Object Oriented Programming in C# 2:2

Topics

- Questions to the lesson 2 exercises
- Static and non-static class members
- Derived classes (inheritance)
  - Class hierarchy
  - Polymorphism
  - Overriding methods
  - Type casting
  - The Object class
- Access modifiers (overview)
- Interfaces
- The Heap and the Stack

Static and non-static class members

Static and non-static member in a class

- Class **member** are: fields, properties, methods and events
- If a member is static, it belongs to the class
- If a member is non-static, it belongs to a specific object of the class
- Static members are defined with the keyword **`static`**
- Members who's data or behavior is the same for all instances of the class are suitable candidates for static members of the class
- Example>>

```
public class Product {
  // is the same for all instances of Product
  public static decimal Moms = 0.25M;

  // Automatic properties
  public string Name { get; set; }
  public double Price  { get; set; }
}

// danish consumption tax
decimal myMoms = Product.Moms; // 0.25
Product.Moms = 0.2M; // converts to decimal
myMoms = Product.Moms; // 0.2
```

```
public class Product {
  // is the same for all instances of Product
  private static decimal moms = 0.25M;

  // Automatic properties
  public string Name { get; set; }
  public double Price  { get; set; }

  // Static read-only property
  public static decimal Moms  { get {return
  moms;} }
}
// danish consumption tax
decimal myMoms = Product.Moms;
Product.Moms = 0.2M; // error
```

Examples from Framework

```
// Examples of static properties
Math.PI;
DateTime.Now;

// Examples of static methods
Math.Min(2.22, 4.44);
DateTime.IsLeapYear(2028);
```

A user defined **Time** class

```
public class Time {
    private static int minPerDay=1440; // field

    public int Hour { get; set; } // property
    public int Min  { get; set; } // property
    public static int MinPerDay { // static property
      get {return minPerDay; }
    }
  // constructor
  public Time(int min, int hour) {
    Min = min;
    Hour = hour;
  }
}
```

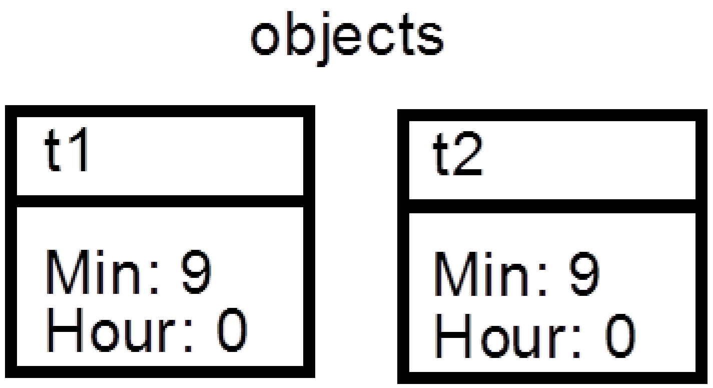
- As the `int` field, `MinPerDay`, is static it is accessed through the class-name:

```
int m = Time.MinPerDay;

Time t1 = new Time(9,0);
Time t2 = new Time(45, 12);
```

- `MinPerDay` is independent of `t1` and `t2`, it is always 1440, therefore ~~`t1.MinPerDay`~~ and ~~`t2.MinPerDay`~~ are not meaningful, but `Time.MinPerDay` are.

- The properties **Hour** and **Min** are non-static
- They belongs to a specific object of the class

```
int m1 = t1.Min;
int h1 = t1.Hour;

int m2 = t2.Min;
int h2 = t2.Hour;
```



objects

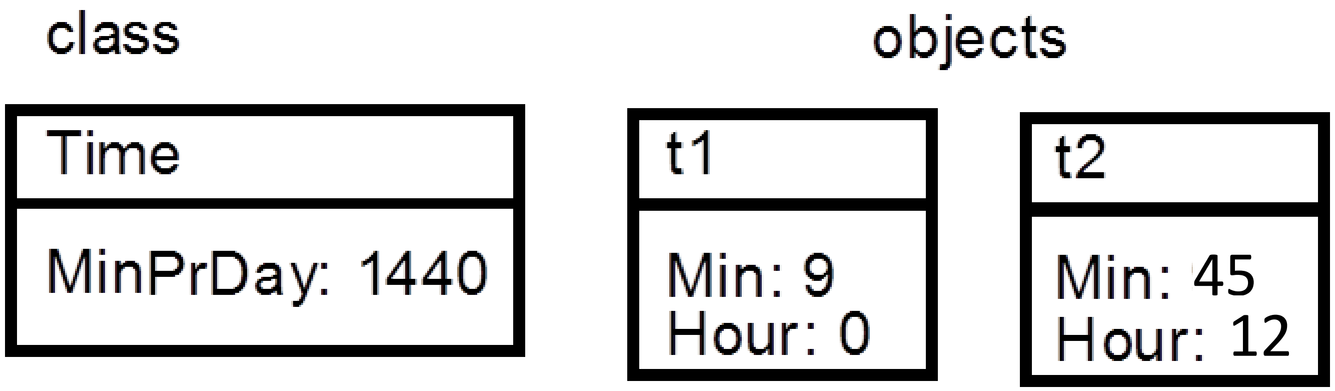
t1

Min: 9
Hour: 0

t2

Min: 9
Hour: 0

Illustration



class

Time

MinPrDay: 1440

objects

t1

Min: 9
Hour: 0

t2

Min: 45
Hour: 12

- The property **`MinPerDay`** is static and belongs to the class
- The properties **`Min`** and **`Hour`** are non-static and belongs to the object(s)
- 1440 belongs to **`Time`** class, 9 and 0 to **`t1`** object, 12 and 45 to **`t2`** object

More examples from Framework

- **DateTime** has a static method **DaysInMonth**:

```
int n = DateTime.DaysInMonth(2015,2);
```

The method returns the number of days in month 2 in the year 2015, that is 28

- **DateTime** has non-static members for year, month and day

```
DateTime dt = new DateTime(2010,9,14);
```

More examples from Framework

- **DateTime** has a non-static method **AddDays**:

```
DateTime d2 = d1.AddDays(20);
DateTime d1 = DateTime.Now;
DateTime d2 = d1.AddDays(20);
int n = DateTime.DaysInMonth(2009,2);
int n = d2.Year;
```

Questions

- Why is **`Now`** static?
- Why can’t **`AddDays`** be static?
- Why is **`DaysInMonth`** static?
- Why is **`Year`** non-static?

Inheritance

Derived classes

Inheritance

- The purpose of inheritance is to avoid, to write the same code more than once (avoid redundancy)
- You can declare classes that **inherits members** (fields, properties, methods, and events) from another class: the **base class** (or **super class**).
- This way the **general code**, which applies to all classes, is declared in the **base class** (or superclass) while the **special code** is defined in one or more **derived classes** (or subclasses).

Inheritance: **Person -> Employee**

```
public class Person { // Person is the base class
     protected string firstname; // fields
     protected string lastname;
     public string Firstname { // properties
        get { return firstname; }
        set { firstname = value; }
     }
     ...
     public Person(string firstname, string lastname) { // constructor
        this.firstname = firstname;
        this.lastname = lastname;
  }
}
```

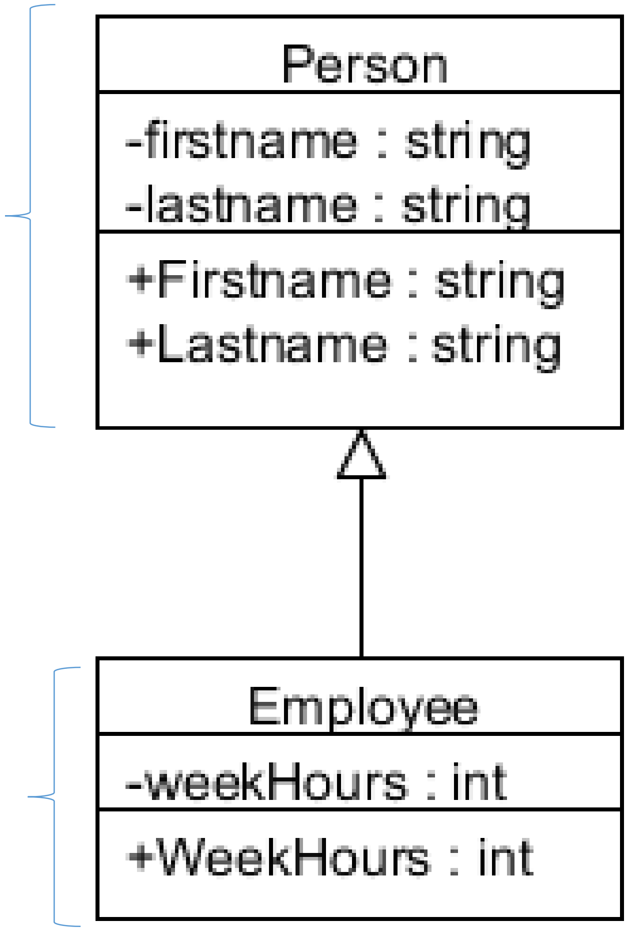
Keywords for accessibility

Keyword	Accessibility
public	Can be accessed by any class
private	Can be accessed only by members inside the current class
internal	Can be accessed by members in any of the classes in the current assembly (the compiled code file)
protected	Can be accessed by members in the current class or in any class that inherits from this class
protected internal	Can be accessed by members in the current application (as with internal) and by the members in any class that inherits from this class

An example of inheritance

- **`Person`** (*Person.cs*)
- **`Employee`** (*Employee.cs*)

The convention is each class in its own file with the class name as file name.



Base class

Person

-firstname : string
-lastname : string

+Firstname : string
+Lastname : string

Derived class

Employee

-weekHours : int

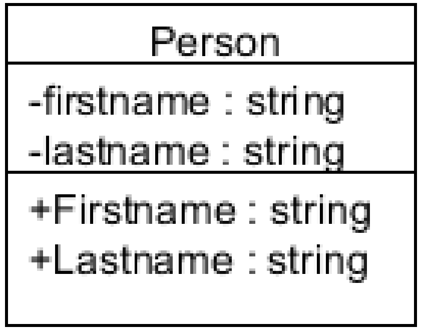
+WeekHours : int

```
public class Employee : Person
{
  private int weeklyHours;
  public int WeeklyHours {
    get {return weeklyHours;}
    set {weeklyHours = value;}
  }

  public Employee(string firstname, string lastname,
    int weeklyHours): base(firstname, lastname)
  {
    this.weeklyHours = weeklyHours;
  }
}
```

Call the base class constructor

- **`Person`** is called **base class** and **`Employee`** is called **derived class**

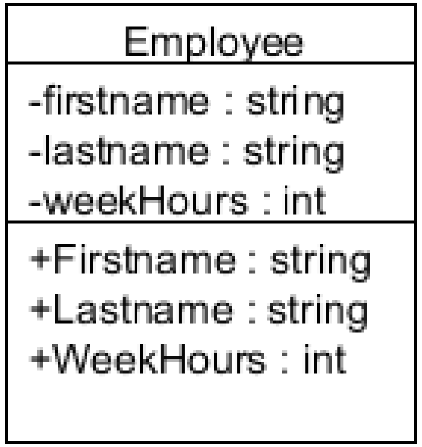
- **`Employee`** inherits every member from **`Person`** and adds some new.
  - It inherits two fields and two properties: **`firstname`** , **`lastname`** , **`Firstname`** and **`Lastname`**
  - and adds a field and a property: **`weekyHours`** and **`WeekyHours`**



Person

-firstname : string
-lastname : string

+Firstname : string
+Lastname : string



Employee

-firstname : string
-lastname : string
-weekHours : int

+Firstname : string
+Lastname : string
+WeekHours : int

An Employee is a Person

A Person is not necessarily an Employee

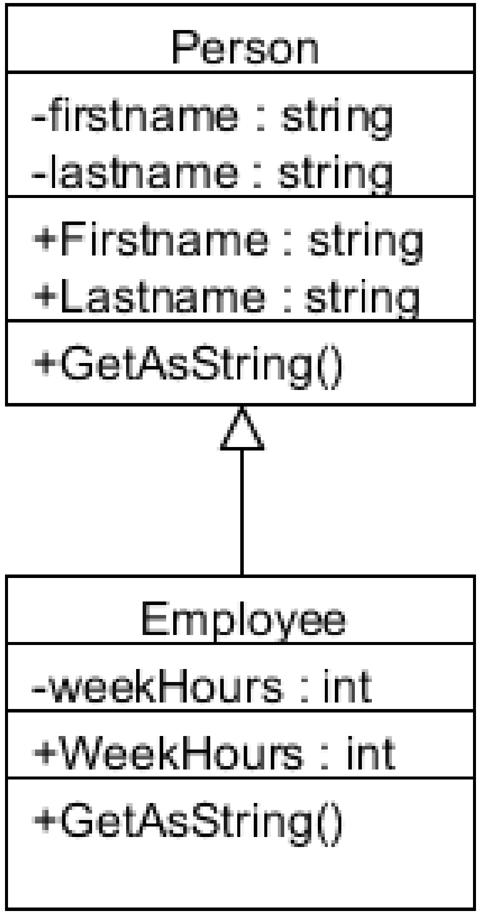
```
Person p1 = new Person("Susan", "Thompson");
Employee e1 = new Employee("Bob", "Simon",
37);

string p1Name = p1.Name;
int p1Weekhour = p1.WeeklyHours; // error
string e1Name = e1.Name;
int e1Weekhours = e1.WeeklyHours; // ok
```

Benefit of inheritance

- Re-use of code:
  - In our example we can use everything programmed in **`Person`** without copying it to **`Employee`**
  - If we make some improvements of **`Person`**, all **`Employee`** objects automatically inherits it.

Polymorphisme

- The term polymorphism comes from greek and means many forms
- With polymorphism methods of the base class can be redefined in the derived class



Person

-firstname : string
-lastname : string

+Firstname : string
+Lastname : string

+GetAsString()

Employee

-weekHours : int

+WeekHours : int

+GetAsString()

```
Person p1; Person p2;

p1 = new Person("Susan", "Thompson");
// GetAsString() in Person
string s1 = p1.GetAsString();

// GetAsString() in Employee
p2 = new Employee("Bob", "Hudson", 37);
string s2 = p2.GetAsString();
```

`p1` is a **`Person`**

`p2` is a **`Person`** but it is also an **`Employee`**

- In this example, we want to call the method in the class of the actual object (the one created with new) and not what the reference-variable is declared as:

```
Person p1; Person p2;

p1 = new Person("Susan", "Thompson");
// GetAsString() in Person
string s1 = p1.GetAsString(); // GetAsString() in Person

// GetAsString() in Employee
p2 = new Employee("Bob", "Hudson", 37);
string s2 = p2.GetAsString(); // GetAsString() in Employee
```

- This is achieved with the keywords:
  - `virtual` (in the super class)
  - `override` (in the sub class)

Overriding methods in base class

In the **Person** class

```
public virtual string GetAsString()
{
  string s = "Person: " + firstname
             + " " + lastname;
  return s;
}
```

Overriding methods in the derived class

- In the Employee class

```
public override string GetAsString()
{
  string s = "Employee: ";
  s += firstname;
  s += " " + lastname;
  s += " [" + weeklyHours + "] ";
  return s;
}
```

List example 1:2

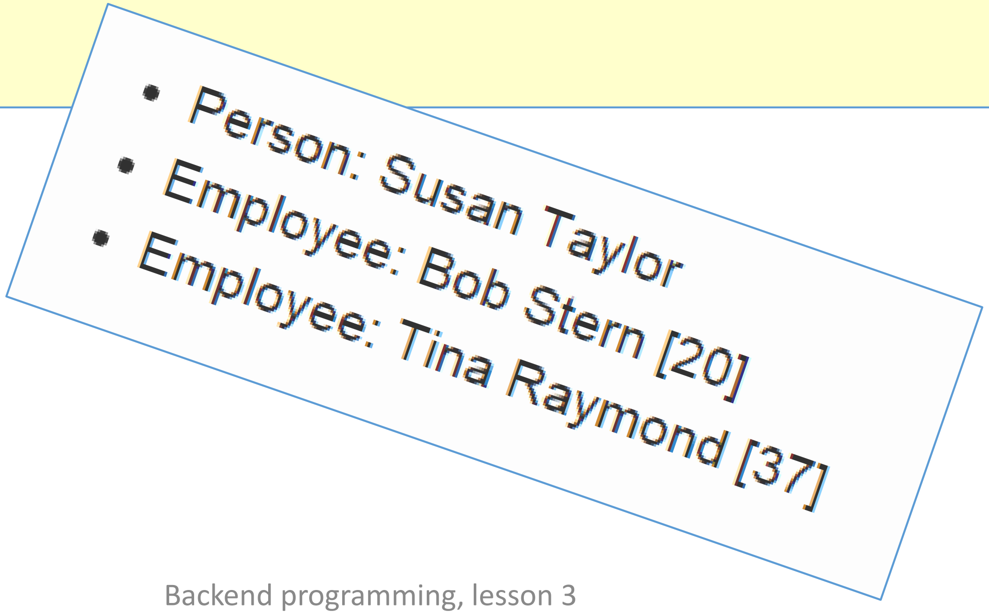
```
Person p1, p2, p3;
p1 = new Person("Susan", "Taylor");
p2 = new Employee("Bob", "Stern", 20);
p3 = new Employee("Tina", "Raymond", 37);

List<Person> persons = new List<Person>();
persons.Add(p1);
persons.Add(p2);
persons.Add(p3);
ViewBag.Persons = persons;
```

Example01

List example 2:2

```
List<Person> persons = ViewBag.persons;

<ul>
@foreach (Person p in persons ) {
      <li>@p.GetAsString()</li>
}
</ul>
```

Example01



- Person: Susan Taylor
- Employee: Bob Stern [20]
- Employee: Tina Raymond [37]

```
Person p1 = new Person(...);
Person p2 = new Employee(…);
// Error
// Employee e = new Person(…);
Employee e = new Employee(…);
```

- Rule: A Person-variable can point to an Employee object (because it is also a Person), but an Employee variable *can't* point to a Person (because a Person might not be an Employee)

The **object** class

- Any class we define and any class in the Framework is a derived class (subclass) of a special class **Object**
- We create new objects without specifying the inheritance from **Object**. This is implicit.
- We don’t write (although we could):

```
public class Person: Object {
   …
}
```

ToString() method

- **Object** has a few methods, no fields and no properties.
- The most important is **ToString()**
- The **ToString()** method in **object** returns the string:

```
System.Object
```

- The **ToString()** method is declared **virtual**, meaning it is possible to override in subclases>>

Overriding **ToString()**

```
public class Person
{
  . . .
  public override string ToString()
  {
    return firstname + " " + lastname;
  }
}
```

Example of use 1:2 (the controller)

- In a dropdownlist you might want to add a full name to a **SelectListItem**-object:

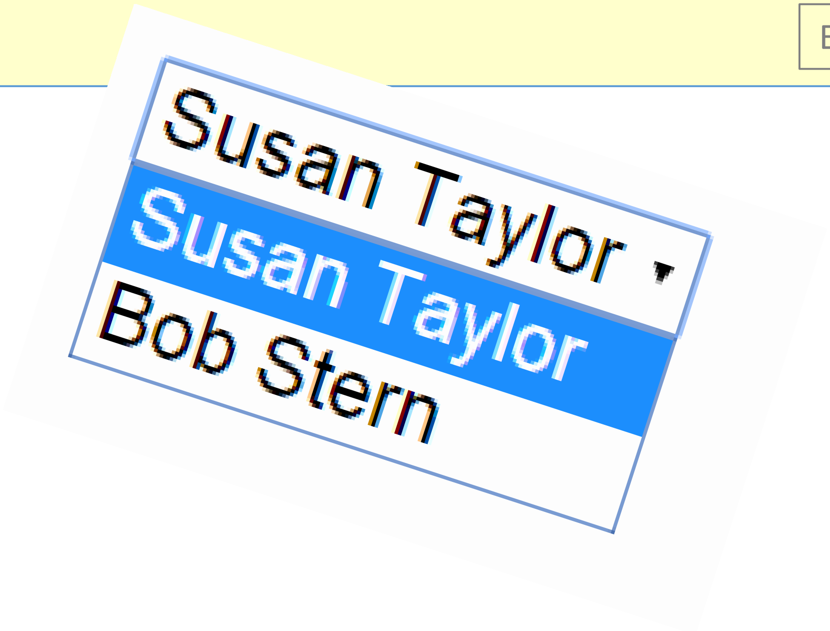
```
List<Person> persons = new List<Person>();
persons.Add(new Person(1, "Susan", "Taylor"));
persons.Add(new Employee(2, "Bob", "Stern", 20));

// Dropdown list
List<SelectListItem> items = new List<SelectListItem>();
foreach (Person p in persons) {
    items.Add(new SelectListItem {
        Text = p.ToString(),
        Value = p.PersonId.ToString() });
}
ViewBag. Persons = items;
```

Example02

Example of use 2:2 (the view)

```
@Html.DropDownList("Persons", ViewBag.Persons
 as IEnumerable<SelectListItem>)
```

Example02



Susan Taylor

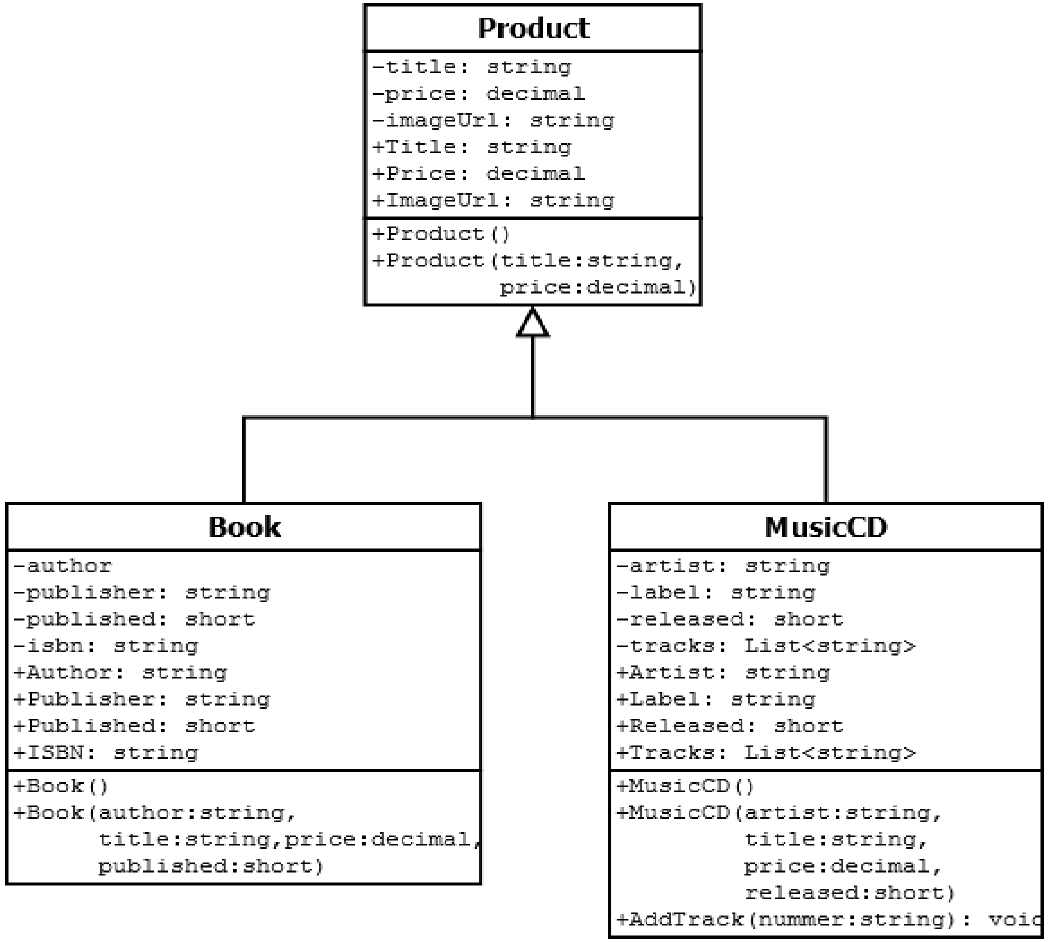
Susan Taylor

Bob Stern

Introduction to the exercises

Base class

Derived classes



Product

```
-title: string
-price: decimal
-imageUrl: string
+Title: string
+Price: decimal
+ImageUrl: string
```

```
+Product()
+Product(title:string,
         price:decimal)
```

Book

```
-author
-publisher: string
-published: short
-isbn: string
+Author: string
+Publisher: string
+Published: short
+ISBN: string
```

```
+Book()
+Book(author:string,
      title:string,price:decimal
      published:short)
```

MusicCD

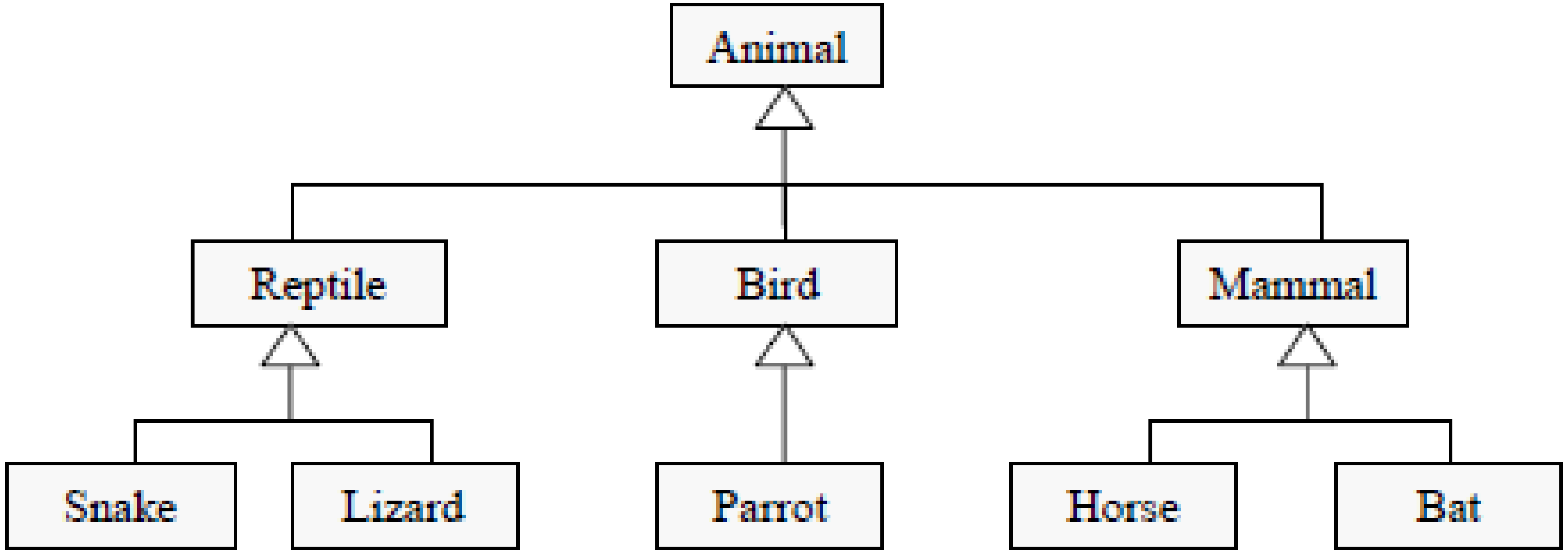
```
-artist: string
-label: string
-released: short
-tracks: List<string>
+Artist: string
+Label: string
+Released: short
+Tracks: List<string>
```

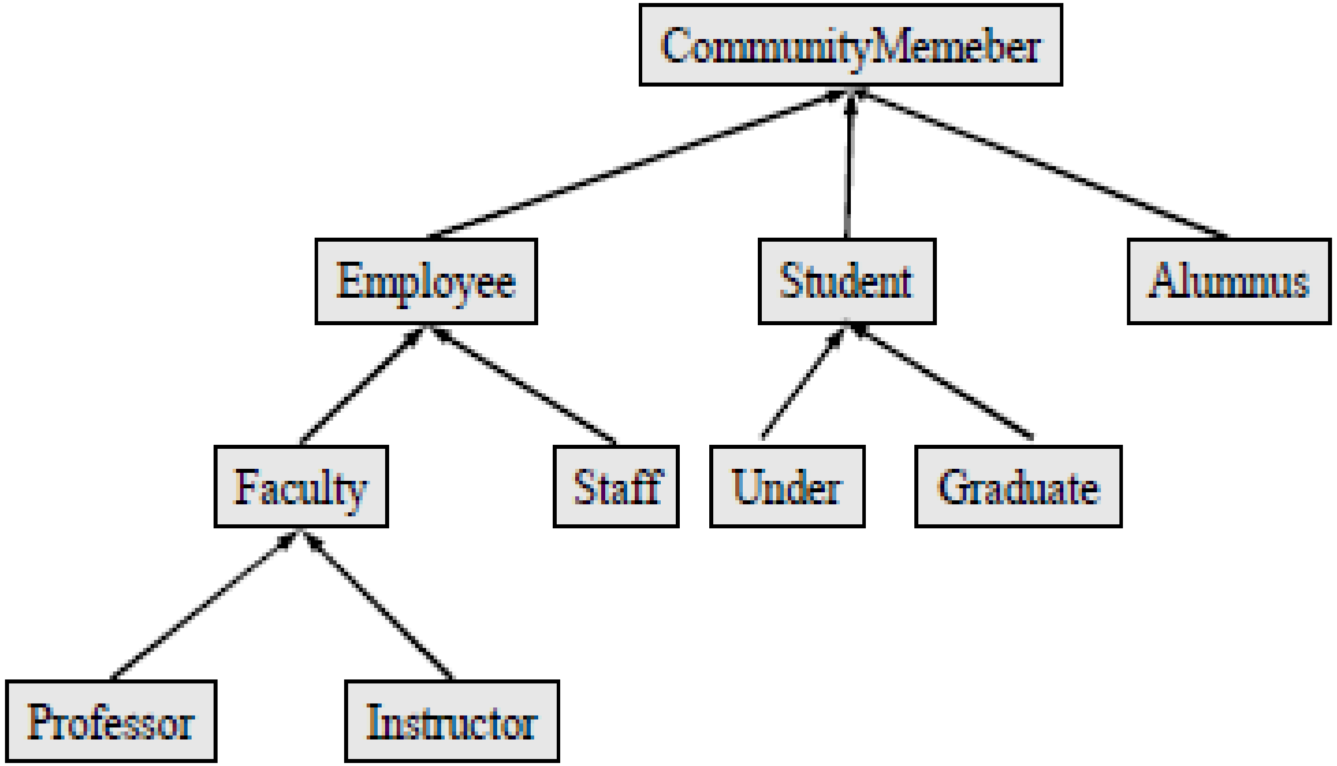
```
+MusicCD()
+MusicCD(artist:string,
         title:string,
         price:decimal,
         released:short)
+AddTrack(nummer:string): voic
```

Exercises 1

Examples of class hierarchies

- ❐ A child class of one parent can be the parent of another child, forming a *class hierarchy*



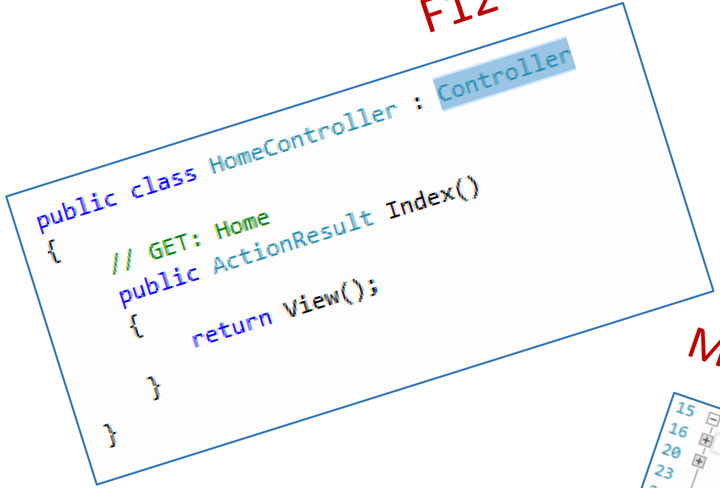

CommunityMemeber
Employee
Student
Alumnus
Faculty
Staff
Under
Graduate
Professor
Instructor

Inheritance in Framework

- You will properly not need to write many class hierarchies yourself, but the Framework has many class hierarchies
- An understanding of class hierarchies is therefore important
- The following pages gives a few examples

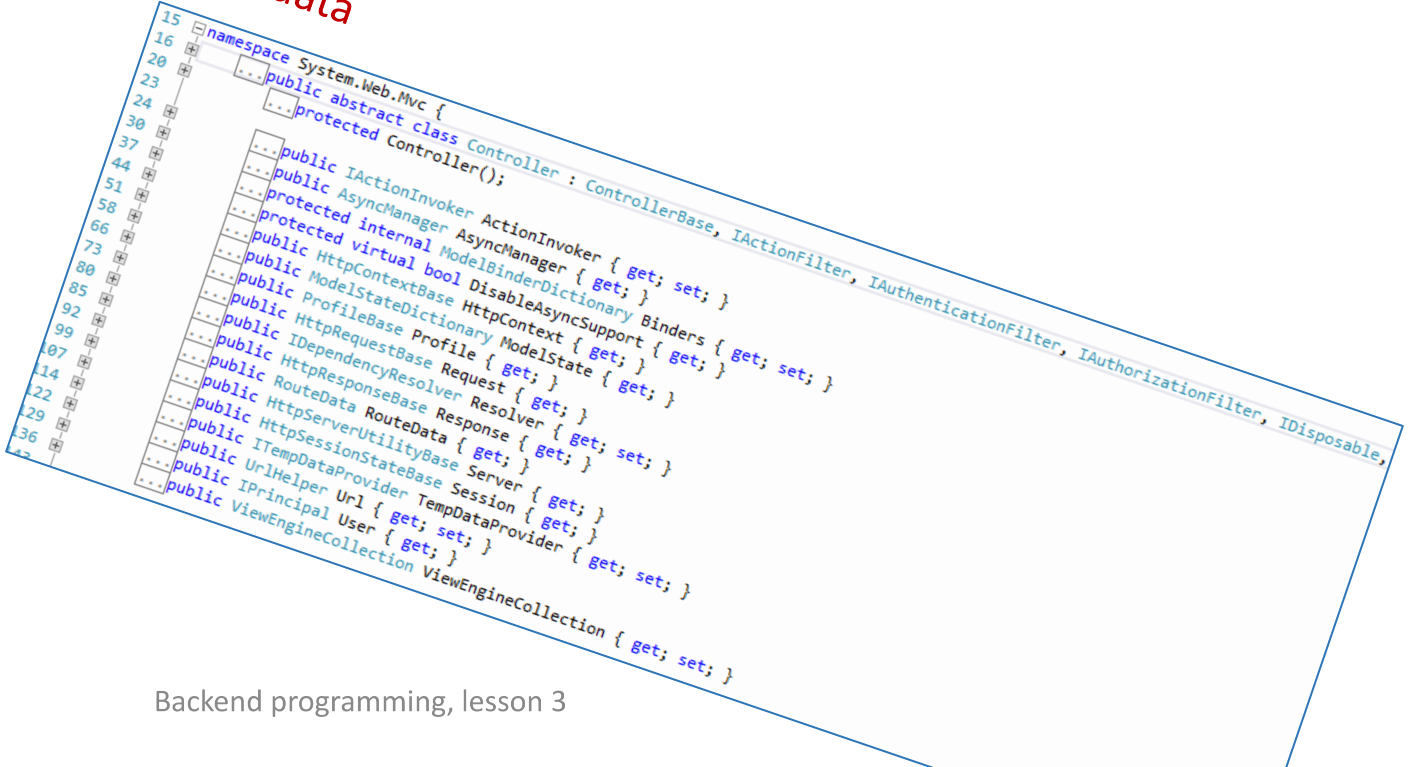
Inheritance in ASP.NET MVC

F12



```
public class HomeController : Controller
{
    // GET: Home
    public ActionResult Index()
    {
        return View();

    }
}
```

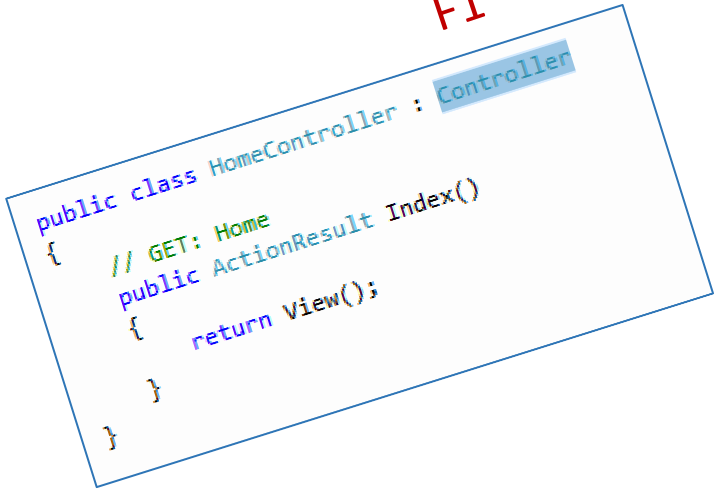
Metadata



```
namespace System.Web.Mvc {
    ...public abstract class Controller : ControllerBase, IActionFilter, IAuthenticationFilter, IAuthorizationFilter, IDisposable,
        ...protected Controller();

        ...public IActionInvoker ActionInvoker { get; set; }
        ...public AsyncManager AsyncManager { get; }
        ...protected internal ModelBinderDictionary Binders { get; set; }
        ...protected virtual bool DisableAsyncSupport { get; }
        ...public HttpContextBase HttpContext { get; }
        ...public ModelStateDictionary ModelState { get; }
        ...public ProfileBase Profile { get; }
        ...public HttpRequestBase Request { get; }
        ...public IDependencyResolver Resolver { get; set; }
        ...public HttpResponseBase Response { get; }
        ...public RouteData RouteData { get; }
        ...public HttpServerUtilityBase Server { get; }
        ...public HttpSessionStateBase Session { get; }
        ...public ITempDataProvider TempDataProvider { get; set; }
        ...public UrlHelper Url { get; set; }
        ...public IPrincipal User { get; }
        public ViewEngineCollection ViewEngineCollection { get; set; }
```

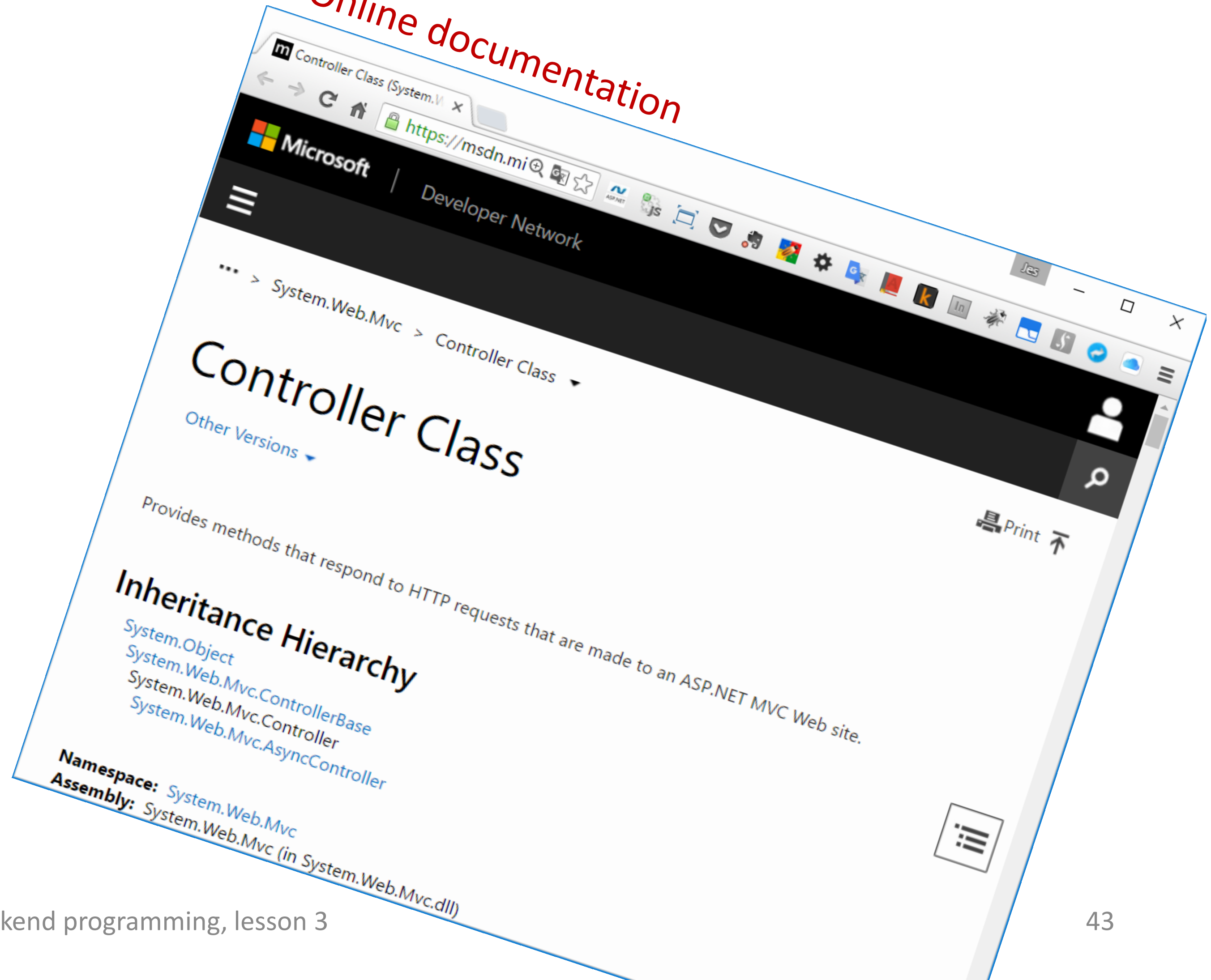
Documentation in ASP.NET MVC

F1



```
public class HomeController : Controller
{
    // GET: Home
    public ActionResult Index()
    {
        return View();
    }
}
```

Online documentation



Controller Class (System.W
https://msdn.mi
Microsoft | Developer Network
... > System.Web.Mvc > Controller Class
Other Versions
Print

Controller Class

Provides methods that respond to HTTP requests that are made to an ASP.NET MVC Web site.

Inheritance Hierarchy

System.Object
System.Web.Mvc.ControllerBase
System.Web.Mvc.Controller
System.Web.Mvc.AsyncController

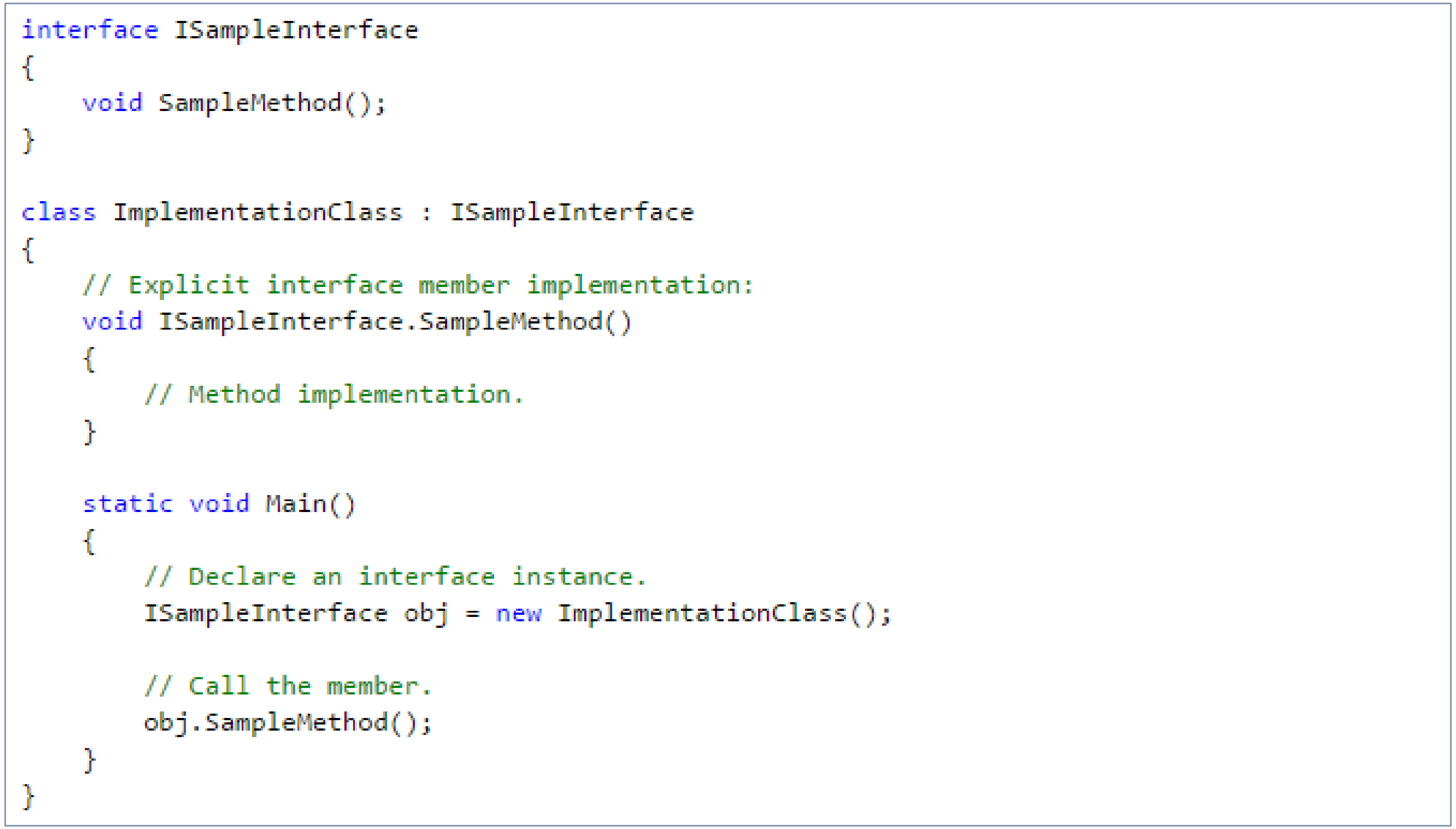
Namespace: System.Web.Mvc
Assembly: System.Web.Mvc (in System.Web.Mvc.dll)

Interface

Interface

- Is a contract:
  - Defines a set of properties, methods and events that must be declared in all classes that implements that interface.
  - An interface contains only the signatures of methods, properties, events or indexers (no implementation).
  - A class or structure that implements the interface must implement the members of the interface that are specified in the interface definition
  - Programming against an interface makes it easy to change the implementation because classes that implement the interfaces all have the same members (methods, properties and events).

Example



```
interface ISampleInterface
{
    void SampleMethod();
}

class ImplementationClass : ISampleInterface
{
    // Explicit interface member implementation:
    void ISampleInterface.SampleMethod()
    {
        // Method implementation.
    }

    static void Main()
    {
        // Declare an interface instance.
        ISampleInterface obj = new ImplementationClass();

        // Call the member.
        obj.SampleMethod();
    }
}
```

http://msdn.microsoft.com/en-us/library/87d83y5b.aspx

Using the IEnumarable interface with a strongly typed View 1:2

```
List<Person> persons = new List<Person>();
persons.Add(new Person(1, "Susan", "Taylor"));
persons.Add(new Employee(2, "Bob", "Stern", 20));

// return a strongly typed view
return View(persons as IEnumerable<Person>);
```

Example03

- The IEnumerable interface is used with many collections such as List and Array, and also with LINQ.

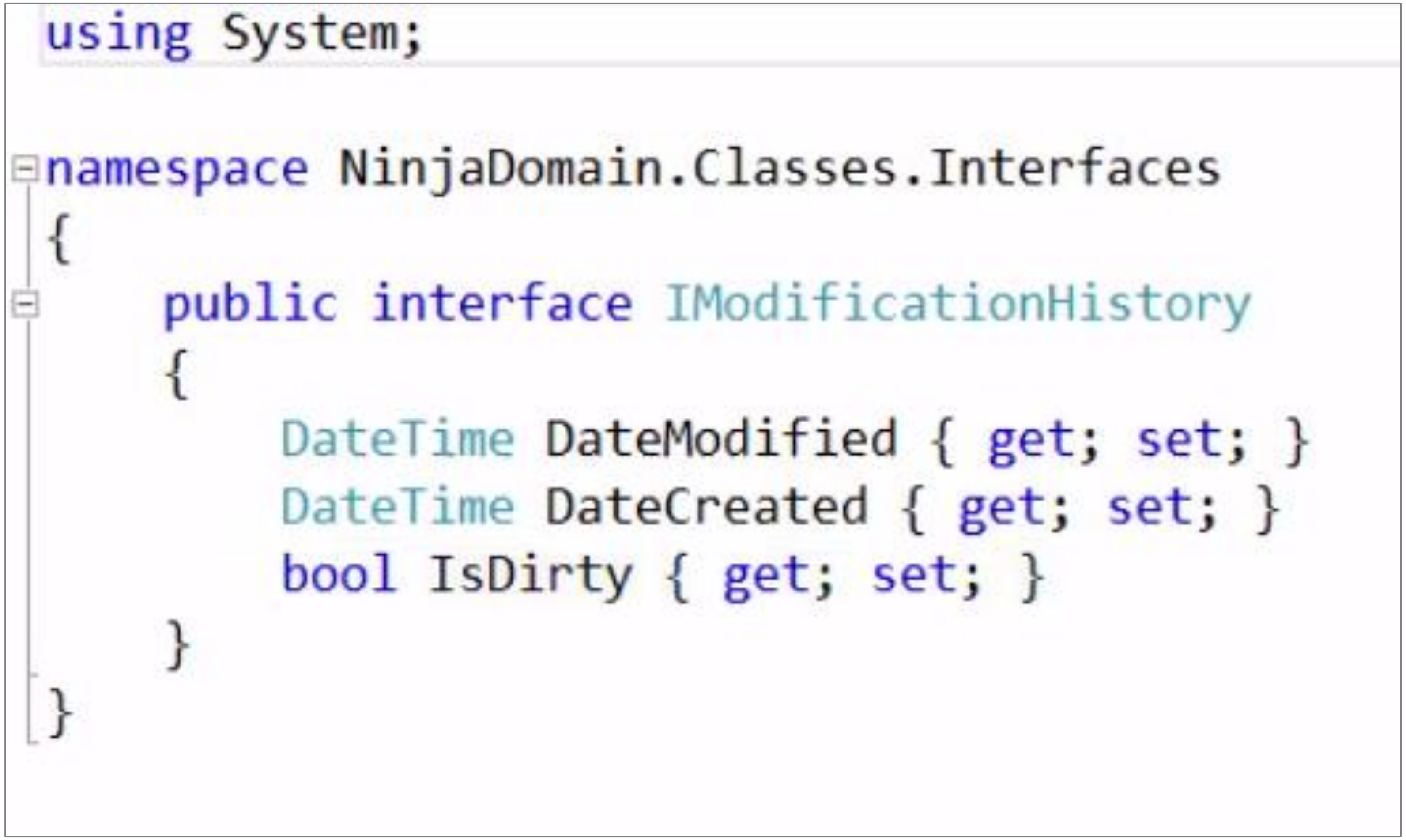
Using the **IEnumarable** interface with a strongly typed View 2:2

If we want a special string if a **Person** in the List is **Employee** it can be done like:

```
@using lesson03_examples.Models;
@model IEnumerable<Person>

@foreach (Person p in Model) {
    if (p is Employee) {
        Employee e = (Employee) p;
        <li>@e.ToString() (@e.WeeklyHours)</li>
    }
    else {
        <li>@p.ToString()</li>
    }
}
```

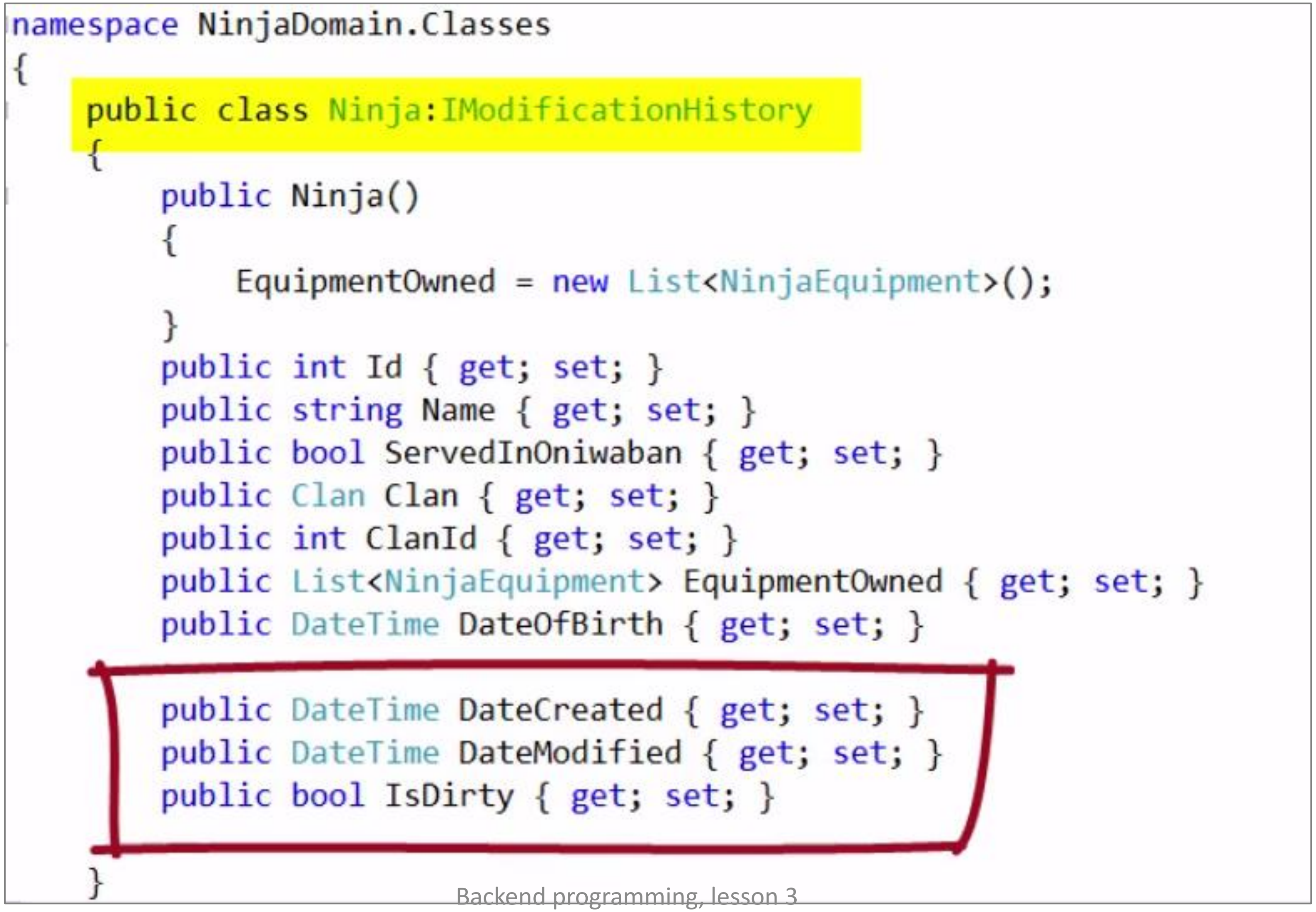
Example03

Another Example (Julie Lerman)



```
using System;

namespace NinjaDomain.Classes.Interfaces
{
    public interface IModificationHistory
    {
        DateTime DateModified { get; set; }
        DateTime DateCreated { get; set; }
        bool IsDirty { get; set; }
    }
}
```

Implementation



```
namespace NinjaDomain.Classes
{
    public class Ninja:IModificationHistory
    {
        public Ninja()
        {
            EquipmentOwned = new List<NinjaEquipment>();
        }
        public int Id { get; set; }
        public string Name { get; set; }
        public bool ServedInOniwaban { get; set; }
        public Clan Clan { get; set; }
        public int ClanId { get; set; }
        public List<NinjaEquipment> EquipmentOwned { get; set; }
        public DateTime DateOfBirth { get; set; }

        public DateTime DateCreated { get; set; }
        public DateTime DateModified { get; set; }
        public bool IsDirty { get; set; }

    }
```

A remark 1

```
Employee e = (Employee) p;
```

Can also be written as:

```
Employee e = p as Employee;
```

Check if you’re not sure that **`Person`** p is an **`Employee`**:

```
if (p is Employee) {
    Employee e = (Employee) p;
}
```

A remark 2 – LINQ example

```
IEnumerable<Movie> movies = new List<Movie>();
// add music, books and movies to the list
// get the movies
movies = Products.OfType<Movie>().ToList();
ViewBag.Movies = movies;
```

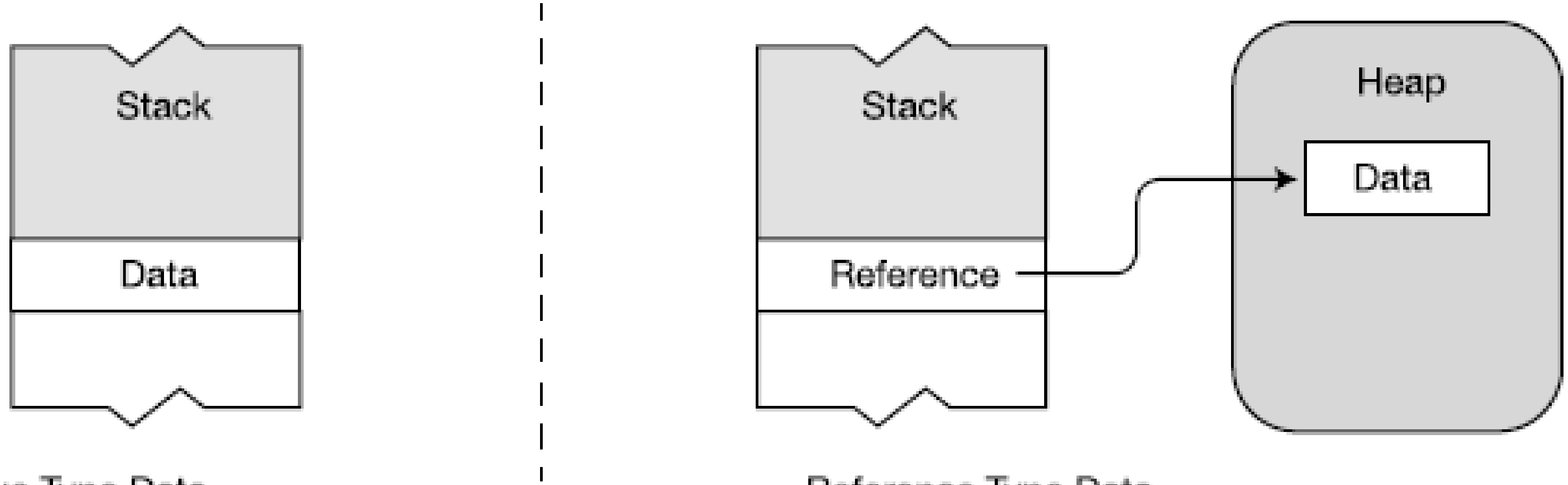
Value Types and Reference Types

The Stack and the Heap

`Struct` (like `DataTime` for example)

- Classes are Reference types and Structures are Values types.
- Classes support Inheritance while Structures don’t.
- Classes can have explicitly parameterless constructors whereas Structures can’t.
- Member variable initialization is possible in Class whereas in Structures, it is not.
- It is not possible to declare destructor in Structure but in Class it is possible.

The stack and the heap

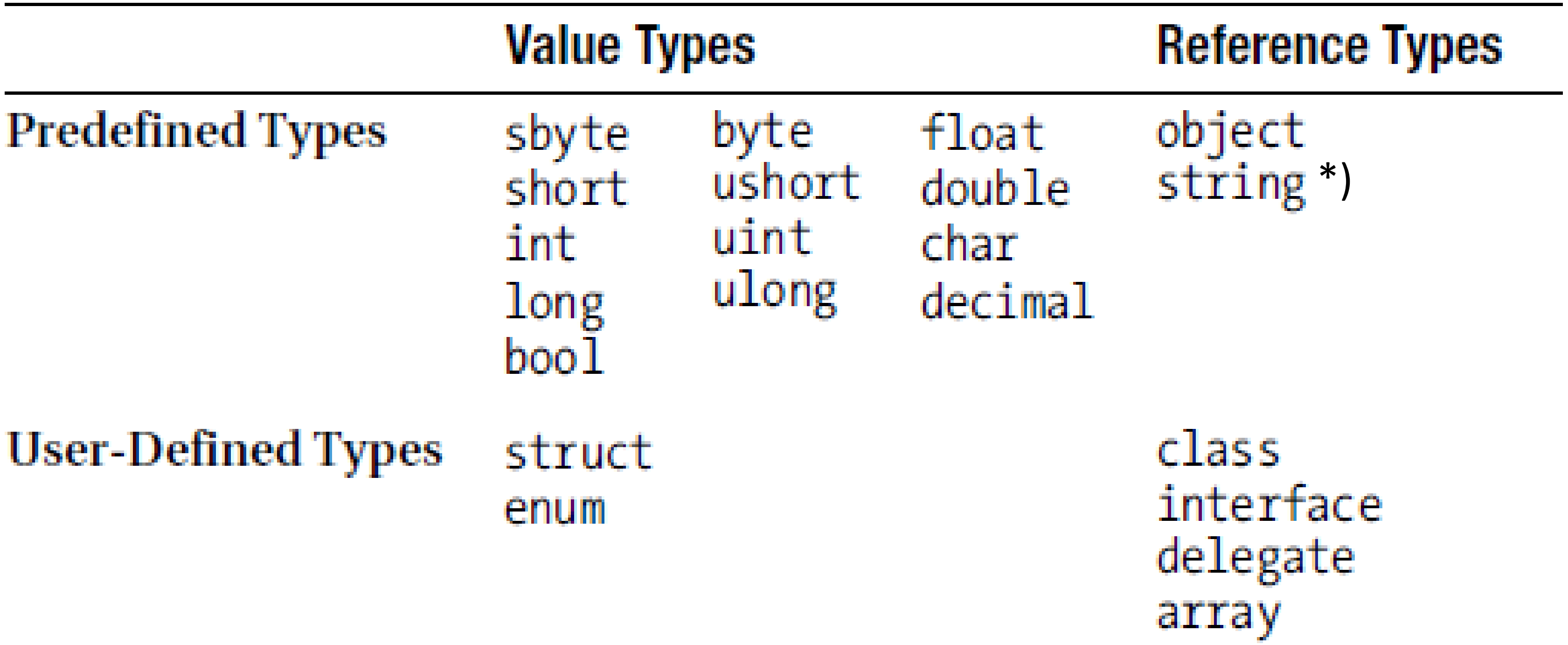


Value Type Data
– The data is stored on the stack.

Reference Type Data
– The data is stored in the heap.
– The reference is stored on the stack.

Kilde: Daniel Solis: Illustrated C# 2008, s. 41

Value Types and Reference Types in C#



	Value Types			Reference Types
Predefined Types	sbyte short int long bool	byte ushort uint ulong	float double char decimal	object string *)
User-Defined Types	struct enum			class interface delegate array

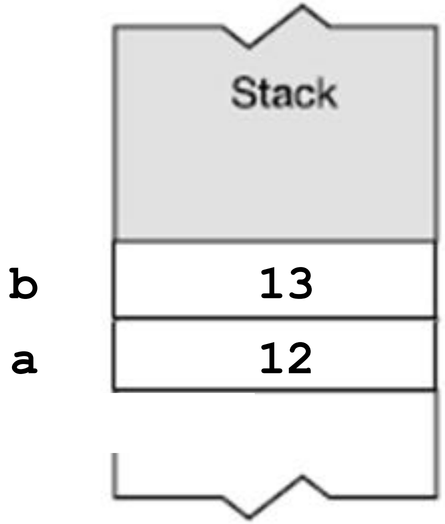
*) Ligheds- og tildelingsoperateren fungerer i forhold til variabelindhold, ikke som reference.

Kilde: Daniel Solis: Illustrated C# 2008, s. 41

Tildelingsoperationer: Værditype

```
int a = 12;
int b = a;
b++; // b is 13 og a is still 12
```

To referencer til to forskellige



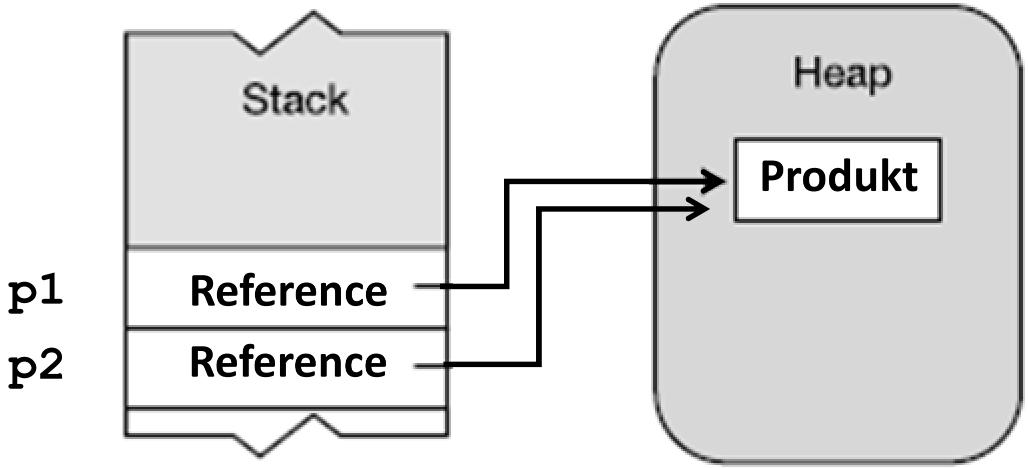
Value Type Data
– The data is stored on the stack.

Reference types

```
public class Produkt {

    public decimal Price = 0.00M;
}
```

```
Product p1 = new Produkt();
Product p2 = p1;
p2.Price = 12.50M; // p1.Prics is 12,50
```

To referencer til det samme objekt



Exercises 2-3

Info

- The 1st mandatory assignment is on Fronter