Device Programming

Tuur Vanhoutte

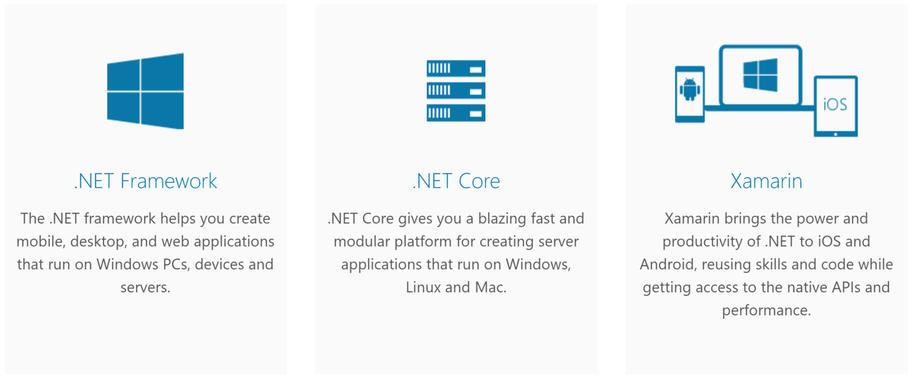
October 19, 2020

Contents

1 .NET

.NET is a free, cross-platform, open source developer platform (*) for building many different types of applications.

* languages + libraries



.NET Framework

The .NET framework helps you create mobile, desktop, and web applications that run on Windows PCs, devices and servers.

.NET Core

.NET Core gives you a blazing fast and modular platform for creating server applications that run on Windows, Linux and Mac.

Xamarin

Xamarin brings the power and productivity of .NET to iOS and Android, reusing skills and code while getting access to the native APIs and performance.

Figure 1: .NET ecosystem

1.1 Languages

- Syntax very similar to C, C++, Java & JavaScript
- Functional programming language, cross-platform, open source
- Approachable English-like language for OOP

1.2 Applications

- desktop
- web & server
- mobile
- gaming
- IoT
- AI

1.2.1 Desktop

- UWP (Universal Windows Project)
- Xamarin.Mac
- WPF (Windows Presentation Foundation)
- WinForms (Windows Forms)

1.2.2 Web & Server

- ASP.NET
- ASP.NET Core

1.2.3 Mobile

- UWP (Universal Windows Project)
- Xamarin

1.2.4 Gaming

- Unity
- CryEngine

1.2.5 IoT

- UWP
- .NET Core IoT

1.2.6 AI

- Cognitive Services
- Azure Machine Learning
- Machine Learning and AI Libraries
- F# for Data Science and ML

1.3 Xamarin

- ‘Target all platforms with a single, shared codebase for Android, iOS, Windows’.
- Developen van Mobile devices lastig: verschillende platformen, verschillende talen voor elk device.
- Oplossing: Xamarin
- Extensie op Visual Studio.

Figure 2: Xamarin Logo

1.3.1 Xamarin - UI Technology

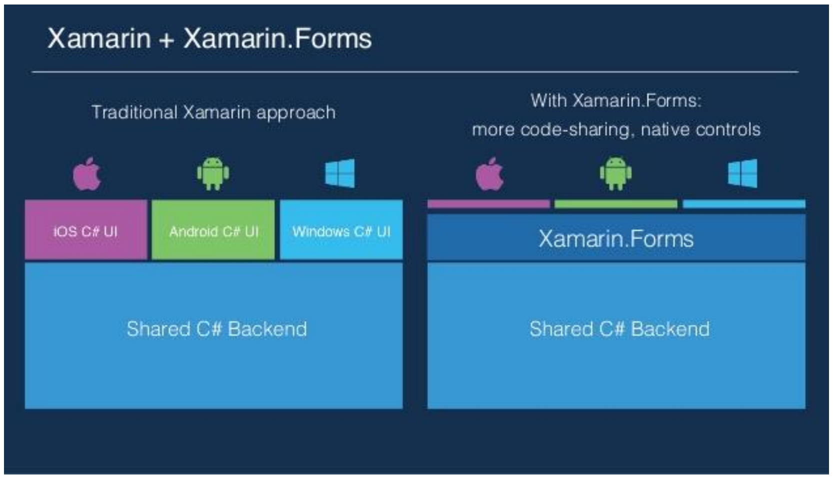


Figure 3: Native vs Xamarin.Forms

1.3.2 Xamarin - Code Sharing strategy

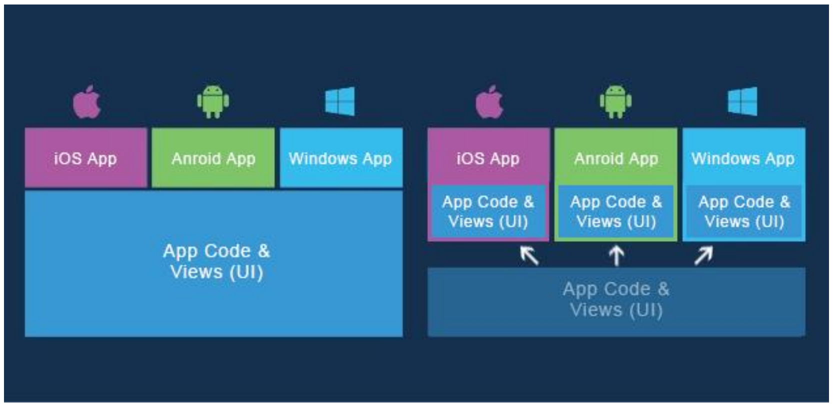


Figure 4: .NET Standard vs Shared (Assets) Project

Met Shared Assets Project maken we de UI voor elk platform apart. Wij gaan vooral werken met .NET Standard.

1.4 Summary

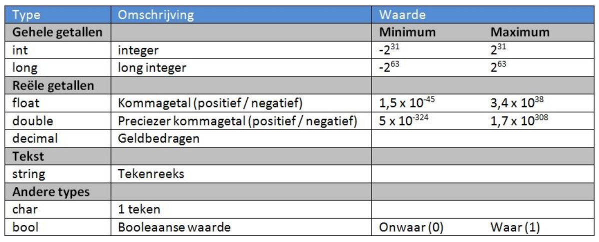
- What devices, platforms, etc. can we target using .NET, and what programming languages can we use?
- What is the basic difference between .NET Standard and Shared Assets projects in Xamarin?
- What is the difference between Xamarin native and Xamarin.Forms? What are the advantages and disadvantages?
- How to set up and understand the structure of a Xamarin project for the labs in this course, and how to debug on the different platforms.

2 C# Syntax

2.1 Python vs C#

- curly brackets { } in plaats van indenting

2.2 Datatypes



Type	Omschrijving	Waarde	
Gehele getallen		**Minimum**	**Maximum**
int	integer	-2^{31}	2^{31}
long	long integer	-2^{63}	2^{63}
Reële getallen			
float	Kommagetal (positief / negatief)	$1{,}5 \times 10^{-45}$	$3{,}4 \times 10^{38}$
double	Preciezer kommagetal (positief / negatief)	5×10^{-324}	$1{,}7 \times 10^{308}$
decimal	Geldbedragen		
Tekst			
string	Tekenreeks		
Andere types			
char	1 teken		
bool	Booleaanse waarde	Onwaar (0)	Waar (1)

Figure 5: Datatypes in C#

2.3 Collections

- Array
- Dictionary<TKey, TValue>
- List<T>

Collection type = fixed! ⇒ Je kan alleen objecten van het gekozen type toevoegen aan een collection

```
//collections of type Person:
Person[] teacherArr = new Person[10];
List<Person> teacherList = new List<Person>();

//You can only add Person objects to these collections!
```

2.3.1 Arrays

= meerdere variabelen van hetzelfde type

```
//initialize int array with 10 positions:
int[] numbers = new int[10];
//save number 13 in the first position
numbers[0] = 13;
//print the value of the first number in the array:
Debug.WriteLine("The␣first␣number␣is:" +numbers[0]);
//intialize and fill another array with 4 numbers:
int[] startPositions = { 4, 1, 9, 3 };
```

2.3.2 Dictionary <TKey, TValue>

```
//declare dictionary with key type & value type
Dictionary<string, int> studentScores = new Dictionary<string, int>();
//add two elements (key value pairs)
studentScores.Add("Jean-Jacques", 13);
studentScores.Add("Jean-Louis", 4);
//get the score of Jean-Jacques
int score = studentScores["Jean-Jacques"];
```

2.3.3 List<T>

```
//declare list, fill one by one:
List<string> emailList = new List<string>();
emailList.Add("stijn.walcarius@howest.be");
emailList.Add("frederik.waeyaert@howest.be");
//get elements out (two ways):
string first = emailList.ElementAt(0);
string second = emailList[1];
//declare + fill list:
List<string> teacherList = new List<string> { "SWC", "FWA" };
```

2.4 Selections

if / else if / else / switch

```
if(findTheoryTeacher == true) {
    email1 = "frederik.waeyaert@howest.be";
    email2 = null;
}
else if(findLabTeachers == true) {
    email1 = "stijn.walcarius@howest.be";
    email2 = "␣frederik.waeyaert@howest.be";
} else {
    email1 = email2 = null;
}
```

```
switch (teacher){
    case "SWC":
        email = "stijn.walcarius@howest.be";
        break;
    case "FWA":
        email = "frederik.waeyaert@howest.be";
        break;
    default:
        email = "info@howest.be";
        break;
}
```

2.5 Loops

for / foreach / while / do while

```
for(int i = 0; i < 100; i++) {
    //do something 100 times
}
```

```
List<string> teacherList = new List<string> { "SWC", "FWA" };
foreach(string teacher in teacherList) {
    //do something
}
```

```
while(endOfClass == false){
    //might never be executed
}
```

```
do {
    //executed at least once!
} while(endOfClass == false);
```

2.6 Classes

```
public class Person
{
    //property
    public string Name {
        get {...};
        set {...};
    }

    //constructor
    public Person(string name) {
        this.Name = name;
    }

    //method
    public void Subscribe() {
        //do something
    }
}
```

2.7 Instantiate objects

```
Persons p1 = new Person("Stijn");

// Based on the following constructor in the Person class:
public Person (string name) {
    this.Name = name;
}
```

2.8 Properties

2.8.1 Fields vs properties

- Fields store the actual data
- Properties are used to access those fields
- Auto-implemented properties have a hidden field
- Use properties to control field access
- Enhance input/output control using get & set
- Calculated properties build on other properties
  - No field required
  - Reusability

```
//private field
private int _id;

//property (zetten we altijd public)
public int Id {
    // getter
    get { return _id; }
    // setter
    set { _id = value; }
}
```

2.8.2 Default values for properties

- Setting default values can be useful
- Default values can be set. . .
  - . . . with full properties
  - . . . with auto-implemented properties
  - . . . in the constructor

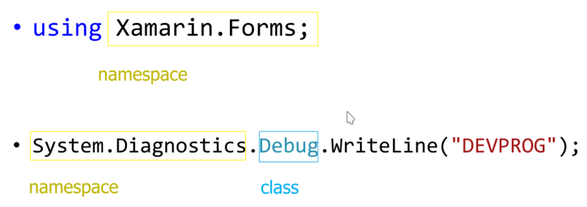
2.9 Constructor

- A constructor is called every time you create an instance of a class
- It is used to allow / force the user to provide certain values
- Default constructor is (only) added if a model has no constructors
- Constructor overloading = multiple constructors with either . . .
  - . . . a different number of parameters, or
  - . . . a different type of paramters, or
  - . . . the same parameters in a different order
- Constructors should call each other for enhanced efficiency
- Constructors in inheriting classes call the constructors of the base class

3 Streamreader

- Namespaces
- System.Reflection
- Embedded Files
- System.IO

3.1 Namespaces



```
• using Xamarin.Forms;

• System.Diagnostics.Debug.WriteLine("DEVPROG");
```

Figure 6: Namespaces

3.2 System.Reflection

"The classes in the System.Reflection namespace, together with System.Type, enable you to obtain information about loaded assemblies and the types defined within, such as classes, interfaces, and value types. You can also use ***reflection*** *to create type instances at run time and to invoke them."*

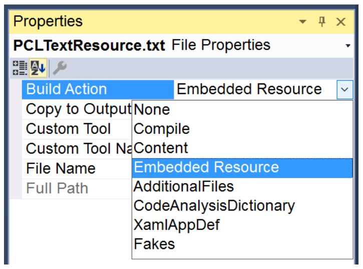
3.3 System.IO

= Input/Output `https://developer.xamarin.com/api/namespace/System.IO/`

- StreamReader `https://developer.xamarin.com/api/type/System.IO.StreamReader/`
- StreamWriter `https://developer.xamarin.com/api/type/System.IO.StreamWriter/`

3.4 Embedded files

- Textfiles, images, etc.
- Generates a **ResourceID** for the file



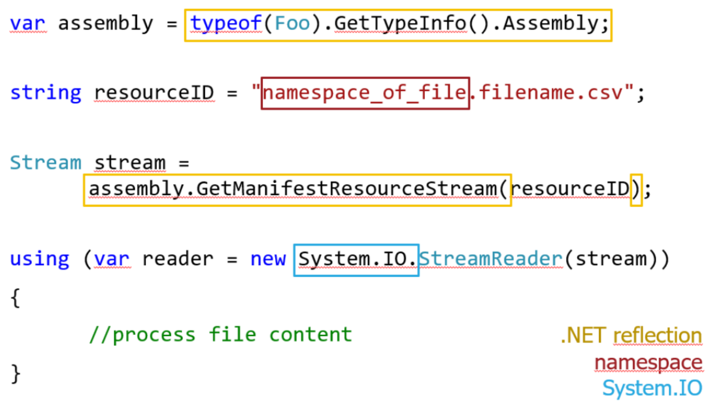
Properties

PCLTextResource.txt File Properties

Build Action	Embedded Resource
Copy to Output	
Custom Tool	
Custom Tool Na	
File Name	
Full Path	

Figure 7: Embedded files inladen in een Visual Studio project: rechtermuisknop op 1 of meerdere files ⇒ properties ⇒ build action = Embedded resources

3.4.1 Read an embedded file in Xamarin

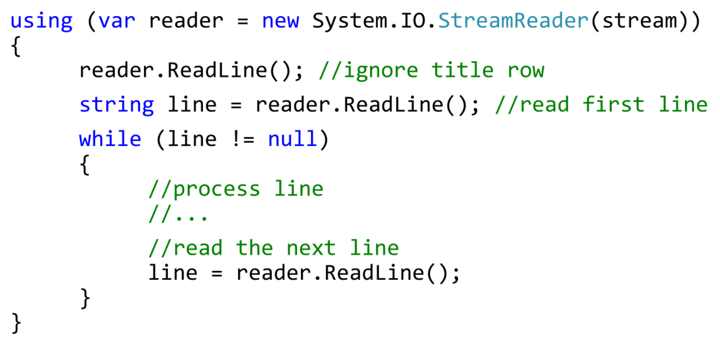


```
var assembly = typeof(Foo).GetTypeInfo().Assembly;

string resourceID = "namespace_of_file.filename.csv";

Stream stream =
       assembly.GetManifestResourceStream(resourceID);

using (var reader = new System.IO.StreamReader(stream))
{
       //process file content
}
```

Figure 8

•

3.4.2 Processing the file's content



```
using (var reader = new System.IO.StreamReader(stream))
{
      reader.ReadLine(); //ignore title row
      string line = reader.ReadLine(); //read first line
      while (line != null)
      {
            //process line
            //...
            //read the next line
            line = reader.ReadLine();
      }
}
```

Figure 9

3.5 Summary

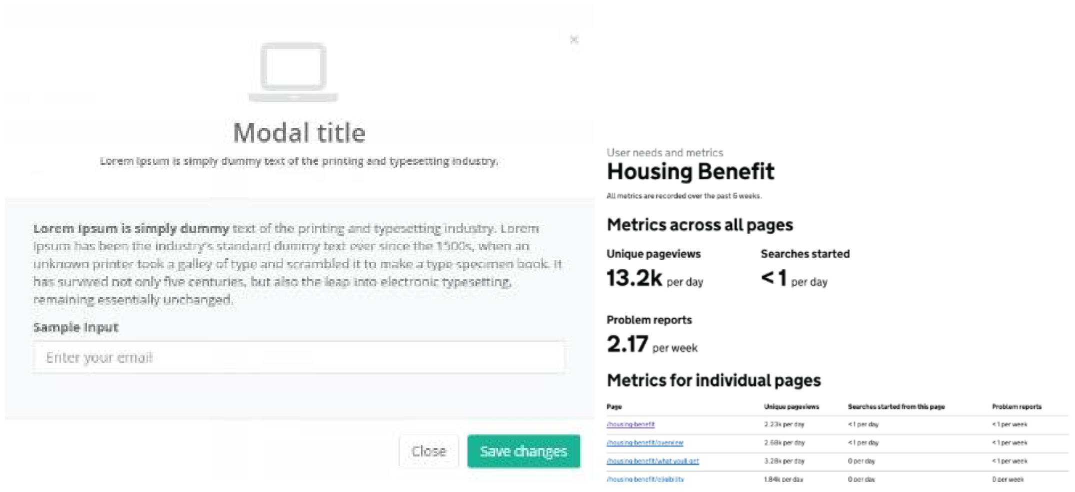
- You understand the importance of **namespaces**, and the techniques of using them in your own projects.
- You can explain the very basics of the **System.IO** and **System.Reflection** namespaces, and what they have to do with reading an embedded file in Xamarin.
- You understand the how and why of the **ResourceID** that's being generated for an embedded file.

4 Navigation

4.1 Modal vs Modeless

- Modal page: requires user input to continue

- Modeless page: user can go back any time he wants; no input required


Modal title

Lorem Ipsum is simply dummy text of the printing and typesetting industry.

Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged.

Sample Input

Enter your email

Close | Save changes

User needs and metrics

Housing Benefit

All metrics are recorded over the past 6 weeks.

Metrics across all pages

Unique pageviews: 13.2k per day

Searches started: < 1 per day

Problem reports: 2.17 per week

Metrics for individual pages

Page	Unique pageviews	Searches started from this page	Problem reports
/housing-benefit	2.23k per day	<1 per day	<1 per week
/housing-benefit/overview	2.68k per day	<1 per day	<1 per week
/housing-benefit/what-youll-get	3.28k per day	0 per day	<1 per week
/housing-benefit/eligibility	1.84k per day	0 per day	0 per week

Figure 10: Modal page vs Modeless page

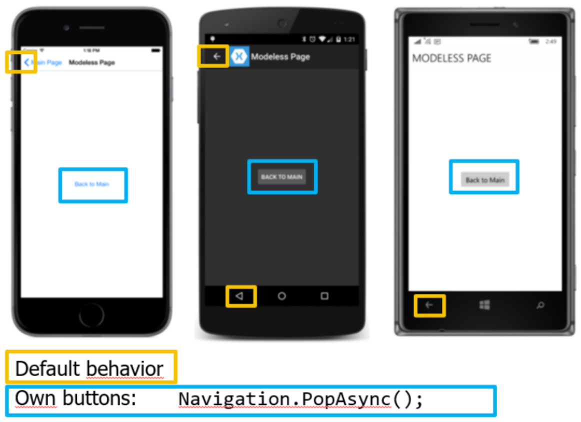
4.2 Navigate forward

```
Navigation.PushAsync(new FooPage());
Navigation.PushModalAsync(new FooPage());

// FooPage is hier de XAML page waar we willen naar navigeren
```

- PushAsync vs PushModalAsync
- Navigation object: controls the navigation stack

4.3 Navigate back

4.3.1 Go back - Modeless page

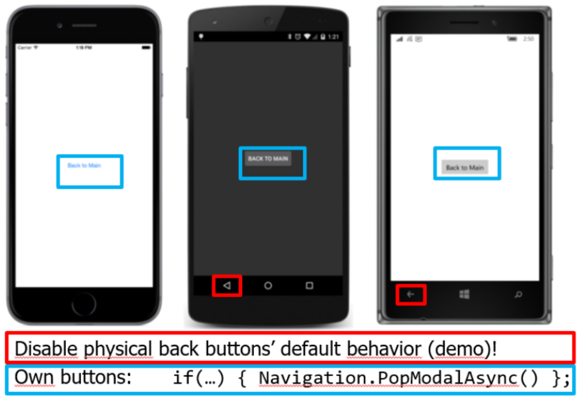


Default behavior

Own buttons: `Navigation.PopAsync();`

Figure 11

4.3.2 Go back - Modal page



Disable physical back buttons’ default behavior (demo)!

Own buttons: `if(…) { Navigation.PopModalAsync() };`

Figure 12

4.4 Navigation stack

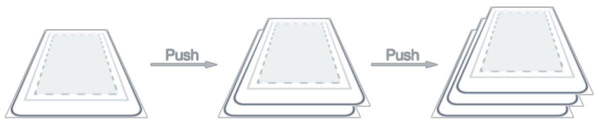


Figure 13: Pushen op de stack

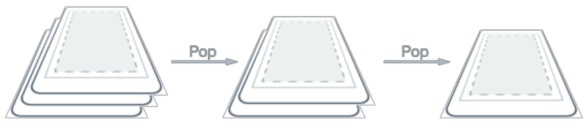


Figure 14: Pop’en van de stack

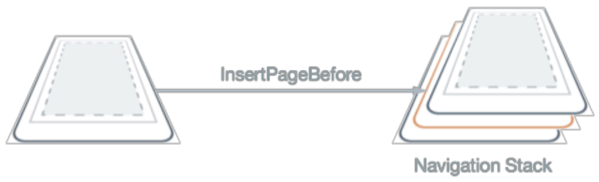


Figure 15: InsertPageBefore

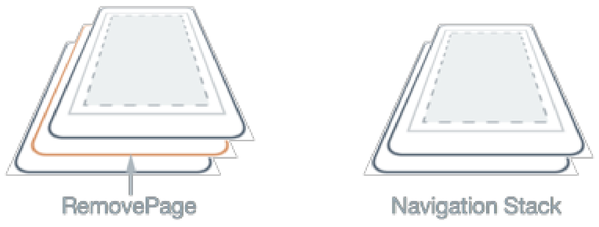


Figure 16: RemovePage

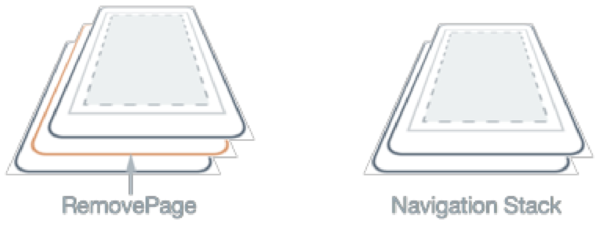


Figure 17: PopToRoot

4.5 Page types

- ContentPage
- MasterDetailPage (zie Demo_MasterDetail)
- NavigationPage (zie Demo_Navigation)
- TabbedPage (zie Demo_TabbedPage)
- TemplatedPage
- CarouselPage

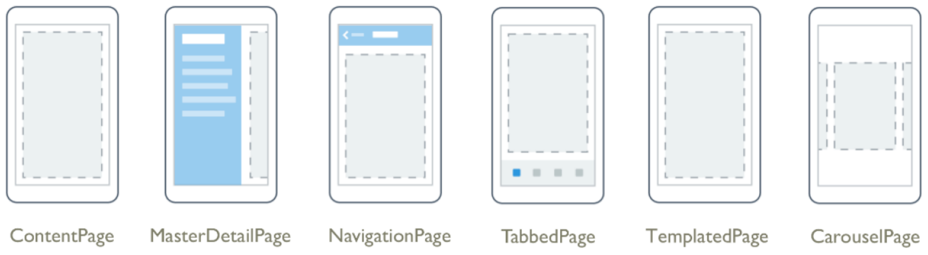


Figure 18

4.6 Exchanging data

How to exchange data between several pages:

1. Constructor (Demo_MasterDetail)
2. Properties (Demo_TabbedPage)

4.7 Summary

- The different **page types** and how to use them.
- The difference between **Modal** and **Modeless** pages, and how to manage navigation for both.
- You know how to **exchange data** between pages in the navigation process.
- You understand the **navigation stack** and how you can manipulate it.
- You can explain the concept of a **master-detail** relation with an example

5 Object Orientation

5.1 Inheritance

= klasses nemen methods en properties over van een andere klasse.

Er ontstaat een hi"erarchie.

```
// the base class:

public class Advisor
{
    // properties
    public string Name { get; set; }

    // methods
    public void Advise() { }
}

// the deriving class
// notice the : between the base class and deriving class

public class MinisterOfDefense : Adviser {
    // code here
}
```

- All C# classes, of any type, are treated as if they ultimately derive from System.Object

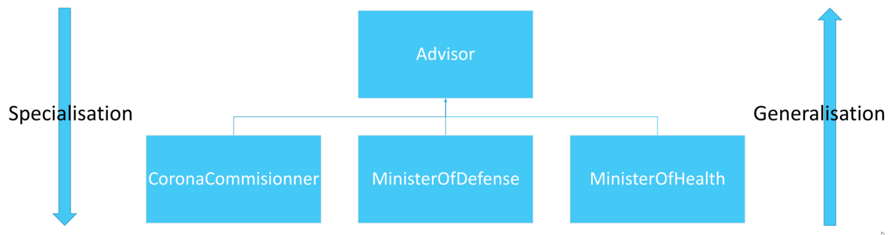
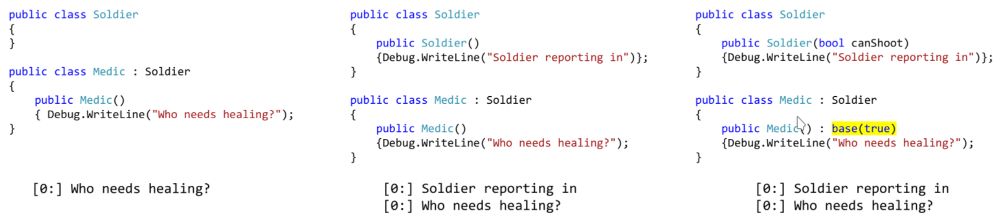


Figure 19

- **Generalize** properties (equal for all) by putting them in the **base class**
- **Specify** properties (specific for one) by putting them in the **deriving class**

5.1.1 Constructor

- Constructors are **not** inherited!
- Constructor without parameter in base class?
  - ⇒ Automatically called by deriving class
- No constructor without parameters in base class?
  - ⇒ Explicitly call it in deriving classes



```
public class Soldier
{
}

public class Medic : Soldier
{
    public Medic()
    { Debug.WriteLine("Who needs healing?");
}

    [0:] Who needs healing?
```

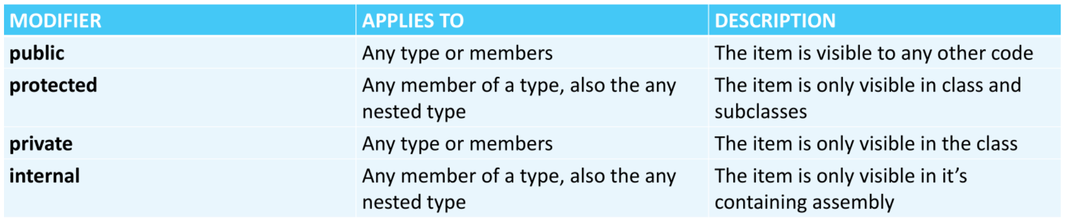
```
public class Soldier
{
    public Soldier()
    {Debug.WriteLine("Soldier reporting in")};
}

public class Medic : Soldier
{
    public Medic()
    {Debug.WriteLine("Who needs healing?");
}

    [0:] Soldier reporting in
    [0:] Who needs healing?
```

```
public class Soldier
{
    public Soldier(bool canShoot)
    {Debug.WriteLine("Soldier reporting in")};
}

public class Medic : Soldier
{
    public Medic() : base(true)
    {Debug.WriteLine("Who needs healing?");
}

    [0:] Soldier reporting in
    [0:] Who needs healing?
```

Figure 20: Inheritance: constructor example

5.1.2 Access modifiers

public is the default access modifier.



MODIFIER	APPLIES TO	DESCRIPTION
public	Any type or members	The item is visible to any other code
protected	Any member of a type, also the any nested type	The item is only visible in class and subclasses
private	Any type or members	The item is only visible in the class
internal	Any member of a type, also the any nested type	The item is only visible in it's containing assembly

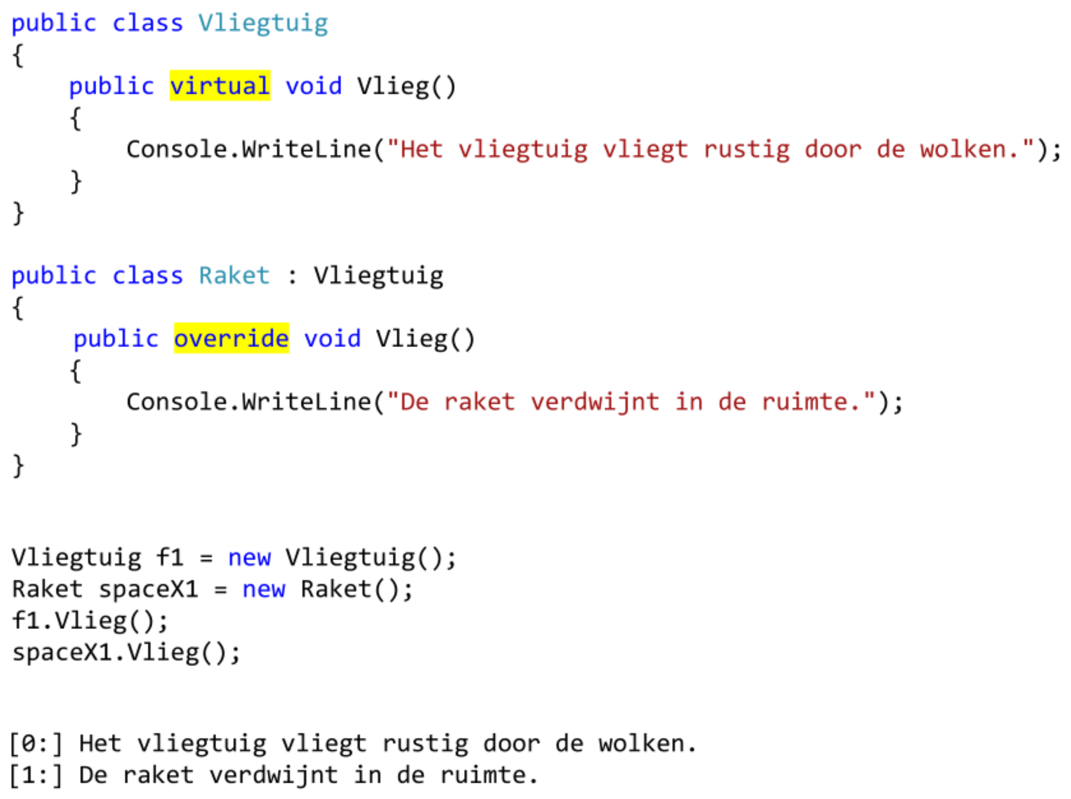
Figure 21: Inheritance: access modifiers

5.1.3 Properties/methods: VIRTUAL and OVERRIDE

When you want to override a method from the base class, use the virtual keyword in the base method, and the override method in the derived method.

Virtual properties/methods:

- Default implementation in base class
- 'virtual' keyword, to **replace** the way an object behaves
- **CAN** be overriden in subclasses, only if necessary.



```
public class Vliegtuig
{
    public virtual void Vlieg()
    {
        Console.WriteLine("Het vliegtuig vliegt rustig door de wolken.");
    }
}

public class Raket : Vliegtuig
{
    public override void Vlieg()
    {
        Console.WriteLine("De raket verdwijnt in de ruimte.");
    }
}


Vliegtuig f1 = new Vliegtuig();
Raket spaceX1 = new Raket();
f1.Vlieg();
spaceX1.Vlieg();
```

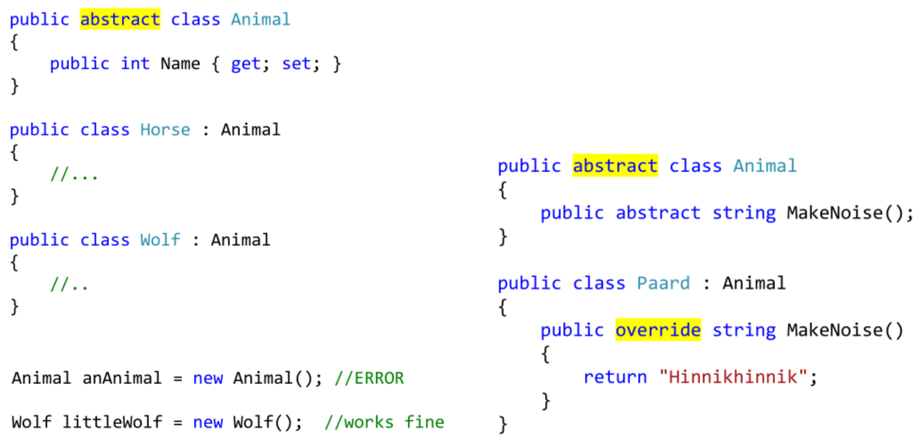
```
[0:] Het vliegtuig vliegt rustig door de wolken.
[1:] De raket verdwijnt in de ruimte.
```

Figure 22

5.1.4 Properties/methods: ABSTRACT and OVERRIDE

Abstract properties/methods:

- No default implementation possible in base class
- ‘abstract’ keyword, to **extend** the way an object behaves
- **MUST** be present in each deriving class



```
public abstract class Animal
{
    public int Name { get; set; }
}

public class Horse : Animal
{
    //...
}

public class Wolf : Animal
{
    //..
}


Animal anAnimal = new Animal(); //ERROR

Wolf littleWolf = new Wolf();  //works fine
```

```
public abstract class Animal
{
    public abstract string MakeNoise();
}

public class Paard : Animal
{
    public override string MakeNoise()
    {
        return "Hinnikhinnik";
    }
}
```

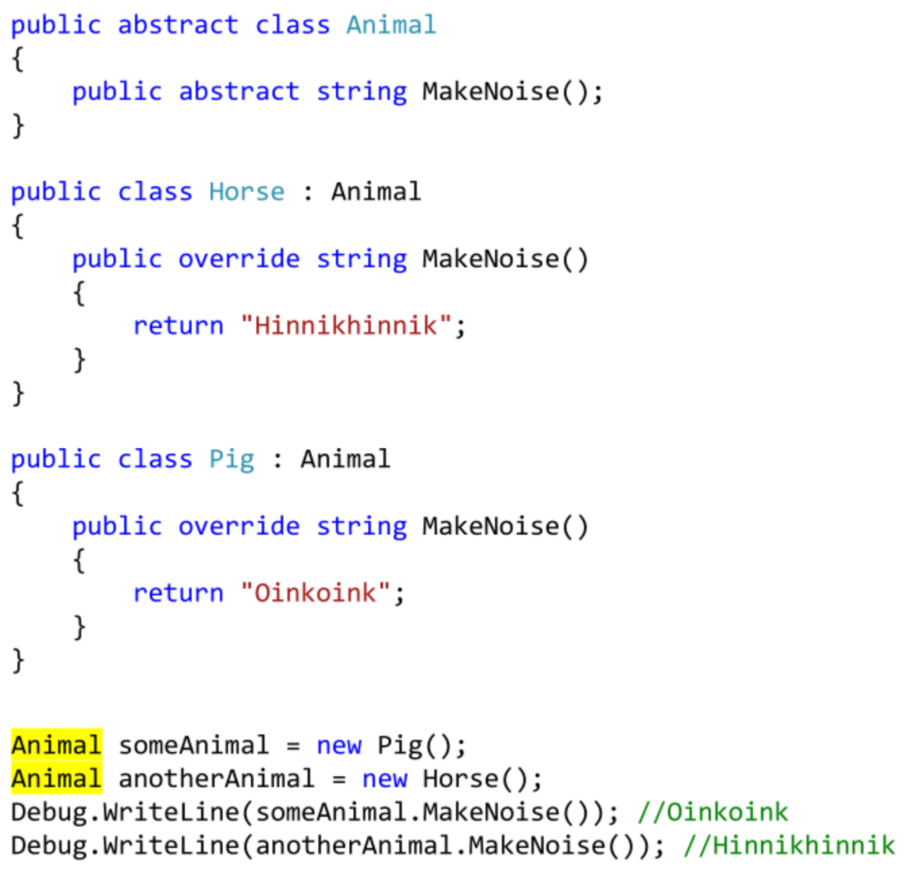
Figure 23

5.2 Polymorphisme

= Objects of a derived class can be treated like objects of the base class at runtime

Example: say we have a class Animal, and two classes Cat and Dog that inherit the Animal class. Then, this is possible:

```
List<Animal> animals = new List<Animal>();
Animal dog = new Dog();
Animal cat = new Cat();

animals.Add(dog);
animals.Add(cat);
```



```
public abstract class Animal
{
    public abstract string MakeNoise();
}

public class Horse : Animal
{
    public override string MakeNoise()
    {
        return "Hinnikhinnik";
    }
}

public class Pig : Animal
{
    public override string MakeNoise()
    {
        return "Oinkoink";
    }
}

Animal someAnimal = new Pig();
Animal anotherAnimal = new Horse();
Debug.WriteLine(someAnimal.MakeNoise()); //Oinkoink
Debug.WriteLine(anotherAnimal.MakeNoise()); //Hinnikhinnik
```

Figure 24: Polymorphism example

5.2.1 Disadvantage

!!! **Multiple inheritance** is **NOT** allowed through classes in C# !!!

5.3 Interfaces

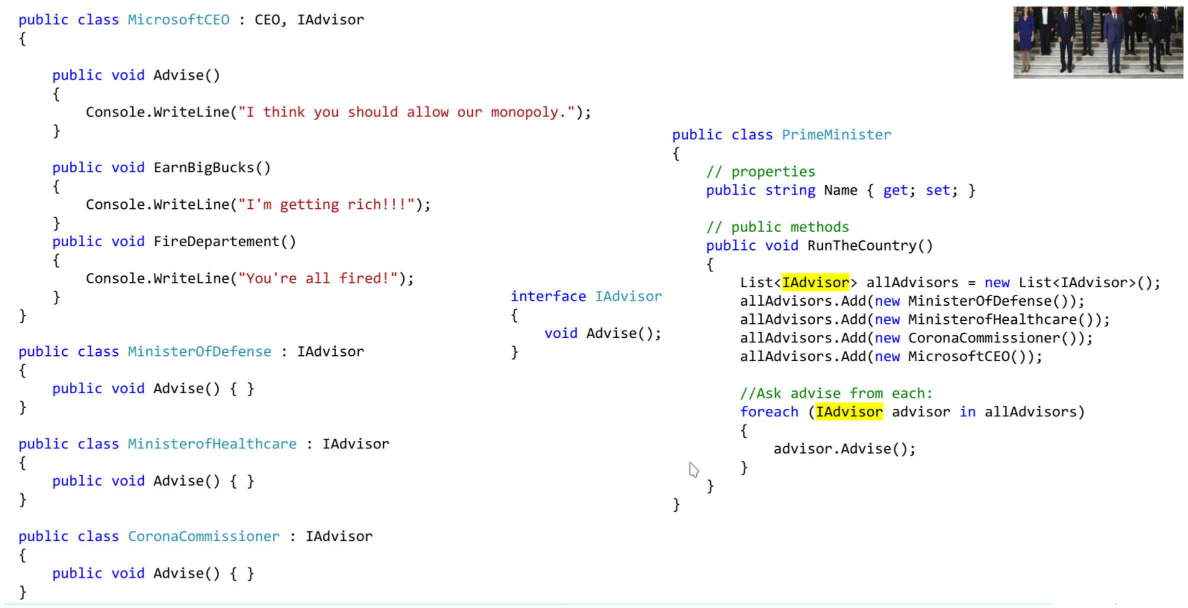
- Interfaces can be seen as contracts for classes
- Implementing = applying the contract
- An interface **forces** all implementing classes to implement all properties and/or methods
- An interface has no default implementation on its own (=you can't create an instance from an interface)

5.3.1 Summary

- Contract + NO implementations = interface
- Contract + SOME implementations = abstract (base) class
- Implementation for all properties & methods = normal (base) class

5.3.2 Example

- The IAdvisor interface has an Advice() method (notice that method has no default implementation)
- Every class that implements this interface also must have its own Advice() method
- A class can implement multiple interfaces (see the MicrosoftCEO class)
- In the PrimeMinister class:
  - A list is created with the same type as the interface
  - Every element in that list is of a class that implements the interface
  - Can therefore also be used in a foreach() loop



```
public class MicrosoftCEO : CEO, IAdvisor
{

    public void Advise()
    {
        Console.WriteLine("I think you should allow our monopoly.");
    }

    public void EarnBigBucks()
    {
        Console.WriteLine("I'm getting rich!!!");
    }
    public void FireDepartement()
    {
        Console.WriteLine("You're all fired!");
    }
}

public class MinisterOfDefense : IAdvisor
{
    public void Advise() { }
}

public class MinisterofHealthcare : IAdvisor
{
    public void Advise() { }
}

public class CoronaCommissioner : IAdvisor
{
    public void Advise() { }
}
```

```
interface IAdvisor
{
    void Advise();
}
```

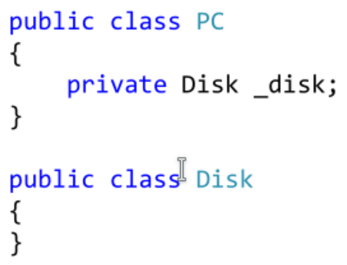
```
public class PrimeMinister
{
    // properties
    public string Name { get; set; }

    // public methods
    public void RunTheCountry()
    {
        List<IAdvisor> allAdvisors = new List<IAdvisor>();
        allAdvisors.Add(new MinisterOfDefense());
        allAdvisors.Add(new MinisterofHealthcare());
        allAdvisors.Add(new CoronaCommissioner());
        allAdvisors.Add(new MicrosoftCEO());

        //Ask advise from each:
        foreach (IAdvisor advisor in allAdvisors)
        {
            advisor.Advise();
        }
    }
}
```

Figure 25: Interfaces example

5.4 Composition

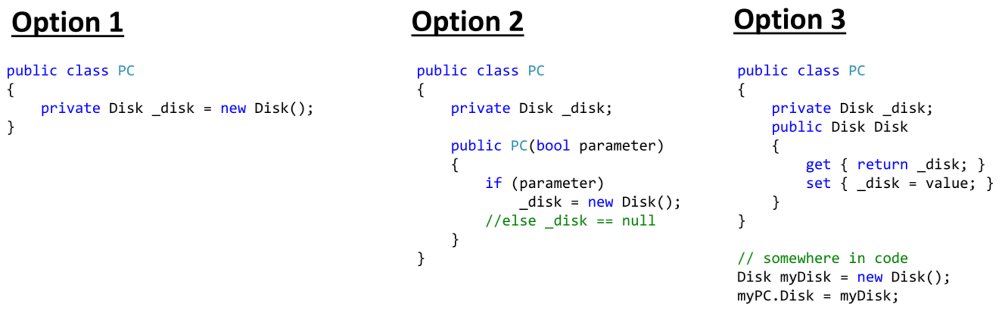
= Creating an instance of an object from a class in another class.

5.4.1 Example



```
public class PC
{
    private Disk _disk;
}

public class Disk
{
}
```

Figure 26: How can we make an instance of '_disk'?



Option 1

```
public class PC
{
    private Disk _disk = new Disk();
}
```

Option 2

```
public class PC
{
    private Disk _disk;

    public PC(bool parameter)
    {
        if (parameter)
            _disk = new Disk();
        //else _disk == null
    }
}
```

Option 3

```
public class PC
{
    private Disk _disk;
    public Disk Disk
    {
        get { return _disk; }
        set { _disk = value; }
    }
}

// somewhere in code
Disk myDisk = new Disk();
myPC.Disk = myDisk;
```

Figure 27: Solution: 3 options

Option 1: creating it at the start of the class (=composition)

Option 2: using the constructor (=composition)

Option 3: Outside of the class, by creating a new object an assigning that object to the '_disk' property in the class.

The 3rd option is called **Aggregation**. Unlike the other options, the 'myDisk' object keeps existing even if the PC class stops existing.

5.4.2 Interfaces in Xamarin(.Forms)

Interfaces in Xamarin(.Forms) is extremely useful:

Say you need to get data from a specific sensor on your Android/iOS/UWP device. We can create an interface in our project, and implement that interface in each device's code. Once we need to get that data, we can automatically call the correct method for the correct device, by just calling the interface's method.

5.5 Summary

- You are convinced by the advantages of **inheritance** and **polymorphism**, and can explain using an example
- You understand the usage and consequences of the **virtual** and **abstract** keywords for properties and methods.

- You know when to use **abstract classes** and/or **interfaces**, and can explain the difference between those two.
- You understand the specific importance of interfaces in **Xamarin**(.Forms)

6 Asynchronous programming: async and await keywords

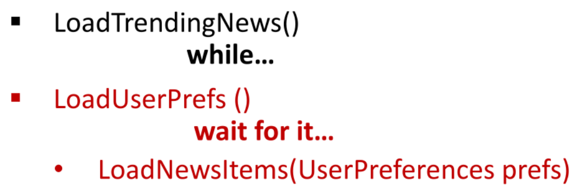
6.1 Why?

To make the app continue to respond to use interaction while. . . :

- Reading from or writing to a database or file
- Accessing a web service
- Performing data processing

6.2 Example: newspaper app

- Load the trending newspaper items
- Load user preferences
- Load newspaper items based on preferences ⇒ needs to wait until user preferences are set



- LoadTrendingNews()

  while…

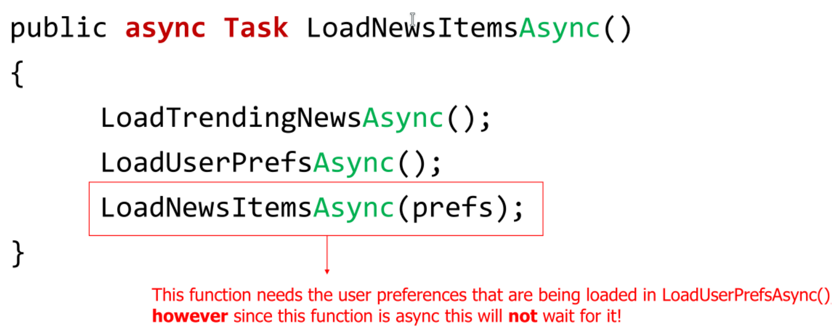
- LoadUserPrefs ()

  wait for it…

  - LoadNewsItems(UserPreferences prefs)

Figure 28

6.2.1 Problem

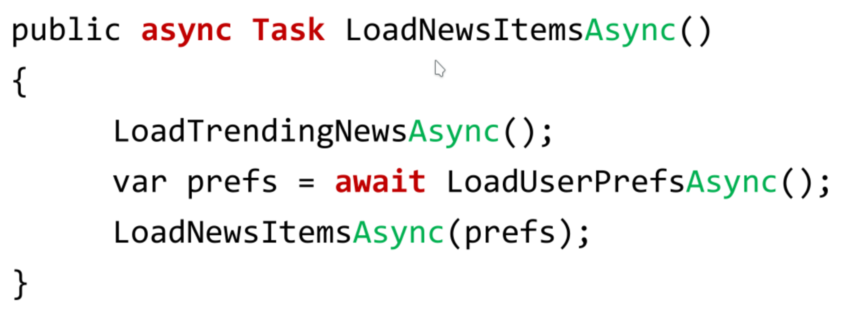


```
public async Task LoadNewsItemsAsync()
{
      LoadTrendingNewsAsync();
      LoadUserPrefsAsync();
      LoadNewsItemsAsync(prefs);
}
```

This function needs the user preferences that are being loaded in LoadUserPrefsAsync()
however since this function is async this will **not** wait for it!

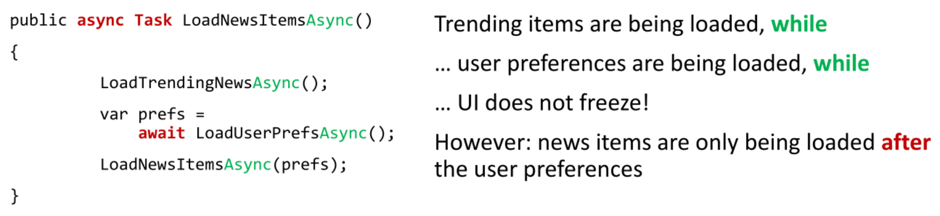
Figure 29: LoadNewsItemsAsync(prefs) needs to wait

6.2.2 Solution



```
public async Task LoadNewsItemsAsync()
{
        LoadTrendingNewsAsync();
        var prefs = await LoadUserPrefsAsync();
        LoadNewsItemsAsync(prefs);
}
```

Figure 30: Solution: use the ‘await’ keyword



```
public async Task LoadNewsItemsAsync()
{
        LoadTrendingNewsAsync();

        var prefs =
            await LoadUserPrefsAsync();

        LoadNewsItemsAsync(prefs);
}
```

Trending items are being loaded, **while**

… user preferences are being loaded, **while**

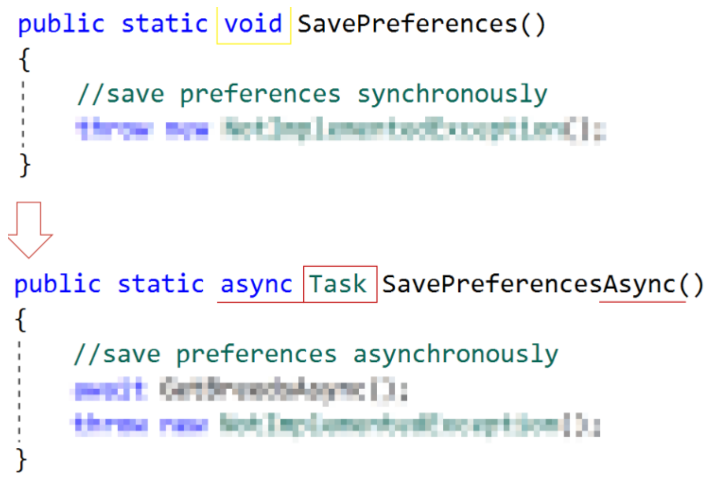
… UI does not freeze!

However: news items are only being loaded **after** the user preferences

Figure 31

6.3 Creating an asynchronous function

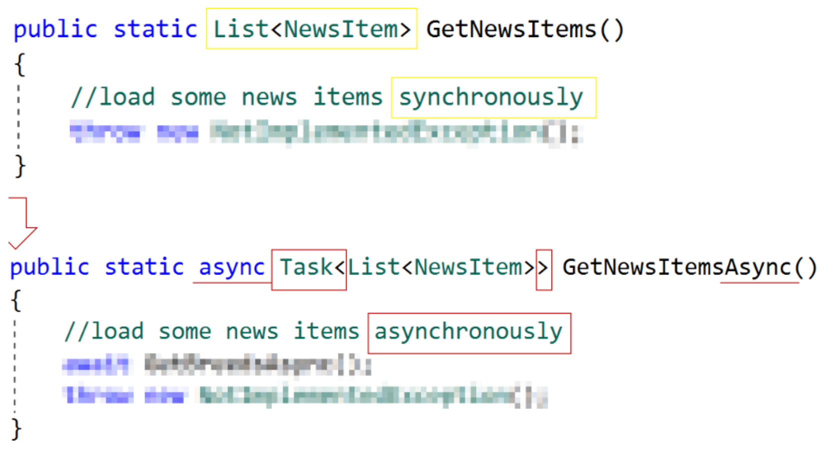
6.3.1 With void-functions: use Task



```
public static void SavePreferences()
{
    //save preferences synchronously
    [redacted]
}

public static async Task SavePreferencesAsync()
{
    //save preferences asynchronously
    [redacted]
}
```

Figure 32: Turning a void function asynchronous

6.3.2 With a function that returns a type T

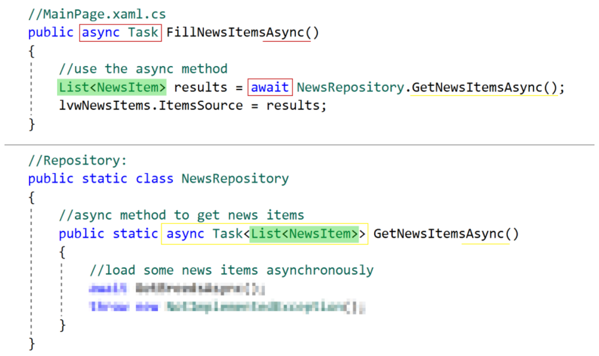


```
public static List<NewsItem> GetNewsItems()
{
    //load some news items synchronously
    [redacted]
}

public static async Task<List<NewsItem>> GetNewsItemsAsync()
{
    //load some news items asynchronously
    [redacted]
}
```

Figure 33: Turning a type function asynchronous

6.4 Calling an asynchronous function

- ‘async’ in both the function you call it in, and the function you are calling
- await when calling the function



```
//MainPage.xaml.cs
public async Task FillNewsItemsAsync()
{
    //use the async method
    List<NewsItem> results = await NewsRepository.GetNewsItemsAsync();
    lvwNewsItems.ItemsSource = results;
}
```

```
//Repository:
public static class NewsRepository
{
    //async method to get news items
    public static async Task<List<NewsItem>> GetNewsItemsAsync()
    {
        //load some news items asynchronously
        [redacted]
    }
}
```

Figure 34

6.5 Summary

- The difference between **synchronous** and **asynchronous** programming
- The **what** and the **why** of asynchronous programming
- The meaning and usage of the **async** keyword
- The meaning and usage of the **await** keyword
- The **return type** of async functions