

Module 4

"Reference Types and Statements"



TEKNOLOGISK
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Agenda

- ▶ **Arrays**
- ▶ Strings
- ▶ Value Types Revisited – **Nullable**
- ▶ Selection Statements
- ▶ Iteration Statements
- ▶ Jump Statements
- ▶ Lab 4
- ▶ Discussion and Review

What Are Arrays?

- ▶ An array is a set of data items

42	87	112	...	256
----	----	-----	-----	-----

- ▶ All items are of the same type
- ▶ An array is accessed using a numerical index starting from 0!

Declaring an Array

- ▶ An array variable is declared as

```
Type[] Name;
```

- ▶ Array size is not a part of the declaration!

```
int[ 10 ] myArray;
```



- ▶ Can declare arrays of several dimensions

```
char[ , ] myCharGrid;
```

```
double[ , , ] myCube;
```

Indexing Arrays

- ▶ Arrays are indexed by variable name and index

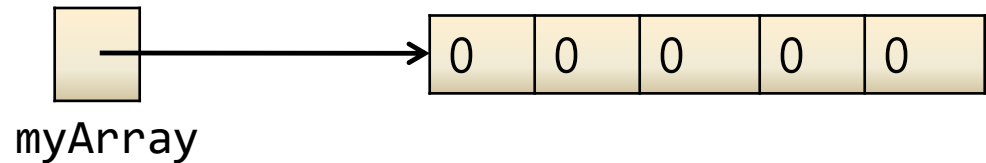
```
int[] myArray;  
...  
Console.WriteLine( myArray[2] ); // 112
```

42	87	112	...	256
----	----	-----	-----	-----

Creating Arrays

- ▶ Declaring an array variable does not create the array itself!
- ▶ It must be explicitly created with the **new** operator

```
int[] myArray;  
...  
myArray = new int[ 5 ];
```



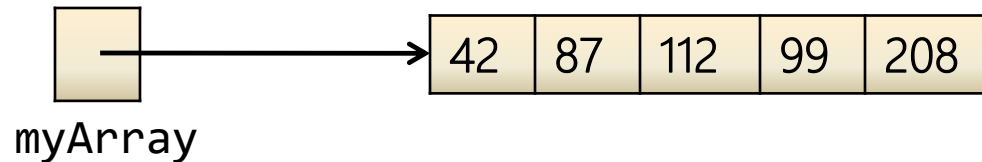
```
int[] myArray = new int[ 5 ];
```

- ▶ Arrays are by default initialized with "Zero Whitewash"

Initializing Arrays

- ▶ Arrays can be explicitly initialized

```
int[] myArray = new int[ 5 ] { 42, 87, 112, 99, 208 };
```



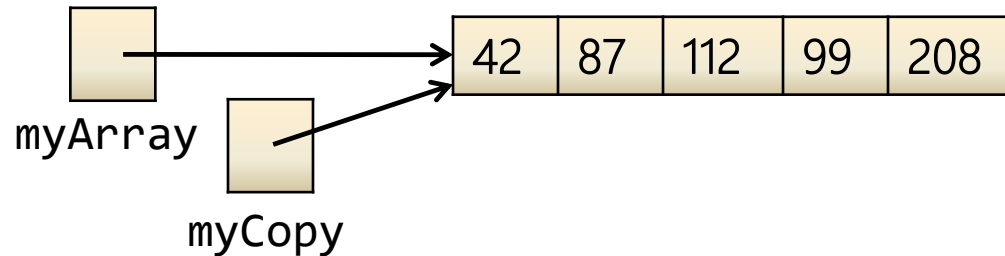
- ▶ A convenient shorter syntax exists

```
int[] myArray = { 42, 87, 112, 99, 208 };
```

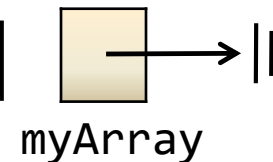
Assigning Array Variables

- ▶ Copying array variables amounts to copying references only!

```
int[] myArray = new int[ 5 ] { 42, 87, 112, 99, 208 };
int[] myCopy = myArray;
myArray[ 1 ] = 0;
Console.WriteLine( myCopy[ 1 ] );
```



```
myArray = null;
```



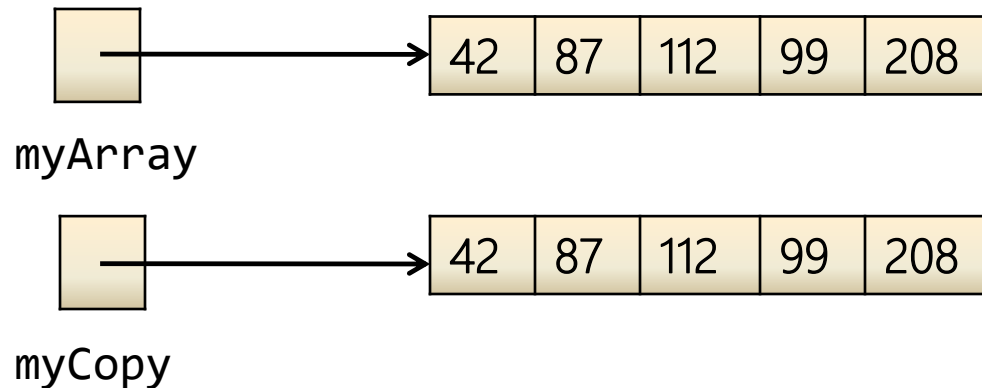
- ▶ This is the case for reference types in general



Comparing Array Variables

- ▶ Comparing array variables amounts to comparing references

```
int[] myArray = { 42, 87, 112, 99, 208 };  
int[] myCopy = { 42, 87, 112, 99, 208 };  
Console.WriteLine( myArray == myCopy ); // ???
```



- ▶ This is the case for reference types in general



System.Array

- ▶ Arrays are instances of **System.Array**
- ▶ Static methods
 - `Clear()`
 - `Reverse()`
 - **`Sort()`**
 - `IndexOf()`
 - ...



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- ▶ **Strings**
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System.String

- ▶ Strings have a number of useful methods and properties
 - Length
 - Compare()
 - Contains()
 - Equals()
 - **Format()**
 - Insert()
 - PadLeft()
 - PadRight()
 - Remove()
 - Replace()
 - Split()
 - Substring()
 - Trim()
 - ToUpper()
 - ToLower()
 - ...



Interpolating Strings

- ▶ C# 6.0 offers easier formatting of strings
 - *String Interpolation* is essentially a built-in `string.Format()`

```
string firstName = "Bruce";  
string lastName = "Campbell";  
  
string name = $"{firstName} {lastName}";
```

- ▶ Very flexible
 - Works with any expression
 - Respects usual formatting characters etc.



Manipulating Strings

- ▶ The **+** operator concatenates strings

```
string s1 = "Programming ";  
string s2 = "C# 5.0";  
string s3 = s1 + " in " + s2;  
Console.WriteLine( s3 );
```

- ▶ It is a convenient shorthand for **String.Concat**

```
string s3 = string.Concat( s1, string.Concat( " in ", s2 ) );
```

- ▶ Escaped strings

```
string s = "This is a \t \\tab\\ with newline\r\n";
```

- ▶ Verbatim strings

```
string s = @"This is a \t \\tab\\ with newline\r\n";
```



Strings and Equality

- ▶ String is a reference type!

```
string s1 = "Hello!";  
string s2 = "Hello!";  
string t = "Yo!";  
  
Console.WriteLine( s1 == s2 );           // ???  
Console.WriteLine( s1 == "Hello!" );     // ???  
Console.WriteLine( s1 == "HELLO!" );     // ???  
Console.WriteLine( s1.ToUpper() == "HELLO!" ); // ???  
Console.WriteLine( s1.Equals( t ) );      // ???  
Console.WriteLine( "Yo!".Equals( t ) );   // ???
```

- ▶ The `==` operator has been redefined for strings to compare values
 - Uses the **Equals()** method under the covers




Strings Are Immutable

- ▶ Don't be fooled: All string operations return copies of strings!

```
string s1 = "Hello!";  
s1.ToUpper();  
Console.WriteLine( s1 == "Hello!" );           // ???  
Console.WriteLine( s1 == "HELLO!" );           // ???  
  
s1 += " Again...";
```

```
Console.WriteLine( s1[ 0 ] );  
s1[ 0 ] = 'Y';
```



- ▶ **System.Text.StringBuilder** is specially designed for gradually building strings

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What Are Nullable Types?

- ▶ Can assume the values of the underlying value type as well as **null**

```
int? i = 87;  
int? j = null;  
if( i.HasValue )  
{  
    int k = i.Value + j.GetValueOrDefault( 42 );  
    Console.WriteLine( k );  
}
```

```
int k = i.Value + ( j ?? 42 );
```

- ▶ The ?? operator is an elegant shorthand



Characteristics of Nullable Types

- ▶ Make no mistake about it: Nullable types are **value types**!
- ▶ Only value types can be nullable!
- ▶ **int?** is actually defined as

```
Nullable<int> i = 42;
```
- ▶ This will become apparent when we discuss Generics later...

Null-conditional Operator

- ▶ C# 6.0 introduces a new null-conditional operator `?.`
 - Also known as the “Elvis operator” 😊

```
string s = null;  
  
// ...  
  
string t = s?.ToUpper(); // Upper-case (or null if s == null)
```

- ▶ Right-hand side only evaluated if left-hand side is not null
 - Propagates null through expression
- ▶ Interacts brilliantly with the null-coalescing operator `??`

```
string t = s?.ToUpper() ?? "No string";
```



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if-else Statements

```
if( i > 0 )  
{  
    Console.WriteLine( "i is greater than 0" );  
}  
else  
{  
    Console.WriteLine( "i is 0 or less" );  
}
```

- ▶ Condition must be Boolean
- ▶ Parenthesis are required!
- ▶ Use braces!
- ▶ **else**-branch is optional



Nested if-else

```
if( i > 100 )  
{  
    Console.WriteLine( "i is really large" );  
}  
else if( i > 10 )  
{  
    Console.WriteLine( "i is okay big" );  
}  
else if( i > 0 )  
{  
    Console.WriteLine( "i is big" );  
}  
else  
{  
    Console.WriteLine( "i is not much" );  
}
```

- ▶ No **elseif** keyword



switch

- ▶ Switch handles a predefined set of choices

```
Console.WriteLine("1 [C#], 2 [VB]");  
string langChoice = Console.ReadLine();  
int n = int.Parse( langChoice );  
switch( n )  
{  
    case 1:  
        Console.WriteLine("Good choice, C# is the best!");  
        break;  
    case 2:  
        Console.WriteLine("VB .NET: OOP and more!");  
        break;  
    default:  
        Console.WriteLine("Well...good luck with that!");  
        break;  
}
```



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for Loop

- ▶ Uses Initialization, a terminating Condition, and an Incrementation statement

```
// Note! "i" is only visible within the for loop.  
for( int i = 0; i < 4; i++ )  
{  
    Console.WriteLine( "Number is: {0} ", i );  
}  
  
// "i" is not visible here.
```

- ▶ Can iterate over several variables
- ▶ Any of the three can be left out

```
for( int i = 0, j = 10; ; i++, j -= 10 )  
{  
    Console.WriteLine( "i = {0}. j = {1}", i, j );  
}
```



foreach Loop

- ▶ Iterates over all elements of an enumerable set

```
int[] myArray = { 42, 87, 112, 99, 208 };  
foreach( int i in myArray )  
{  
    Console.WriteLine("Number is: {0} ", i);  
}  
  
// "i" is not visible here.
```

- ▶ Counter variable is read-only!
- ▶ Type must implement the **IEnumerable** interface
 - Works for a number of predefined as well as user-defined types
 - See Module 10



while Loop

- ▶ Iterates zero or more times
- ▶ Iterating Boolean condition is evaluated before each iteration
- ▶ Executes statement block if condition is true

```
string userIsDone = "";  
while( userIsDone.ToLower() != "yes" )  
{  
    Console.Write("Are you done? [yes] [no]: ");  
    userIsDone = Console.ReadLine();  
}
```

- ▶ Condition must be Boolean
- ▶ Parentheses are required – braces are not

do-while Loop

- ▶ Iterates one or more times
- ▶ Iterating Boolean condition is evaluated after each iteration
- ▶ Executes statement block if condition is true

```
string userIsDone = "";  
do  
{  
    Console.Write("Are you done? [yes] [no]: ");  
    userIsDone = Console.ReadLine();  
} while( userIsDone.ToLower() != "yes" );
```

- ▶ Condition must be Boolean
- ▶ Parentheses are required

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continue

- ▶ Used in loop constructs
- ▶ Skips remainder of iteration

```
foreach (int i in myArray)
{
    if( i != 87 )
    {
        continue;
    }
    Console.WriteLine( "Number is: {0} ", i );
}
```



break

- ▶ Used in loop constructs
- ▶ Skips remainder of iteration and exits loop

```
foreach (int i in myArray)
{
    if( i == 87 )
    {
        Console.WriteLine( i );
        break;
    }
}
```

- ▶ Also used in **switch** statements

goto

- ▶ Redirects flow of control to a labeled statement

```
if( i == 42 )  
{  
    goto Mol;  
}  
goto End;  
Mol:  
    Console.WriteLine( 42 );  
    goto End;  
End:
```

- ▶ Also used in **switch** statements
- ▶ Avoid using **goto** except...



Quiz: Statements – Right or Wrong?

```
if( i = 0 )  
{  
    ...  
}
```

```
if( myString.Length )  
{  
    ...  
}
```

```
if( i == 87 )  
    i++;
```

```
while i == 87  
{  
    ...  
}
```

```
foreach( var i in myGrid )  
{  
    ...  
}
```

```
do  
    i++  
while( i < 87 );
```



Lab 4: Using Reference Types and Statements in Programs



Discussion and review

- ▶ Arrays
- ▶ Strings
- ▶ Value Types Revisited – **Nullable**
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- ▶ Jump Statements



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