Introduktion till OO

Andreina Francisco
(based on slides by Tobias Wrigstad)

Föreläsning 15

What is object-oriented software

Objects are like people. They're living, breathing things that have knowledge inside them about how to do things and have memory inside them so they can remember things. And rather than interacting with them at a very low level, you interact with them at a very high level of abstraction [...]

Ole Johan Dahl

Kristen Nygaard

Why Smalltalk?

I made up the term "object-oriented," and I can tell you I did not have C++ in mind.

– Alan Kay

Alan Kay

Trivia: Smalltalk was the second "most loved programming language" in the Stack Overflow Developer Survey in 2017

```
|i|
i := 5.
[i > 0] whileTrue: [
  Transcript show: ((i*2) asString) ; cr.
  i := i - 1.
].
```

```
whileTrue: aBlock
  ^self value
    ifTrue: [
      aBlock value.
      [self value] whileTrue: [aBlock value].
    ].
```

Objekt

- Gäst A, gäst B, gäst C…
- Waiters …
- Kock A, …
- Tallrikar med mat
- Tables…
- Chairs…
- Tablecloths, glasses, silverware …

Objektorienteringens grundkoncept

Active and passive objects (Aktiva och passiva objekt)

Messaging (Meddelandesändning)

Aggregation (Aggregering)

Encapsulation (Inkapsling)

Inheritance (Arv)

Polymorphism (Polymorfism)

Objektorienteringens grundkoncept

Aktiva och passiva objekt

Aktiva: serveringspersonal, gäster, kockar

Passiva: maten, stolarna, borden, etc.

Meddelandesändning

Aggregering

Inkapsling

Arv

Polymorfism

Objektorienteringens grundkoncept

Aktiva och passiva objekt

Meddelandesändning

Mellan aktiva objekt: beställa mat

Aktiva—passiva objekt: dra ut stol, äta, lyfta en gaffel

Aggregering

Inkapsling

Arv

Polymorfism

Objektorienteringens grundkoncept

Aktiva och passiva objekt

Meddelandesändning

Aggregering

Ett bord består av en bordsskiva och fyra ben

Ett middagssällskap består av flera gäster

Inkapsling

Arv

Polymorfism

Objektorienteringens grundkoncept

Aktiva och passiva objekt

Meddelandesändning

Aggregering

Inkapsling

A waiter can serve the customers but can’t set their mood to “happy”

Hur maten lagas (Det är inte uppenbart att det är hästkött i lasagnen, jmf. abstraktion)

Arv

Polymorfism

Objektorienteringens grundkoncept

Aktiva och passiva objekt

Meddelandesändning

Aggregering

Inkapsling

Arv

En Gäst är en Person, en Kypare är en Person, en Kock är en Person

Om $\mathscr{P}(\text{Person}) \Longrightarrow \mathscr{P}(\text{Gäst}) \wedge \mathscr{P}(\text{Kypare}) \wedge \mathscr{P}(\text{Kock})$

Polymorfism

Objektorienteringens grundkoncept

Aktiva och passiva objekt

Meddelandesändning

Aggregering

Inkapsling

Arv

Polymorfism

Different objects can have the same interface

Different dishes taste different, people act different, etc.

The chefs also go to a restaurant as guests, you can drink wine from beer glasses

Playing The Sims

Image taken from http://simcitizens.com

Java Bootstrap

Two labs

Dice

Cash register simulator (note that you get to report goals on this task!)

Deadline for both labs: 25/10

Continue with assignments 3 and 4

Already published

Warning! Assignment 4 has been pushed out quickly! Please, make suggestions for improvements!

Concepts

Object

Class – descriptions of objects

Concept

Object

The world consists of objects (which consist of objects ...) that send **messages** to each other

Objects "of the same kind" are grouped into **classes** that describe how the objects work

Object relationships: **aggregation** (objects have references to other objects)

An object's "building blocks" are not directly accessible (**encapsulation**)

Class - descriptions of objects

Koncept

Object

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Class - descriptions of objects

Describes not only what an object contains (**state**) but also its **behaviour**

Relationships between classes: **inheritance** (A poodle is a dog, which is an animal, which is a…)

A class’ internal structure is not visible from the outside (**encapsulation**)

Procedurell programmering

f(x) — du bestämmer ”nu skall jag göra f på datat x”

Objektorienterad programmering

x.f() — du ber ”snälla objekt x, utför f”

Statisk bindning i C

f(x) — gcc selects f depending on the type of x when compiling

Dynamisk bindning i Java

x.f() — The VM selects f depending on x at runtime!

Introduktion till OOP

med Java

En liten Java-parlör (stämmer för de flesta OOPLs)

Svenska	Engelska
Objekt	Object
Klass	Class
Arv	Inheritance
Instansvariabel / fält	Instance variable / field
Metod	Method
Superklass / basklass	Super class / base class
Subklass / härledd klass	Sub class / derived class
Abstrakt klass	Abstract class
Superanrop	Super call

Svenska	Engelska
Metodspecialisering	Overriding
Överlagring	Overloading
Överskuggning	Shadowing
Klasshierarki	Class hierarchy
Aggregering	Aggregation
Typomvandling	Type cast
Polymorfism	Polymorphism
Barnklass	Child / sub / derived class
Instantieras	Instantiate

Interpreting the Java Compiler Error Messages!

```
<Filnamn.Java>:<Radnummer>: error: <Beskrivning av felet>

        <information om var det uppstår>

   <övrig hjälpinformation om tillämpligt>
```

Template

```
CommonCompilerErrors.java:66: error: cannot find symbol
    LinkedList myList;
    ^
  symbol:   class LinkedList
  location: class ErrorThree
```

Example

Förstå kompilatorns språk

Kompilatorn säger	Betyder i regel
`cannot find symbol`	Felstavat namn, eller namnet är inte synligt ännu, t.ex. inte importerat in, alt finns inte
`method X cannot be applied`	Argumentlistans typer fel (för få argument, fel ordning, fel argument?)
`incompatible types`	Typen på högersidan är inte kompatibel med den till vänster. Är de subtyper?
`X cannot be converted to String`	Glömt att anropa toString()?

Object

- A collection of data and operations that manipulate that data
- You can send messages to an object

  The object selects what to do as a response
- Object-oriented design is data-driven design

  Which actors are there?

  How are they related to **inheritance**, **aggregation**, **usage**, etc. (more later)

Class (finns i nästan alla OO-språk)

- A class is a "model" from which you can build infinitely many objects
- Membership

  Instance variables (also fields)

  Methods
- A class is like a structure + all functions that operate on the structure
- Things we'll talk about later

  Relationships between classes

  Access modifiers

  Inheritance
- **Instanciation**: to create an object from a class

Java

- Developed by Sun (James Gosling) in the early 90's, released in 1995
- Some design principles for Java

  Simple, object oriented and friendly

  Robust and safe

  Architecture independent and portable

  Quick

  Clear

    Class Foo must be in Foo.java

Ett första Java-program

```java
/**
 * @author Tobias Wrigstad (tobias.wrigstad@it.uu.se)
 * @date 2013-10-01
 */
public class Hello {
    String who = null;
    public Hello (String who) {
        this.who = who;
    }
    public void greet() {
        System.out.println("Hello " + who);
    }
    public static void main(String args[]) {
        if (args.length > 0) {
            Hello hello = new Hello(args[0]);
            hello.greet();
        } else {
            System.out.println("Usage: java Hello <who>");
        }
    }
}
```

Koncept

- Klass
- Objekt
- Instansvariabel
- Konstruktor
- Metod
- Main-metod
- Arrays are objects
- Instantiering
- Method call
- Access modifier
- A sensible string type

```
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 * @author Tobias Wrigstad (tobias.wrigstad@it.uu.se)
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public class Hello {
    String who = null;
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        System.out.println("Hello " + who);
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    public static void main(String args[]) {
        if (args.length > 0) {
            Hello hello = new Hello(args[0]);
            hello.greet();
        } else {
            System.out.println("Usage: java Hello <who>");
        }
    }
}
```

Compile and run!

- Compiler “javac”

  Understands dependencies

  Compile to “Java-bytecode”

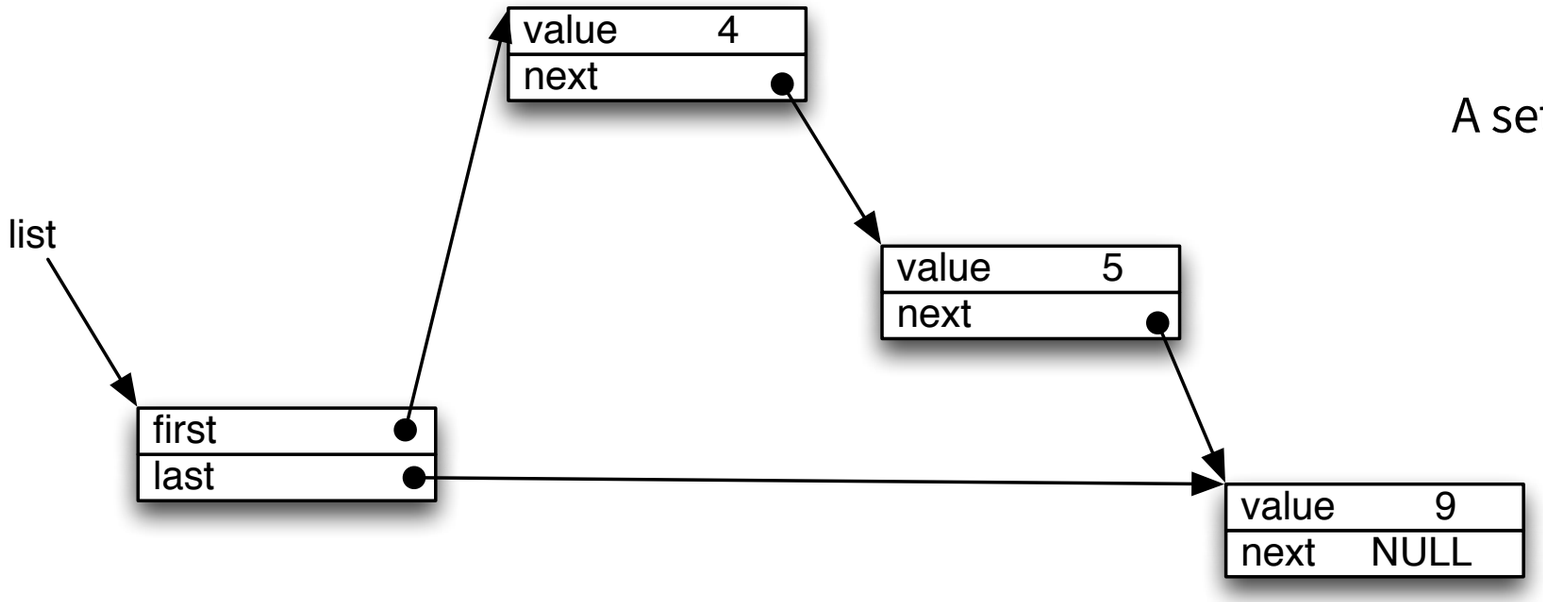
- The program must run in the virtual machine

  The program “java”

  Takes as argument the name of a class with a main method

```
$ javac Hello.java
$ ls
Hello.java
Hello.class
$ java Hello
Usage: java Hello <name>
$ java Hello "Tobias"
Hello Tobias!
$
```

Länkad lista i C

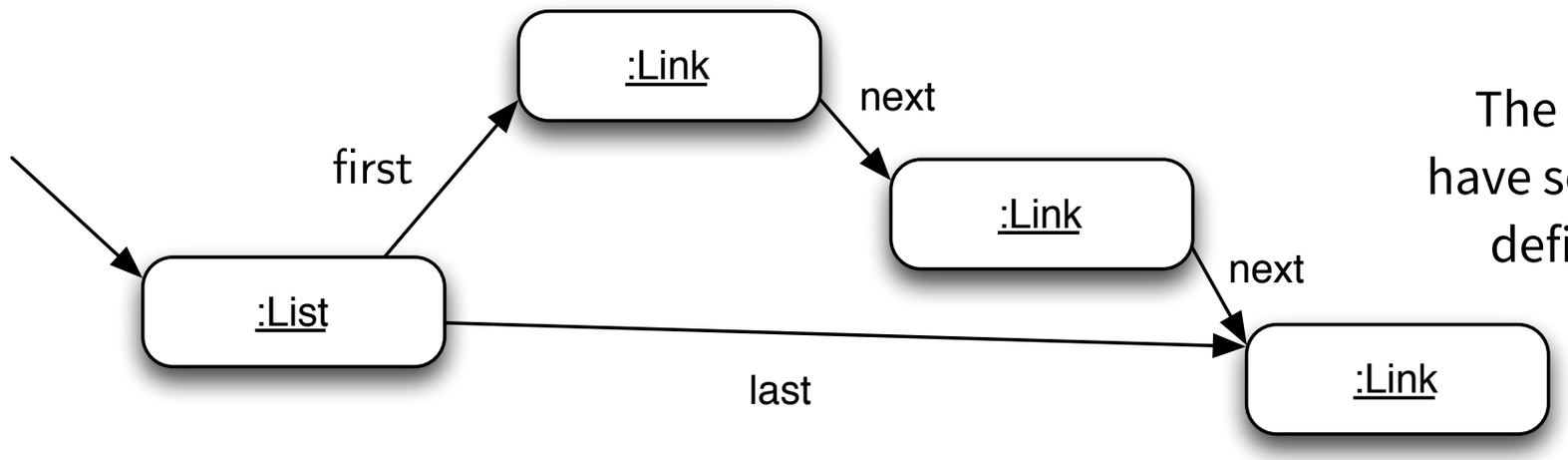


Each link is a “mallocated” structure

A link points to its next link

A set of functions that operate on all parts of the list

Länkad lista i Java



Each link is an Object

Each link **refers** to its next link

The List and the Link Objects have separate permissions and define their own behaviours

Observation!

- Two classes: `List` and `Link`

  `List`-object aggregates `Link`-objects

  Recursion and iteration like in C (Note that the recursive call switching receivers!)

- Private and Public access

  Requires set and get methods in Link for private member variables

References vs Pointers

- A reference is a handle to an object - it is not an address to a place in memory

  All valid pointers in C do not point to what they should (or anything at all)

  All references in Java always point to what they should and to something!

- The reference null is not the address 0

  It is also not a Boolean value!!

- References enable automatic memory management (GC)

Automatic Memory Management

- Java handles memory automatically

  `new ClassName(…)` automatically allocates enough memory to the heap

  When the last reference to an object is removed, the object is junk

  When the memory becomes full, junk is automatically cleared to leave space for new items

- Also:

  No `malloc` (`new` always allocate on the heap, at least what you know!)

  No `free`

Treasonably similar to C!

- The syntax is chosen to make it easy for C and C ++ programmers to program Java
- Many conceptual differences (Java is more like Smalltalk than C ++)

- **BUT:** we **can** take with us a lot from C!

  While, for, if, switch, variable declarations, function syntax, primitive types, etc.…

  By and large, you already know how to program Java, just *not how to program* ***object-oriented*** *in Java!*

- Be careful not to program C in Java!