# Task 3: Relation among (us) classes

# Depth of the inheritance tree (DIT)

*What is it?*

- refers to the number of levels in a class hierarchy
- each level represents a class that inherits from another class
- it refers to the distance between a class and the root of the inheritance tree

# Depth of the inheritance tree (DIT)

*How do you measure it?*

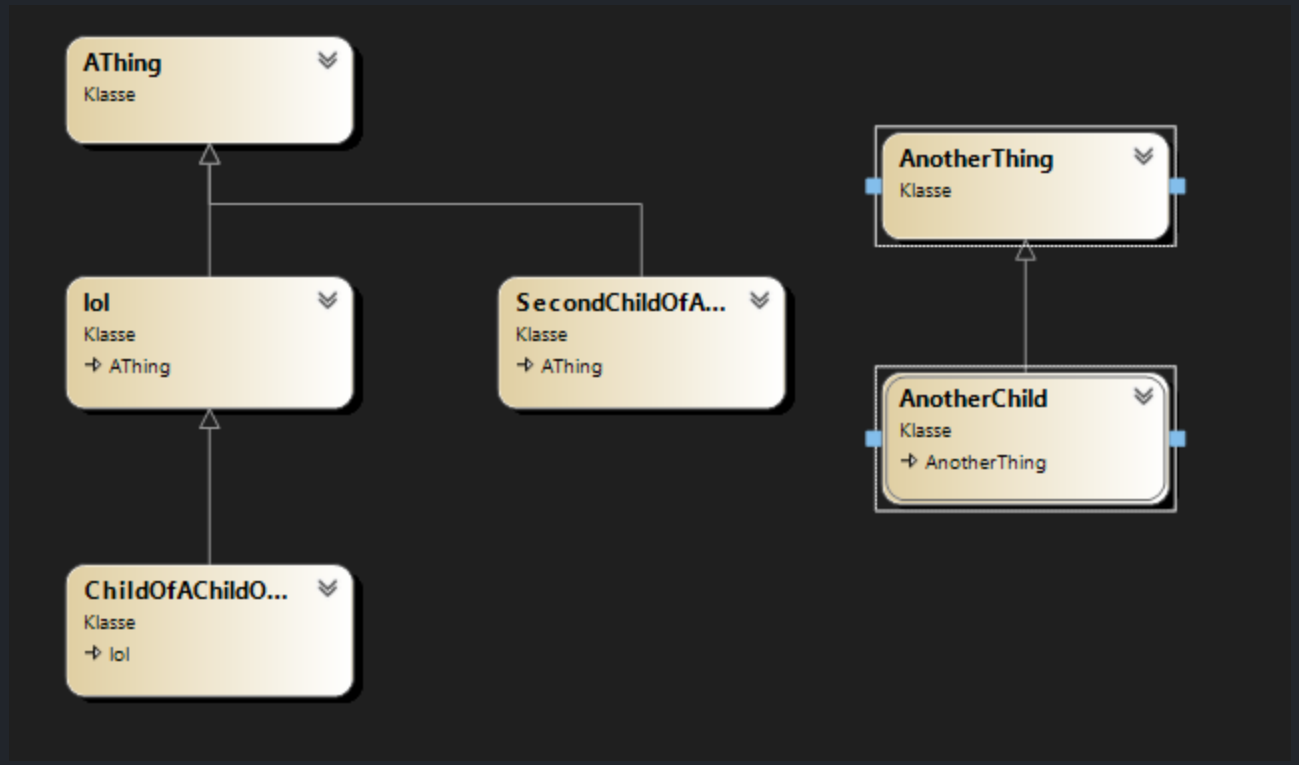
- Class diagramm → many IDEs have tools to generate class diagrams (e. g. Class Designer for Visual Studio)
- Tools that analyze the class hierarchy
- Manually by counting the level of inheritance for each class

# Depth of the inheritance tree (DIT)

*What is good?*

- Low level of inheritance is good
- A high depth of inheritance can lead to a complex and rigid class hierarchy
- Changes to one class can have cascading effects on multiple other classes

# Depth of the inheritance tree (DIT)



# Number of children (NOC)

*What is that?*

- Number of immediate subclasses that inherit from one class
- They measure the width of the inheritance tree
- DIT and NOC are strongly correlated

# Number of children (NOC)

*What is that?*

- Higher value => higher reusability of the class
- But: Risk of improper abstraction and misuse of subclassing

- The importance of testing increases as well

# Number of children (NOC)

*How to calculate them?*

1. Identify the parent class or module for which you want to calculate the NOC.
2. Count the number of immediate sub-classes or sub-modules that inherit from the parent class or module.
3. This count is the NOC for the parent class or module.

=> NOC for a parent class or module

# Number of children (NOC)

*How to calculate them?*

```
2 Verweise
public class ParentClass {
    // Stuff
}

0 Verweise
public class Child : ParentClass {
    // Stuff
}

0 Verweise
public class AnotherChild : ParentClass {
    // Stuff
}
```

**1**

**2**

=> NOC ( ParentClass) = 2

# Number of children (NOC)

*How to calculate them?*

NOC for a whole software:

1. Count the NOC for each parent class/module
2. Aggregate them

# Number of children (NOC)

*Automation with Software possible?*

**Yes.**

For example with:

- SonarQube (Open Source)
- Understand (Commercial)

# Method Inheritance Factor (MIF)

*"Measure the level of inheritance of methods in all classes"*

$$\frac{\text{Number of Inherited Methods}}{\text{Total Number of available Methods}}$$

- Level of Reuse
- Assessment in Testing needed

# Method Inheritance Factor (MIF)

```
1 Verweis
class BaseClass {
    1 Verweis
    public virtual void Foo() { }

    0 Verweise
    public virtual void Bar() { }
}
```

```
1 Verweis
class DerivedClass : BaseClass {
    0 Verweise
    public void Baz() { }

    0 Verweise
    public void FooBar() { }
}
```

**Number of inherited Methods = 2**
**Total number of Methods = 4**

**MIF = 2/4 = 0.5**

# Method Inheritance Factor (MIF)

```
1   using System.Reflect
2
3   float totalMethods =
4   float inheritedMetho
5
6   Type? type = typeof(
7   while (type != null)
8       totalMethods +=
9       inheritedMethods
10          .GetMethods(
11          .Length;
12      type = type.Base
13  }
14
15  float mif = inherite
16  Console.WriteLine($"
17  Console.WriteLine($"
18  Console.WriteLine($"
19
20
```

Microsoft Visual Studio-Debugging-Konsole

```
Inherited Methods: 10
Total Methods: 20
Method Inheritance Factor (MIF) = 0,5

C:\Users\Service\Desktop\Programmieren\c#\TestApp\TestApp\
"0" beendet.
Um die Konsole beim Beenden des Debuggens automatisch zu
"Konsole beim Beenden des Debuggings automatisch schließe
Drücken Sie eine beliebige Taste, um dieses Fenster zu sc
```

```
dingFlags.DeclaredOnly)
```

# Response for a class (RFC)

*The total number of methods that can potentially be executed in response to a message received by an object of a class.*

Given a class, its RFC is the addition of:

- ClassMethod elements
- Method elements
- References to any Method/ClassMethod (including self calls)

On next example, RFC is 7. The elements for the RFC are remarked:

```
ClassMethod CreateProjection(cls As %String, ByRef params) As %Status
{
    set ns=$namespace
    new $namespace
    znspace "%SYS"

    if ('##class(Security.Applications).Exists(..#CSPAPP)) {
        do ##class(Security.System).GetInstallationSecuritySetting(.security)
        set cspProperties("AutheEnabled") = $select((security="None"):64,1:32)
        set cspProperties("NameSpace") = ns
        set cspProperties("Description") = ..#CSPAPPDESCRIPTION
        set cspProperties("DispatchClass") = ..#ROUTER
        write !, "Creating WEB application """_..#CSPAPP_"""..."
         $$$ThrowOnError(##class(Security.Applications).Create(..#CSPAPP, .cspProperties))
        write !, "WEB application """_..#CSPAPP_""" created."

        if ##class(%Studio.General).GetWebServerPort(,,,.url) {
             write !, "You can now open it with a link: "_url_$p(..#CSPAPP,"/",2,*)_"/"
        }
    } else {
        write !, "WEB application """_..#CSPAPP_""" already exists, so it is ready to use."
    }
     Quit $$$OK
}

/// This method is invoked when a class is 'uncompiled'.
ClassMethod RemoveProjection(cls As %String, ByRef params, recompile As %Boolean) As %Status
{
    new $namespace
    znspace "%SYS"

    if (##class(Security.Applications).Exists(..#CSPAPP)) {
        w !, "Deleting WEB application """_..#CSPAPP_"""..."
        do ##class(Security.Applications).Delete(..#CSPAPP)
        w !, "WEB application """_..#CSPAPP_""" was successfully removed."
    }
     QUIT $$$OK
```

# Response for a class (RFC)

*Automatic Measuring*

- In Sonar, from the project dashboard

average RFC for the Apache commons-lang project: