

Module 3

"Value Types and Expressions"



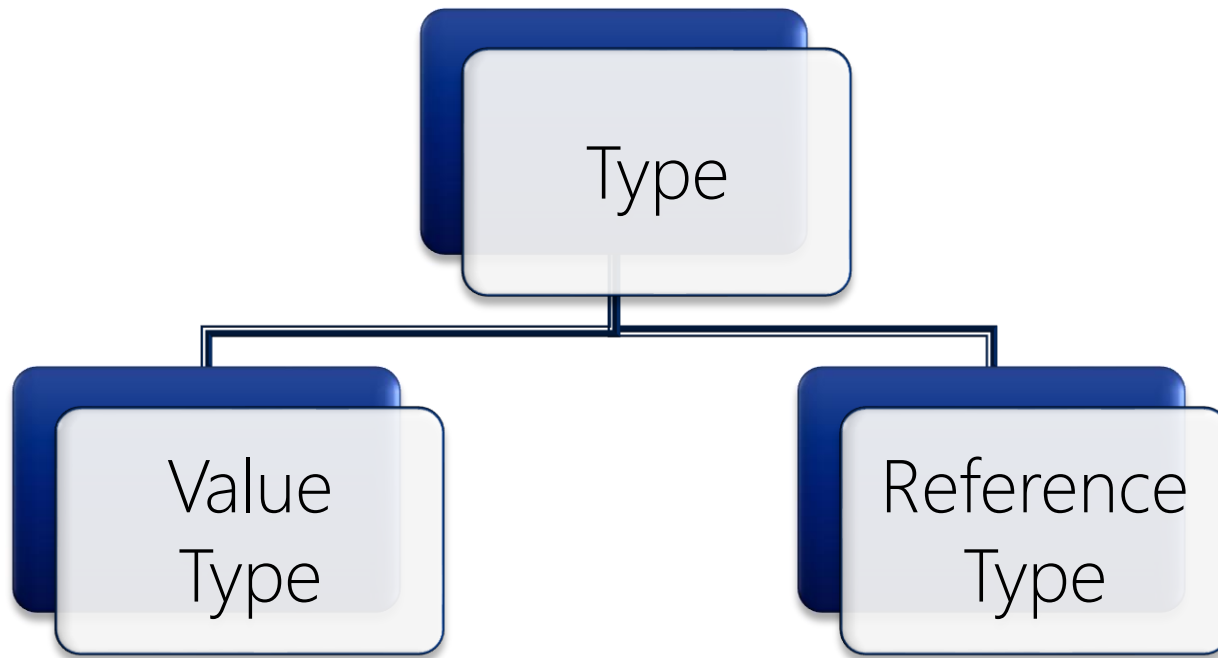
TEKNOLOGISK
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Agenda

- ▶ **.NET Common Type System**
- ▶ Predefined Value Types
- ▶ Expressions
- ▶ Data Type Conversions
- ▶ User-defined Value Types
- ▶ Lab 3
- ▶ Discussion and Review

Anatomy of the Common Type System

- ▶ Every variable has a specified type
- ▶ C# is type-safe...!



Value Types vs. Reference Types

Value Types

- ▶ Directly contain data
- ▶ Allocated on the stack
- ▶ Have to be initialized
- ▶ Each copy has its own data

Reference Types

- ▶ Store references to data ("objects")
- ▶ Stored on the heap
- ▶ Has a default value of null
- ▶ Several references can refer to same data

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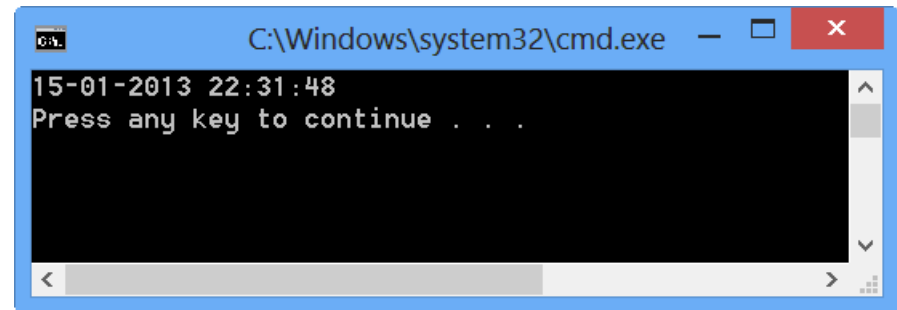
Overview of Predefined Value Types

C# Data Type	CTS Type	Description
<code>bool</code>	<code>System.Boolean</code>	True or false values
<code>int</code>	<code>System.Int32</code>	Signed integers
<code>short</code>	<code>System.Int16</code>	Signed short integers
<code>long</code>	<code>System.Int64</code>	Signed long integers
<code>uint</code>	<code>System.UInt32</code>	Unsigned integers
<code>char</code>	<code>System.Char</code>	Character values
<code>float</code>	<code>System.Single</code>	Single-precision floating
<code>double</code>	<code>System.Double</code>	Double-precision floating
<code>decimal</code>	<code>System.Decimal</code>	128-bit precision number

System.DateTime

- ▶ A very important type with no C# keyword
- ▶ Has a lot of interesting details and features
 - High-precision
 - Versatile formatting is built-in

```
Console.WriteLine( DateTime.Now );
```



- ▶ A corresponding **System.TimeSpan** also exists



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Declaring Variables

- ▶ Declare by data type and variable name

```
bool isStarted;
```

- ▶ Multiple variables can be declared simultaneously

```
int favoriteNumber, i, j;
```

- ▶ Local variables can be declared everywhere in methods
- ▶ Class-level variables are called *members*

Assigning Values

- ▶ Assign values by using the assignment operator =

```
bool isStarted;  
isStarted = true;
```

- ▶ Variables can be declared and assigned simultaneously

```
int favoriteNumber = 87, i = 0, j = i;
```

```
char c = 'A';
```

- ▶ Note: Variables must be initialized before use!

Naming of Variables

- ▶ Compiler requires that only letters, digits, and underscores are used
- ▶ C# keywords are reserved
- ▶ Case-sensitive!

- ▶ Recommendations
 - Don't abbreviate. Characters are cheap! 😊
 - Use camelCasing for variables
 - Use PascalCasing for types, classes, methods.

Constants

- ▶ Use the const keyword to declare constants

```
const int favoriteNumber = 87;
```

- ▶ Must be initialized when declared

Operators

Operator Type	Operators
Equality	<code>==</code> <code>!=</code>
Relational	<code><</code> <code><=</code> <code>></code> <code>>=</code> <code>is</code>
Conditional	<code> </code> <code>&&</code> <code>?:</code>
Arithmetic	<code>+</code> <code>-</code> <code>*</code> <code>/</code> <code>%</code>
Increment, Decrement	<code>++</code> <code>--</code>
Assignment	<code>=</code> <code>+=</code> <code>-=</code> <code>*=</code> <code>/=</code>

Operator Precedence

- ▶ Operator precedence determines order of evaluation
 - Multiplicative > Additive.

$$x = y + 87 * z$$
$$x = y + (87 * z)$$

- ▶ Associativity
 - All binary (except assignment) is left-associative

$$x + y + z$$
$$(x + y) + z$$
$$a = b = c$$
$$a = (b = c)$$

- ▶ Use parentheses whenever there is doubt!

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Implicit Conversions

- ▶ Also known as “widening” conversions
- ▶ Never lose precision or value

```
short i = 16384;  
  
// Implicit/Widening conversion  
int j = i;
```

- ▶ Are always allowed by the compiler
- ▶ Always succeeds



Explicit Conversions

- ▶ Also known as “narrowing” conversions
- ▶ Can lose precision or value

```
int i = int.MaxValue;  
  
// Explicit/Narrowing conversion  
short j = (short) i;
```

- ▶ Are allowed by the compiler
- ▶ Might fail!



Overflow Checking

- ▶ The **checked** keyword turns on over/underflow checking

checked

```
{  
    short j = (short) i;  
}
```

```
short j = checked( (short) i );
```

- ▶ There is an corresponding **unchecked** keyword
- ▶ Default (un)checking can be set in the Visual Studio project properties
 - "Build" -> "Advanced..."



Implicitly Typed Variables

- ▶ You can define local implicitly typed variables using the **var** keyword

```
var myInteger = 87;  
var myBoolean = true;  
var myString = "Hello, there...";
```

- ▶ The compiler infers the type of the local variable!
- ▶ Everything is still completely type-safe

```
var i = 87; ✓  
i = 112; ✓  
int j = i + 42; ✓  
i = "Forbidden!"; ✗
```

- ▶ Must be assigned a value when declared

```
var myInteger;  
myInteger = 87; ✗
```



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Enumerations

- ▶ Used for creating a set of symbolic names

```
enum Fruit
{
    Apple,
    Banana,
    Orange
}
```

```
Fruit f = Fruit.Banana;
```

- ▶ Ordering does not have to be sequential – and can also be bit flags!
- ▶ Underlying enumeration type can be explicitly chosen

```
enum Team : byte
{
    AGF = 1,
    Brøndby = 6,
    FCK = 5,
    Randers = 12
}
```

```
Team t = Team.AGF;
Console.WriteLine( t ); // ???
```



Structures

- ▶ Used for defining a structured value consisting of several subvalues

```
struct Point  
{  
    public int x, y;  
}
```

```
Point pt;  
pt.x = 42;  
Console.WriteLine( pt.y ); // Oops!
```

- ▶ Members are private by default
- ▶ All subvalues must be initialized before use!
- ▶ Value can be default initialized using the **new** construct

```
Point pt = new Point();  
Console.WriteLine( pt.y ); // ???
```



Quiz: Variables and Scope

```
int i = 0, j = 112;
Point pt;
pt.x = 42;
var l = ( 87 * Math.Sin( 11.2 ) / Math.PI ) + "Yo!";
string s = l;

{
    int k = 255;
    pt.x++;
    i = k;

    int j = 13;
}

Console.WriteLine( i );    // ???
Console.WriteLine( j );    // ???
Console.WriteLine( k );    // ???
Console.WriteLine( pt.x ); // ???
Console.WriteLine( s );    // ???
```

Lab 3: Creating and Using Value Types



Discussion and Review

- ▶ .NET Common Type System
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- ▶ Expressions
- ▶ Data Type Conversions
- ▶ User-defined Value Types



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