SOLID

Principles for Maintainability of Code

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Quality Factors

ISO/IEC 25010

- Functional Suitability
- Performance efficiency
- Compatibility
- Usability
- Reliability
- Security
- **Maintainability**
- Portability

Quality Factors - Maintainability

- Testability
- Reusability
- Analysability
- Modularity
- Modifiability

S O L I D

- **S** Single Responsibility
- **O** Open / Closed
- **L** Liskov Substitution
- **I** Interface Segregation
- **D** Dependency Injection/Inversion

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The Single Responsibility Principle

- Heard of High Cohesion ?
  one of the GRASP (General Responsibility Assignment Software Patterns) patterns

- Code that changes for the same reasons should be **grouped together**
- Code that changes for different reasons should be **separated**

- Classes should only have **one** main responsibility
  => classes should only have **one** reason to change
- Keep classes small, focused and abstract

The Single Responsibility Principle

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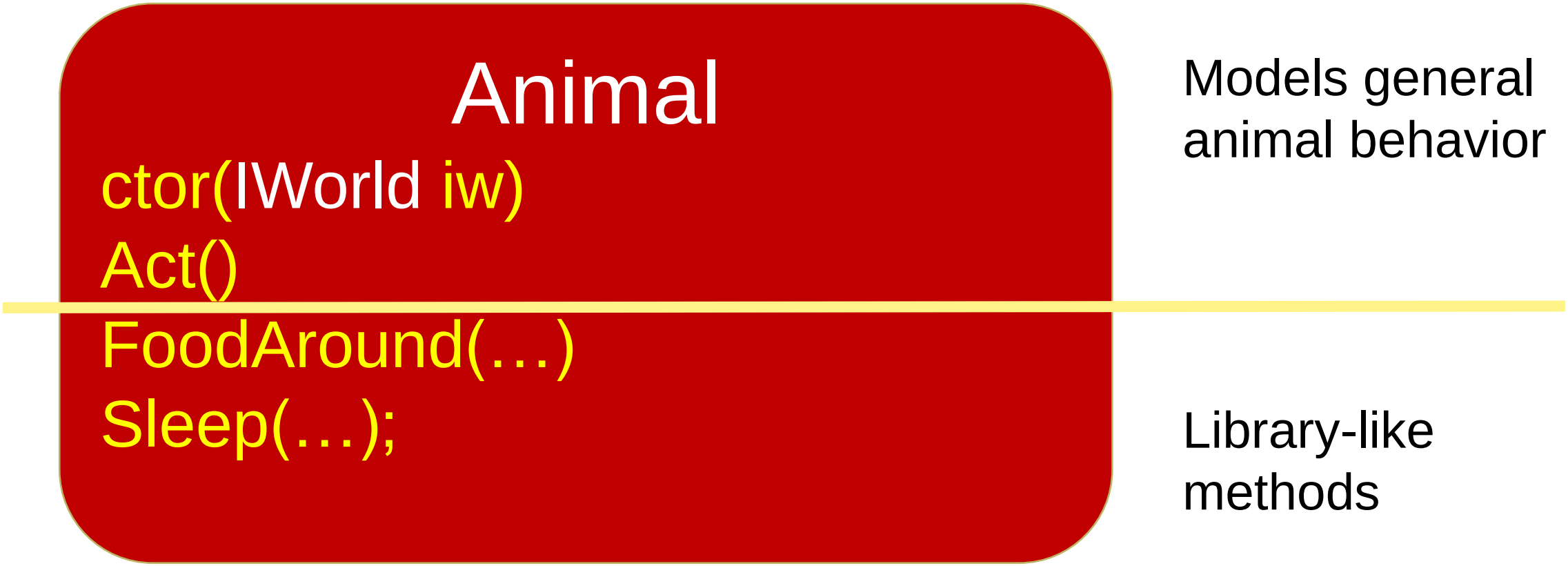
The Single Responsibility Principle



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The Single Responsibility Principle

AnimalBehavior

ctor(IAnimalLibrary ial)

Act()

AnimalLibrary

ctor(IWorld iw)

FoodAround(…)

Sleep(…);

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The Open/Closed Principle

- Software entities should be **open** for extension, but **closed** for modification.

- **Open for extension**: Behaviour can be extended with new behaviours

- **Closed for modification**: Extension does not require change in the source code for the entity

i.e. “closed for modification that requires clients of the code to change”

The Open/Closed Principle

```
public class Client
{
  public CalculatorV10 _calculator;                    // ← quite close for extensions
  public Client()
  {
     _calculator = new CalculatorV10();
  }
  public void ProcessData(Data d)
  {
     int result = _calculator.Calculate(d);
     //...
  }
}
```

The Open/Closed Principle

```
public class Client
{
  public ICalculator _calculator;
  public Client(ICalculator calculator)  // ← Now open for extensions
  {
     _calculator = calculator;
  }
  public void ProcessData(Data d)
  {
      int result = _calculator.Calculate(d);
  }
}
```

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The Interface Segregation principle

- Like Single Responsibility for classes
  - Interfaces must be small and focused

An example for CRUD

```
public interface ICreateReadUpdateDelete<T>
{
        void Create(int key, T obj);
        T Read(int key);
        void Update(int key, T obj);
        void Delete(int key);
}
```

The Interface Segregation principle

- All implementation gets full access to all functionality ! – what if only need get?
- Solution split interface into smaller more focused interfaces e.g.

```
public interface ICreate<T>
{
   void Create(int key, T
obj);
}

public interface IRead<T>
{
   T Read(int key);
}
```

```
public interface IUpdate<in T>
{
    void Update(int key, T
obj);
}

public interface IDelete<T>
{
   void Delete(int key);
}
```

If you need an interface with all CRUD functions

Example:

```
public interface ICreateReadUpdateDelete<T>:ICreate<T>, IRead<T>, IUpdate<T>, IDelete<T>
{
}
```

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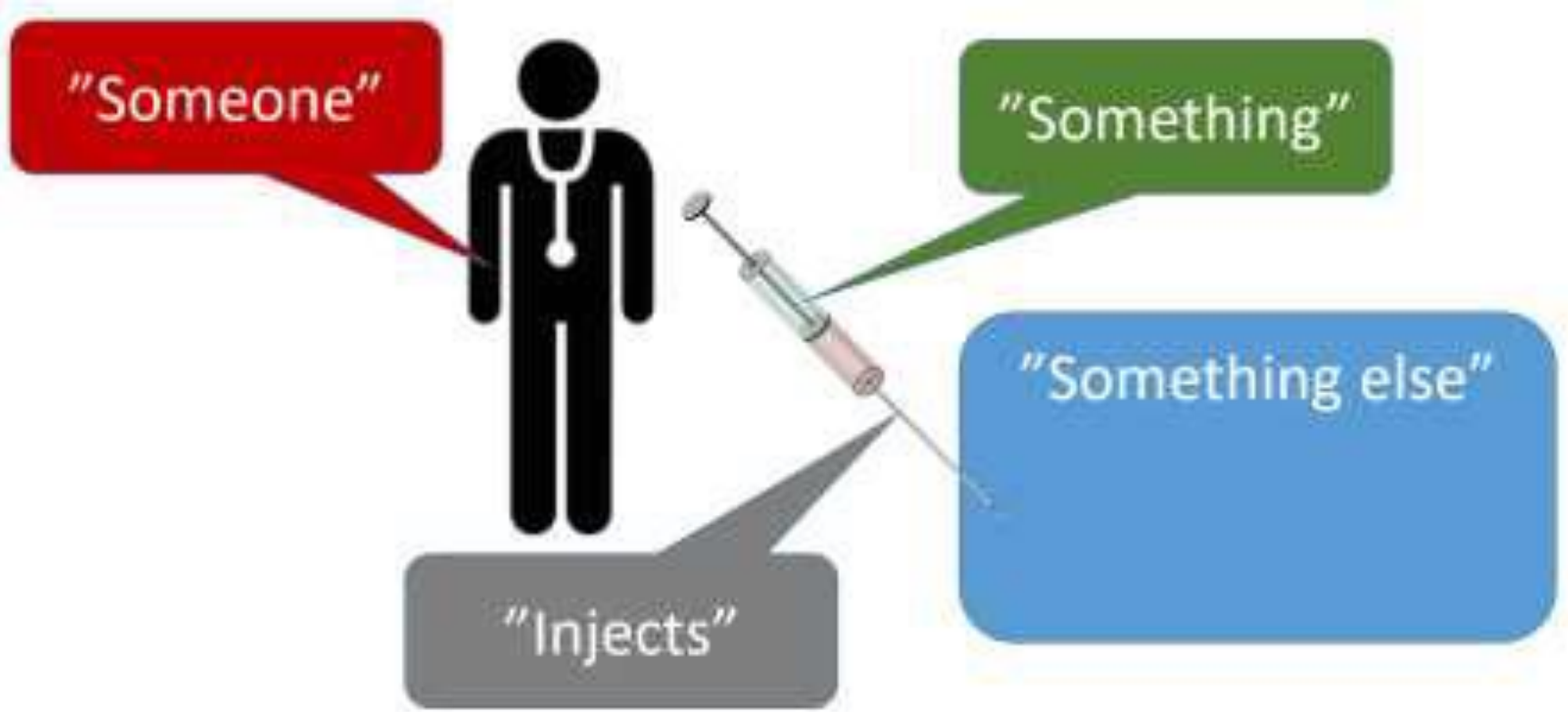
The Dependency Injection/Inversion Principle

- In some SOLID presentations: **Dependency Injection (DI)**
- In other SOLID presentations: **Dependency Inversion**
- **Dependency Inversion**
  aka **Inversion of Control (IoC)**

Tanks to Per Laursen

What is - Inversion of Control (IoC)

- **Parameter Level**
- **Method Level**
- **Object Level**



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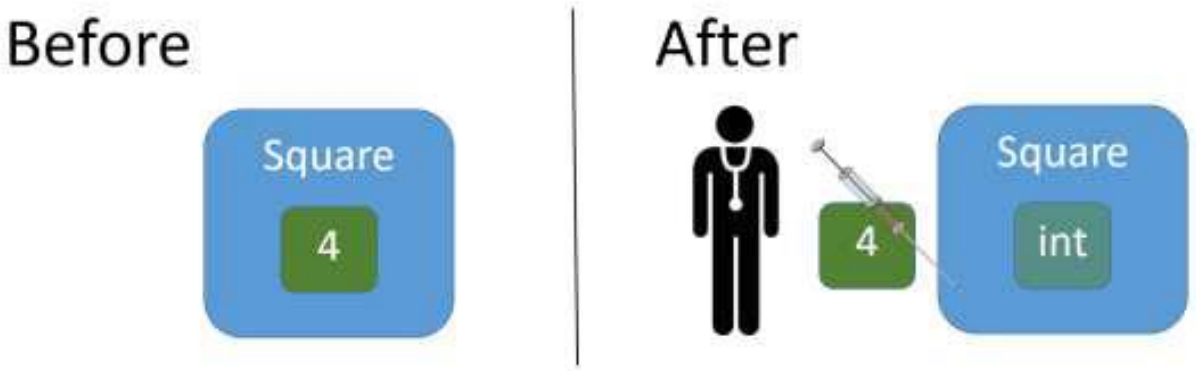
Parameter-level IoC – cont.

- ***Dependency Injection – parameter level***

```
public int SquareOf4()
{
    return 4 * 4;
}

public int SquareOf6()
{
    return 6 * 6;
}
```

```
public int Square(int n)
{
    return n * n;
}
```



Parameter-level IoC – cont.

```
public class Die
{
    private int _faceValue;
    private static Random _random = new Random();
    public Die()
    {
        Roll();
    }
    public int FaceValue
    {
         get { return _faceValue; }
     }
     public void Roll()
    {
        _faceValue = _random.Next(0,6) + 1;
    }
}
```

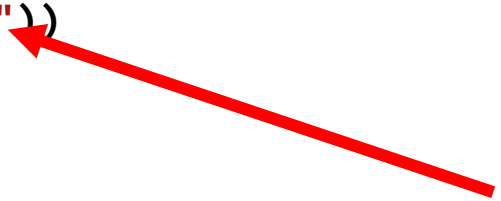


```
public class Die
{
    private int _faceValue;
    private int _noOfSides;
    private static Random _random = new Random();
    public Die(int noOfSides)
    {
        _noOfSides = noOfSides;
        Roll();
     }
     public int FaceValue
     {
         get { return _faceValue; }
      }
     public void Roll()
    {
        _faceValue = _random.Next(0, _noOfSides) + 1;
     }
}
```

Support parameter

Method-level IoC

```
public class Cat : Animal
{
    public override void Act()
    {
        if (FoodAround("Mouse"))
        {
            HuntMice();
        }
       else
     {
         Sleep();
     }
}
private void HuntMice() { }
private void Sleep() { }
}
```



Hard coded

Method-level IoC – cont.

- Template approach

```
public abstract class Animal : IAnimal
{
    public void Act()
    {
        If (FoodAround(PreferredFood()))
        {
            GetFood();
        }
        else
        {
            Idle();
        }
    }
    private bool FoodAround(string food) { return …; }
    protected abstract string PreferredFood();
    protected abstract void GetFood();
    protected abstract void Idle();
}
```

Use of Template method

Template method to be overridden

Method-level IoC – cont.

- ***Dependency Injection – method level***

```
public List<int> FilterValues(List<int> values)
{
   List<int> filteredValues = new List<int>();
   foreach (var value in values)
   {
      if (value > 10)
     {
         filteredValues.Add(value);
      }
   }
   return filteredValues;
}
```



```
public List<int> FilterValues(List<int> values, Func<int,bool>
condition)
{
    List<int> filteredValues = new List<int>();
    foreach (var value in values)
    {
        if (condition(value))
       {
            filteredValues.Add(value);
        }
    }
    return filteredValues;
}
```

Support method

Object-level IoC

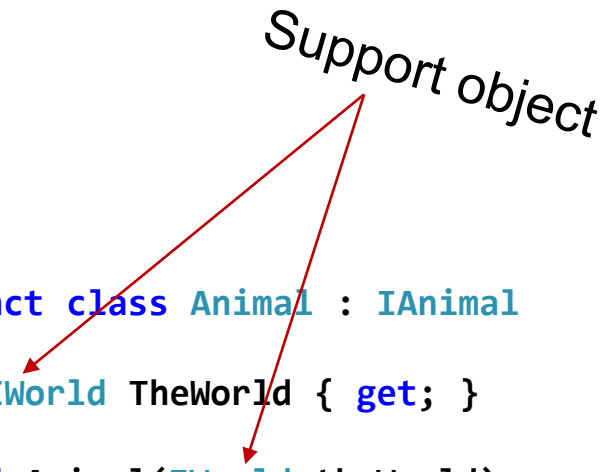
- ***Dependency Injection – object level***

```
public abstract class Animal : IAnimal
{
    private IWorld TheWorld { get; }
    protected Animal(bool manyOrFew)
    {
        if (manyOrFew)
        {
            TheWorld = new WorldManyAnimals();
        }
        else
       {
            TheWorld = new WorldFewAnimals();
       }
    }
}
```



```
public abstract class Animal : IAnimal
{
    private IWorld TheWorld { get; }

    protected Animal(IWorld theWorld)
    {
        TheWorld = theWorld;
     }
}
```



Exercises

- **SOLID 1 + SOLID 2**

og selvfølgelig den obl. opgave