Programmering og Problemløsning
- Object Oriented Programming -

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5-6 sep	Scratch, imperativ programmering, problemløsning
9 sep	LaTeX og næstede strukturer og syntaksfejl, rapportskrivning, problemløsning
12-16 sep	Kom i gang med F#
19-23 sep	Værdier, funktioner, variable og løkker
26 sep -7 oct	Ting på lister og afprøvning af programmer
10oct -4 nov	Sumtyper og Endelige træer , Input/output, internet
21 nov-2 dec	Winforms, Namespaces and Modules
5-9 dec	**Klasser og objekter**
12-16 dec	**Objektorienteret design, UML diagrammer**
19-20 dec	**Nedarvning**
2-10 jan	**Programeksempler**

Today's lecture

- Object-Oriented Programming (OOP) paradigm
- What is an object
- What is a class
- What is an object instance
  - How to create an object instance
  - How to use an object instance
- Implicit and explicit F# syntax

Object-Oriented Programming

Paradigm: model or set of examples for doing something

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1. Functional
2. Imperative
3. Object-Oriented

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Programming paradigm: how you organise your programs

1. Functional: evaluating functions
2. Imperative: executing statements
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Object-Oriented Programming

Paradigm: model or set of examples for doing something

Programming paradigm: how you organise your programs

1. Functional: evaluating functions
2. Imperative: executing statements
3. Object-Oriented: objects

What is an object

“An object is an abstract data type”

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An object is a *thing*

- e.g. person, car, country, notion of gravity, music concert…

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Attributes

Behaviour

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e.g. person, car, country, notion of gravity, music concert…

Attributes: name, legs, mouth, brain…

Behaviour: walks, talks, thinks…

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Programming object

- Attributes: data
- Methods: functions that operate on that data (and possibly other data too)

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Programming object

- Attributes: data [navneord]
- Methods: functions that operate on that data (and possibly other data too) [udsagnsord]

What is an object

Attributes (data)
Methods (functions)

} glued together into one unit, called *object*

What is an object

Encapsulation

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Abstract data types: we invent them

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Encapsulation

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Data Abstraction

Abstract data types: we invent them

(Built-in data types: integer, float, string…)

Program for bank account transactions

Bank account as an object

Program for bank account transactions

Bank account as an object:

Attributes:

- Account number
- Name of account holder
- Amount of money in the account

Methods:

- Take money out
- Put money in

Account object:

number, holder, amount, withdraw, deposit

Account object:

number, holder, amount, withdraw, deposit

All accounts have the above

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All accounts have the above

All accounts can be described by a common template

Account object:

number, holder, amount, withdraw, deposit

All accounts have the above

All accounts can be described by a common template

Class: a template for a collection of objects with the same characteristics in common

Define a class in F# (implicit)

```
type Account(number : int, holder : string) = class
    let mutable amount = 0

    member x.Number = number
    member x.Holder = holder
    member x.Amount = amount

    member x.Deposit(value) = amount <- amount + value
    member x.Withdraw(value) = amount <- amount – value
end
```

Define a class in F# (implicit)

```
type Account(number : int, holder : string) = class
```

- Class declaration

Define a class in F# (implicit)

type Account(number : int, holder : string) = **class**

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- Class constructor (or primary constructor)

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  - These parameters automatically become immutable

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- Class constructor (or primary constructor)
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  - Can be accessed anywhere inside the class
- Class constructor is embedded into class declaration
- Class declaration & class constructor have the same parameters
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int & string not necessary. *Type inference from usage*

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- Use *let-binding* to define *mutable* attribute

Define a class in F# (implicit)

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type Account(number : int, holder : string) = class
    let mutable amount = 0
```

- Use *let-binding* to define *mutable* attribute
- When the class is compiled, amount will be compiled as a class attribute
  - Can be accessed anywhere inside the class

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
    member x.Holder = holder
    member x.Amount = amount
    member x.Deposit(value) = amount <- amount + value
    member x.Withdraw(value) = amount <- amount – value
```

- Class must have *both* attributes & methods as members
- Each member must be defined

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- Class must have *both* attributes & methods as members
- Each member must be defined: self-identifier & .notation

Self-identifiers: x, me, self, this …

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
```

How to read this:

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
```

How to read this:

- We are defining a member of this class

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
```

How to read this:

- We are defining a member of this class
- This member is called Number

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
```

How to read this:

- We are defining a member of this class
- This member is called Number
- Number belongs to the object Account that is currently in scope and we refer to this by x

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
```

How to read this:

- We are defining a member of this class
- This member is called Number
- Number belongs to the object Account that is currently in scope and we refer to this by x
- The value of Number is given by number

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
    member x.Holder = holder
    member x.Amount = amount
    member x.Deposit(value) = amount <- amount + value
    member x.Withdraw(value) = amount <- amount – value
end
```

- Methods take input inside brackets

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
    member x.Holder = holder
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end
```

- Methods take input inside brackets
- Methods use their input to operate on the only mutable attribute in this class, *amount*

OO program

Build the class that describes our objects (what we did now)

OO program

1. Build the class that describes our objects (what we did now)
2. Create instances of our objects by calling the class
3. Use the instances of our objects in the program

Create instance of Account

```
type Account(number : int, holder : string) = class
    let mutable amount = 0
    member x.Number = number
    member x.Holder = holder
    member x.Amount = amount
    member x.Deposit(value) = amount <- amount + value
    member x.Withdraw(value) = amount <- amount – value
end
let max = new Account(123456, “Max Wilson”)
```

- new: creates an instance of class Account
- We pass parameters to the class constructor inside brackets

bankExample.fs

Class inference

```
type Person(name : string) = class
    member x.Name = name
    member x.SayHello() = printfn “Hi, I’m %s” x.Name
end
```

Class inference: omit *class* and *end*

```
type Person(name : string) = class
    member x.Name = name
    member x.SayHello() = printfn "Hi, I'm %s" x.Name
end
```

OR

```
type Person(name : string) =
    member x.Name = name
    member x.SayHello() = printfn "Hi, I'm %s" x.Name
```

Class & type inference: omit *class*, *end*, *string*

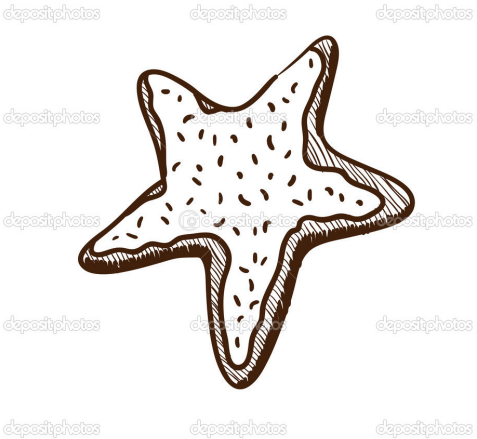
```
type Person(name : string) = class
    member x.Name = name
    member x.SayHello() = printfn “Hi, I’m %s” x.Name
end
```

OR

```
type Person(name) =
    member x.Name = name
    member x.SayHello() = printfn “Hi, I’m %s” x.Name
```

object class instance(s)

object



abstract idea of cookie

class

cookie cutter (template)

instance(s)

the actual cookie(s) we produce using the cutter

Class with primary (implicit) constructor	Class with only explicit constructors

```fsharp
// The class body acts as a constructor
type Car1(make : string, model : string) = class
    // x.Make and x.Model are property getters
    // (explained later in this chapter)
    // Notice how they can access the
    // constructor parameters directly
    member x.Make = make
    member x.Model = model

    // This is an extra constructor.
    // It calls the primary constructor
    new () = Car1("default make", "default model")
end
```

```fsharp
type Car2 = class
    // In this case, we need to declare
    // all fields and their types explicitly
    val private make : string
    val private model : string

    // Notice how field access differs
    // from parameter access
    member x.Make = x.make
    member x.Model = x.model

    // Two constructors
    new (make : string, model : string) = {
        make = make
        model = model
    }
    new () = {
        make = "default make"
        model = "default model"
    }
end
```

Source: https://en.wikibooks.org/wiki/F_Sharp_Programming/Classes#Example

Recap today's lecture

- Object-Oriented Programming paradigm
- Object
- Class
- Object instance
- Build class, Create instance, Use instance
- Implicit and explicit F# syntax

Appendix: bankExample.fs

```
let mutable amount = 0m
```

m is a literal decimal data type (m or M)

- More general than int or float
- 128-bit data type (int & float: 32-bit data types)
- More precision than float
  - Decimal literal: 28-29 significant digits
  - Float: 7 digits
- Appropriate for financial transactions to avoid rounding errors