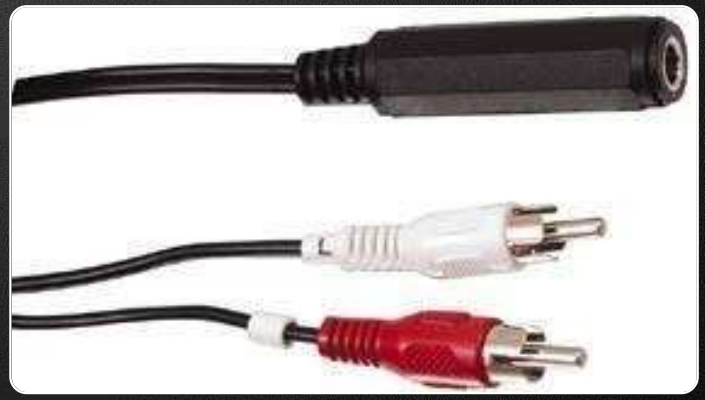
Arrays: Input and Output

Reading and Printing Arrays on the Console



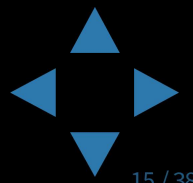
Reading Arrays From the Console

- First, read from the console the length of the array

```
int n = int.Parse(Console.ReadLine());
```

- Next, create the array of given size and read its elements in a `for` loop

```
int[] arr = new int[n];
for (int i = 0; i < n; i++)
{
    arr[i] = int.Parse(Console.ReadLine());
}
```

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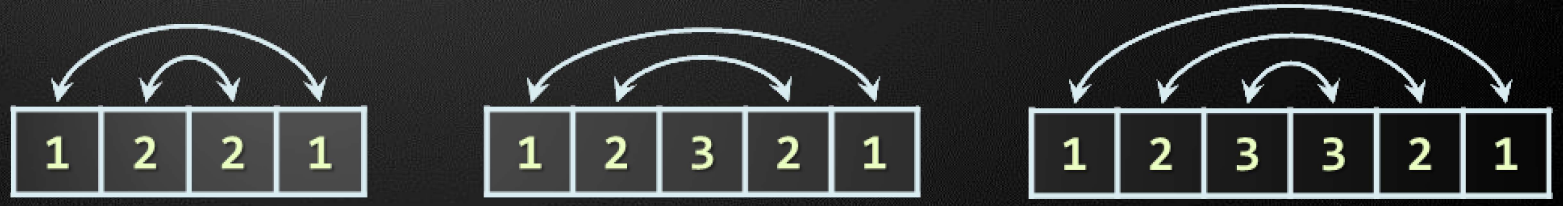
Symmetry Check – *Example*

- Read `int` array from the console and check if it is symmetric:

```
bool isSymmetric = true;
for (int i = 0; i < array.Length / 2; i++)
{
  if (array[i] != array[n - i - 1])
  {
      isSymmetric = false;
  }
}
```



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Symmetry Check

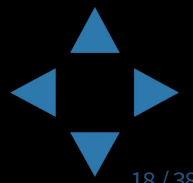
Demo

Telerik Academy Printing Arrays on the Console

- Process all elements of the array
- Print each element to the console
- Separate elements with white space or a new line

```
string[] array = {"one", "two", "three"};

// Process all elements of the array
for (int index = 0; index < array.Length; index++)
{
    // Print each element on a separate line
    Console.WriteLine("element[{0}] = {1}",
        index, array[index]);
}
```

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Printing Arrays

Demo

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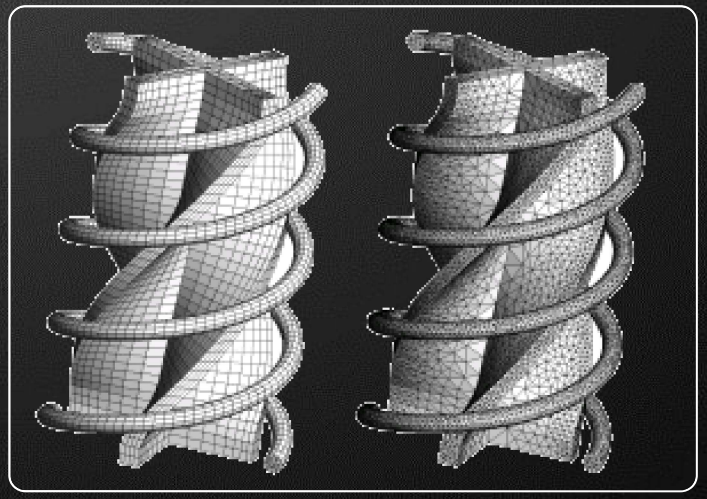
Processing Array Elements Using for and foreach



Processing Arrays: for Statement

- Use `for` loop to process an array when
  - Need to keep track of the index
  - Processing is not strictly sequential from the first to the last element
- In the loop body use the element at the loop index (`array[index]`):

```
for (int index = 0; index < array.Length; index++)
{
    squares[index] = array[index] * array[index];
}
```

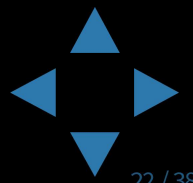
Processing Arrays Using for Loop – *Examples*

- Printing array of integers in reversed order:

```
Console.WriteLine("Reversed: ");
for (int i = array.Length-1; i >= 0; i--)
{
    Console.Write(array[i] + " ");
}
// Result: 5 4 3 2 1
```

- Initialize all array elements with their corresponding index number:

```
for (int index = 0; index < array.Length; index++)
{
    array[index] = index;
}
```



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Processing Arrays: foreach

- How foreach loop works?
  - type – the type of the element
  - value – local name of variable
  - array – processing array

```
foreach (type value in array)
{
// statements
}
```

- Used when no indexing is needed
  - All elements are accessed one by one
  - Elements can not be modified (read only)

Processing Arrays Using `foreach` – *Example*

- Print all elements of a `string[]` array:

```
string[] capitals =
{
    "Sofia",
    "Washington",
    "London",
    "Paris"
};
foreach (string capital in capitals)
{
    Console.WriteLine(capital);
}
```

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Processing Arrays

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Resizable Arrays

List<T>

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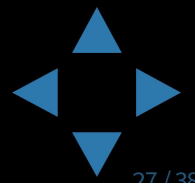
Lists (Resizable Arrays)

- `List<T>` – array that can be resized dynamically
  - Whenadding or removing elements
  - Also have indexers `[]` (like arrays)
  - `T` is the type that the list will hold
    - E.g. `List<int>` will hold `integers`
    - `List<object>` will hold `objects`
- Basic methods and properties
  - `Add(T element)` – adds new element to the end
  - `Remove(element)` – removes the element
  - `Count` – returns the current size of the list



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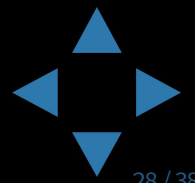
List *Example*

```
List<int> intList = new List<int>();
for(int i = 0; i < 5; i++)
{
    intList.Add(i);
}
```

- Is the same as:

```
int[] intArray = new int[5];
for(int i = 0; i < 5; i++)
{
    intArray[i] = i;
}
```

- The main difference
  - When using lists we don't have to know the exact number of elements



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Lists vs. Arrays

- Lets have an array with capacity of 5 elements

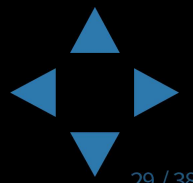
```
int[] intArray = new int[5];
```

- If we want to add a sixth element (we have already added 5) we have to manually resize

```
int[] copyArray = intArray;
int[] intArray = new int[6];
for (int i = 0; i < 5; i++)
{
    intArray[i] = copyArray[i];
}
intArray[5] = newValue;
```

- With `List<T>` we simply call

```
list.Add(newValue);
```



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Lists <T>

Demo

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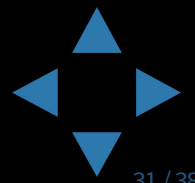
How The List<T> Works?

- Why adding new elements is not slow?
  - When adding n elements in `List<T>` it resizes itself `log(2)n` times instead of n
- Initially a new `List<T>` has size of 0 elements
  - Counter for total capacity (`Capacity`)
  - Counter for number of used capacity (`Count`)
  - When created, both properties of the list have values of 0
  - When adding the first element `Count` becomes `1` and `Capacity` becomes `4`



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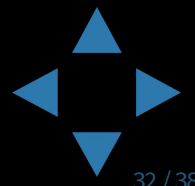
How The List<T> Works?

- Initially the List<T> is empty
  - When adding new element it is resized
  - But not every time
    - Only when it is needed
- Lets have a list with 3 elements
  - It looks like this:

  - When we add new element it is appended to the end

  - Adding a fifth element doubles the Capacity of the list



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Resizing Lists

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Copying Arrays

The Array Class

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Copying Arrays

- Sometimes we must copy the values from one array to another one
  - If we do it the intuitive way we would copy not only the values but the reference to the array
    - Changing some of the values in one array will affect the other

```
int[] array = new [5] { 1, 2, 3, 4, 5 };
int[] copyArray = array;
```

  - The way to avoid this is using `Clone()`
    - This way only the values will be copied but not the reference

```
int[] array = new [5] { 1, 2, 3, 4, 5 };
int[] copyArray = (int[])array.Clone();
```

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Summary

- Arrays are a fixed-length sequences of elements of the same type
- Array elements are accessible by index
  - Can be read and modified
- Iteration over array elements can be done with `for` and `foreach` loops
- `List<T>` holds resizable arrays
  - Good when we don't know the number of elements initially

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C# Arrays

Questions?

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