Module 3

"Value Types and Expressions"

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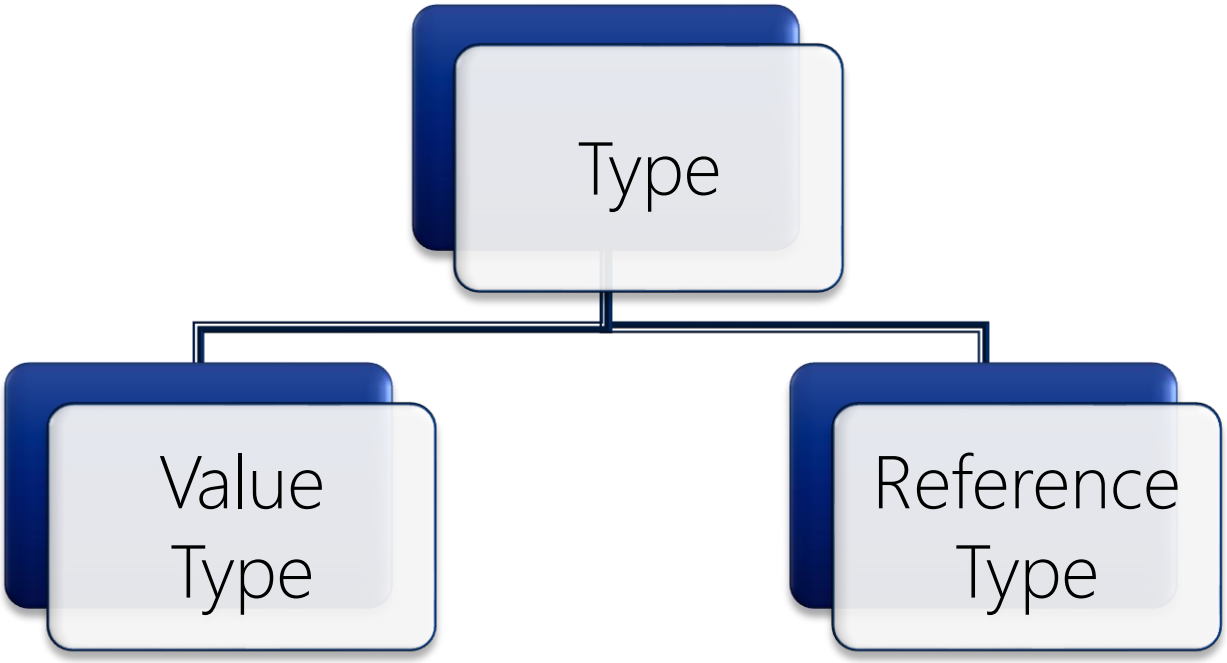
Agenda

- .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

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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

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

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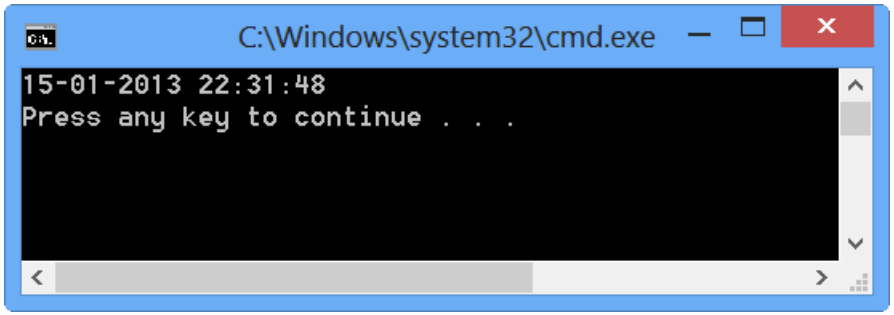
System.DateTime

- 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	`==` `!=`
Relational	`<` `<=` `>` `>=` `is`
Conditional	`||` `&&` `?:`
Arithmetic	`+` `-` `*` `/` `%`
Increment, Decrement	`++` `--`
Assignment	`=` `+=` `-=` `*=` `/=`

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 );    // ???
```

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Lab 3: Creating and Using Value Types

Discussion and Review

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


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