

Module 04

"Operator Overloading"



TEKNOLOGISK
INSTITUT

Agenda

- ▶ **Indexers**
- ▶ Operators
- ▶ Custom Type Conversions
- ▶ Lab 4
- ▶ Discussion and Review

Defining Indexers

- ▶ You can create “array-like” indexing of your own classes using *indexers*

```
class Garage
{
    private List<Car> _list;
    ...
    public Car this[ int index ]
    {
        get { return _list[ index ]; }
        set { _list[ index ] = value; }
    }
}
```

```
Garage garage = new Garage();
Console.WriteLine( garage[ 1 ] );
garage[ 1 ] = new Car("Goofy",87);

foreach( Car car in garage )
{
    Console.WriteLine( car );
}
```

- ▶ This is basically the syntax of a special property named **this** but with square brackets used instead of parentheses



Indexing Objects Using Strings

- ▶ You can create indexers on your own types with any indexing type – not just integers!

```
public Car this[ string index ]  
{  
    get { return list.Find( c => c.PetName == index ); }  
    set {  
        int i = list.FindIndex( c => c.PetName == index );  
        if( i >= 0 ) { list[ i ] = value; }  
        else { list.Add( value ); }  
    }  
}
```

```
Garage garage = new Garage();  
Console.WriteLine( garage[ "Zippy" ] );  
garage[ "Goofy" ] = new Car( "Goofy", 128 );
```

- ▶ Note that indexers can be overloaded in the same manner as methods!



Variations on Indexers

- ▶ Indexers can be multi-dimensional

```
class GridWrapper : IEnumerable
{
    private int[ , ] _grid = new int[ 3, 3 ];
    public int this[ int row, int column ]
    {
        get { return _grid[ row, column ]; }
        set { _grid[ row, column ] = value; }
    }
}

GridWrapper gw = ...;
gw[ 0, 0 ] = 87;

foreach( int i in gw )
{
    Console.WriteLine( i );
}
```

- ▶ Indexers can be members of interfaces

```
public interface IMyStringContainer<T>
{
    string this[ T index ] { get; set; }
}
```







- ▶ Indexers can be virtual and generic



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Operator Overloading

Operator	Overloadability
<code>+ - ! ~ ++ -- true false</code>	Unary can be overloaded 
<code>+ - * / % & ^ << >></code>	Binary can be overloaded 
<code>+= -= *= /= %= = ^= <<= >>=</code>	Shorthands follows automatically 
<code>== != < > <= >=</code>	Comparisons can be overloaded in pairs 
<code>[]</code>	Create indexers instead 
<code>()</code>	Create type conversions instead 

Overloading Binary Operators

- ▶ Operators can be overloaded in your own types

```
struct Point
{
    public int x, y;
    ...
    public static Point operator +( Point p1, Point p2 )
    {
        return new Point( p1.x + p2.x, p1.y + p2.y );
    }
}
```

- ▶ Operator overload must be **public static**!

```
Point P = new Point(1,2);
Point Q = new Point(3,4);
Point R = P + Q;
Console.WriteLine( R );
```

- ▶ Note: Shorthand assignment operators follow automatically when the operator is overloaded

```
Point P = new Point(1,2);
Point Q = new Point(3,4);
P += Q;
```



Parameters Types can be Different

- ▶ There is no restriction stating the parameter types should be identical

```
struct Point
{
    public int x, y;
    ...
    public static Point operator +( Point p1, int delta )
    {
        return new Point( p1.x + delta, p1.y + delta );
    }
}
```

```
Point P = new Point(1,2);
Point Q = P + 10;
Console.WriteLine( Q );
```

- ▶ If you need commutative operators, you must overload both ways
- ▶ Similarly, - does not follow automatically from + etc.



Overloading Unary Operators

- ▶ Unary operators are overloaded in an identical manner
 - but with just a single parameter, of course 😊

```
struct Point
{
    public int x, y;
    ...
    public static Point operator ++( Point p1 )
    {
        return p1 + 1; // Use binary operator from earlier
    }
}
```

```
Point P = new Point(1,2);
P++;
Console.WriteLine( P );
```

- ▶ What happens with **++P**?



Overloading Equality Operators

- ▶ Overload both `==` and `!=` or none at all!
- ▶ Good idea to override **`Equals()`** and use it for the equality operators

```
public override bool Equals( object obj )
{
    return this.ToString() == obj.ToString();
}
public static bool operator ==( Point p1, Point p2 )
{
    return p1.Equals( p2 );
}
public static bool operator !=( Point p1, Point p2 )
{
    return !p1.Equals( p2 );
}
```

```
Point P = new Point( 1, 2 );
Point Q = new Point( 2, 3 );
Console.WriteLine( P == Q );
```

- ▶ Recall that you should override **`GetHashCode()`** when overriding **`Equals()`**



Overloading Comparison Operators

- ▶ Overloading must be in "pairs", i.e. < together with >, and <=, >= likewise
- ▶ Good idea to implement **IComparable** and use it for the comparison operators

```
struct Point : IComparable
{
    public int CompareTo( object obj ) { ... }
    public static bool operator <( Point p1, Point p2 )
    {
        return( p1.CompareTo( p2 ) < 0 );
    }
    public static bool operator >( Point p1, Point p2 )
    {
        return( p1.CompareTo( p2 ) > 0 );
    }
}

Point P = new Point( 1, 2 );
Point Q = new Point( 2, 3 );

Console.WriteLine( P < Q );
```



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- ▶ **Custom Type Conversions**
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Recalling Conversions

- ▶ Implicit (or widening) conversion
- ▶ Always allowed by the compiler

```
short i = 16384;  
int j = i;  
Derived d = new Derived();  
Base b = d;
```

- ▶ Explicit (or narrowing) conversion
- ▶ Can lose precision or value and might fail!

```
int i = int.MaxValue;  
short j = (short) i;  
Base b = new ...;  
Derived d = (Derived) b;
```

```
class Base  
{  
    ...  
}  
  
class Derived : Base  
{  
    ...  
}
```

Defining Explicit Conversions

- ▶ Explicit (or narrowing) conversions can be defined with the **explicit** keyword

```
struct Point
{
    ...
    public static explicit operator int( Point p1 )
    {
        if( p1.x >= 0 && p1.y >= 0 )
        {
            return p1.x * p1.y;
        }
        throw new InvalidCastException( ... );
    }
}
```

```
Point P = new Point( 1, 2 );
Point Q = new Point( -2, 3 );
int areaP = (int) P;
int areaQ = (int) Q; // ???
```



Defining Implicit Conversions

- ▶ Implicit (or widening) conversions can be defined with the **implicit** keyword

```
struct Point : IComparable
{
    ...
    public static implicit operator string( Point p1 )
    {
        return p1.ToString();
    }
}
```

```
string s = new Point( 1, 2 );
string t = new Point( -2, 3 );

Console.WriteLine( s );
Console.WriteLine( t );
```

- ▶ Implicit conversion could be to any appropriate type – not just strings!



Quiz: Operator Overloading Methods – Right or Wrong?

```
public Point operator +( Point p1, Point p2 ) { ... }
```



```
public static Point operator +=( Point p1, Point p2 ) { ... }
```



```
struct Point  
{  
    public static bool operator <( Point p1, Point p2 ) { ... }  
}
```



```
public static Point operator +( Point p1, int delta ) { ... }
```



```
public static operator string( Point p1 ) { ... }
```



```
public static Car operator *( Car c, Person p ) { ... }
```



Lab 4: Operators and Conversions

- ▶ Lab 4.1 – 4.2



Discussion and Review

- ▶ Indexers
- ▶ Operators
- ▶ Custom Type Conversions



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