ETH Zürich
Chair of Software Engineering

Einführung in die Programmierung
Introduction to Programming

Prof. Dr. Bertrand Meyer

Exercise Session 7

News (Reminder)

Mock exam next week! (November 10)

- You have to be present
- Assignment 7 due next Tuesday, as usual
- The week after we will discuss the results

Today

- Abstractions
- Uniform Access Principle
- Naming conventions
- Exporting features

Abstraction

To abstract is to capture the essence behind the details and the specifics.

The client is interested in:

- a set of services that a software module provides, not its internal representation

class

- what a service does, not how it does it

feature

- Object-oriented programming is all about finding right abstractions
- However, the abstractions we choose can sometimes fail, and we need to find new, more suitable ones.

Abstraction

"That is, approximately, the magic of TCP. It is what computer scientists like to call an abstraction: a simplification of something much more complicated that is going on under the covers. As it turns out, a lot of computer programming consists of building abstractions. What is a string library? It's a way to pretend that computers can manipulate strings just as easily as they can manipulate numbers. What is a file system? It's a way to pretend that a hard drive isn't really a bunch of spinning magnetic platters that can store bits at certain locations, but rather a hierarchical system of folders-within-folders containing individual files that in turn consist of one or more strings of bytes."

(from http://www.joelonsoftware.com/articles/LeakyAbstractions.html)

Discussing abstractions

What abstractions were used in the *temperature converter* from assignment 4?

- Why it is better to have a class for *TEMPERATURE* than to store the value in an *INTEGER* variable?
- How was the Celsius value obtained? What about the Kelvin value? Did you see that difference in the class *TEMPERATURE_APPLICATION*?

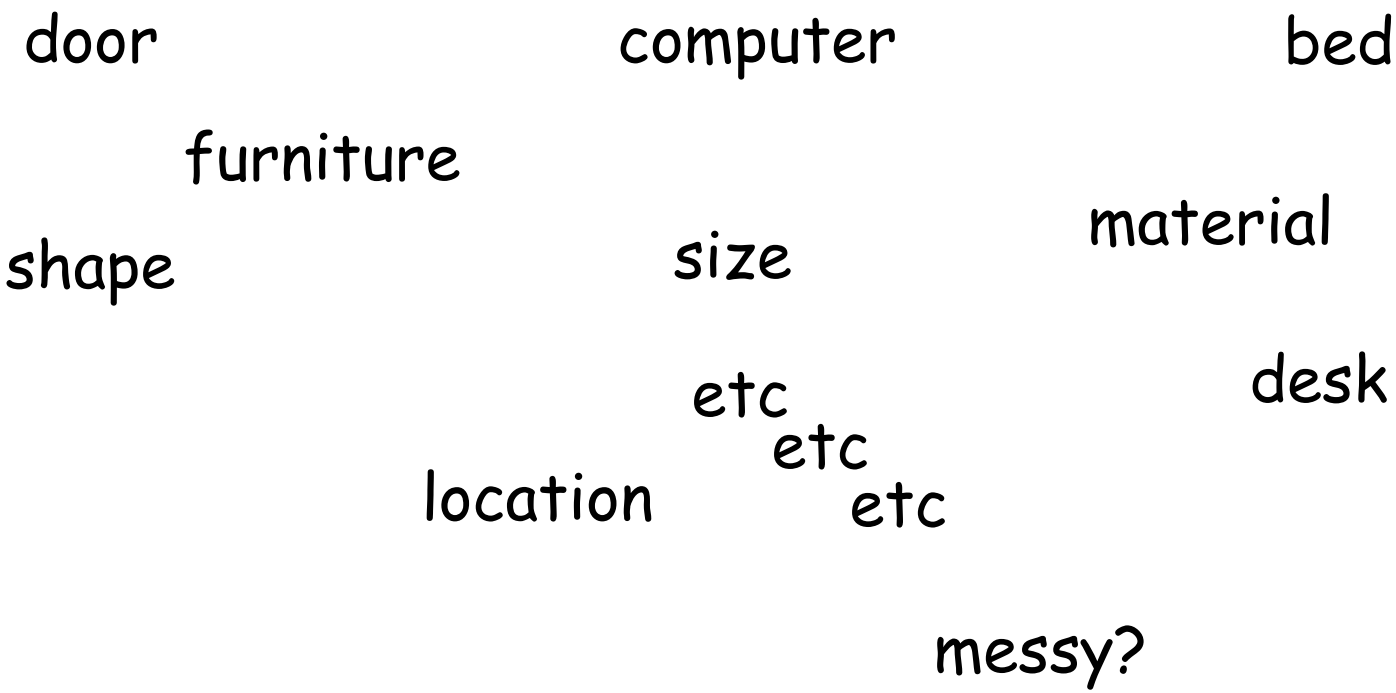
Finding the right abstractions (classes)

Suppose you want to model your room:

```
class ROOM
feature
        -- to be determined
end
```

Your room probably has thousands of properties and hundreds of things in it:

Finding the right abstractions (classes)



Therefore, we need a first abstraction: What do we want to model?

In this case, we focus on the size, the door, the computer and the bed.

Finding the right abstractions (classes)

To model the size, an attribute of type *DOUBLE* is probably enough, since all we are interested in is it's value:

```
class ROOM

feature

        size: DOUBLE

                -- Size of the room.


end
```

Finding the right abstractions (classes)

Now we want to model the door.

If we are only interested in the state of the door, i.e. if it is open or closed, a simple attribute of type *BOOLEAN* will do:

```
class ROOM

feature

        size: DOUBLE

                -- Size of the room.

        is_door_open: BOOLEAN

                -- Is the door open or closed?

        ...

end
```

Finding the right abstractions (classes)

But what if we are also interested in what our door looks like?

- Is there a poster on the door?
- Does it squeak when we close or open it?
- Is it locked?

In this case, it is better to model a door as a separate class!

Finding the right abstractions (classes)

```
class ROOM
feature
        size: DOUBLE
                -- Size of the room in square meters.
        door: DOOR
                -- The room's door.
end
```

Finding the right abstractions (classes)

```
class DOOR
feature
        is_locked: BOOLEAN
                -- Is the door locked?
        is_open: BOOLEAN
                -- Is the door open?
        is_squeaking: BOOLEAN
                -- Is the door squeaking?
        has_playboy_poster: BOOLEAN
                -- Is there a playboy/girl poster on the door?
        open
                -- Opens the door
            do
                        -- Implementation of open
            end

        -- more features…
end
```

Finding the right abstractions (classes)

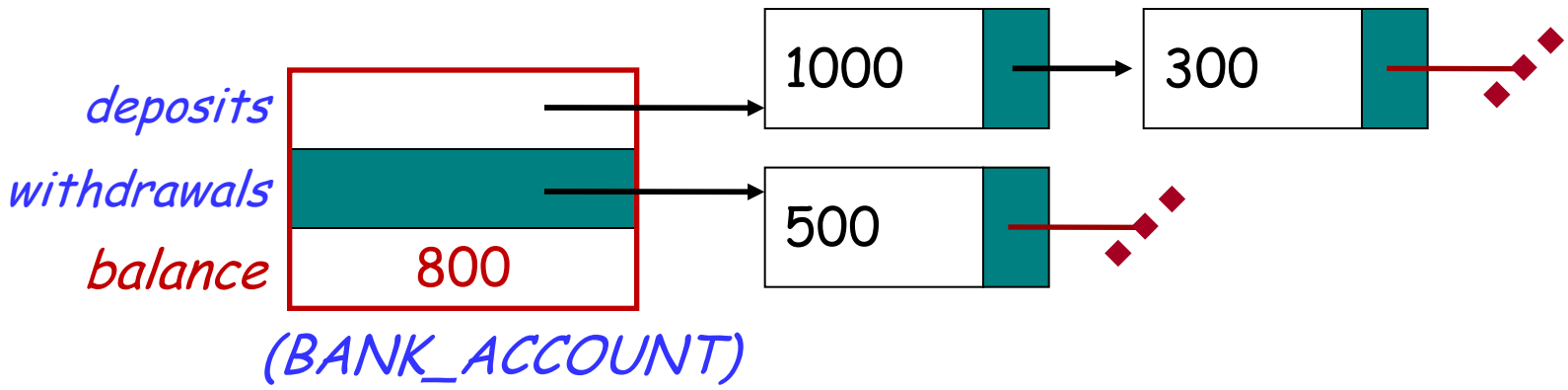
How would you model…

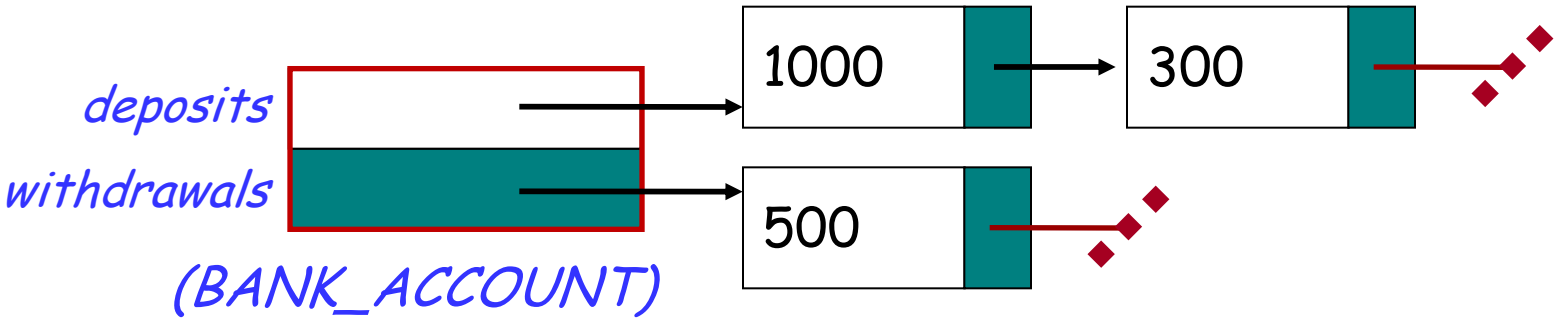
… the computer?

… the bed?

How would you model an elevator in a building?

Finding the right abstractions (features)





invariant: *balance = total (deposits) – total (withdrawals)*

Which one would you choose and why?

Uniform access principle

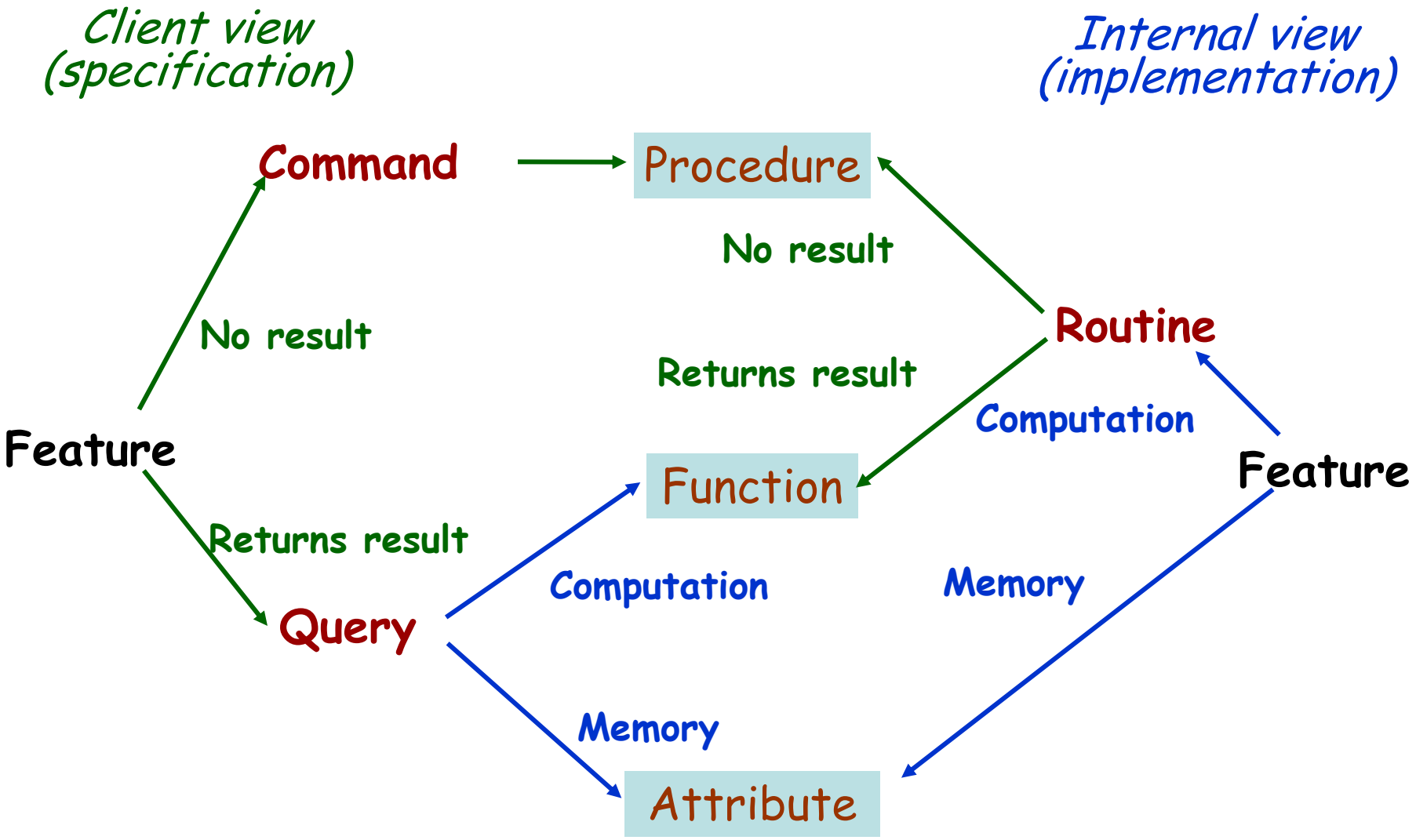
The client is interested in what a service does, not how it does it.

It doesn't matter for the client, whether you store or compute, he just wants to obtain the *balance.*

Features should be accessible to clients the same way, no matter whether they are implemented by storage or computation

my_account.balance

Features: the full story (again…)



Two kinds of routines

Procedure

- from the client's viewpoint it is a command
- call is an instruction

Function

- from the client's viewpoint is a query
- call is an expression

Naming conventions

Names for classes:

PASSENGER, STUDENT, NUMERIC, STORABLE

Names for queries:

balance, name, first_element, list_of_students

- for boolean queries:

full, after, is_empty, is_best_choice

Names for commands:

run, do_nothing, pimp_my_exersice_session

Composed of English words using underscore

Full English words, but short

How do you like these names?


```
class SOLVE_QUADRATIC_EQUATION
feature
        solve (a, b, c: REAL) do ... end

        get_dscrm (a, b, c: REAL): REAL do ... end

        how_many_solutions_there_are: INTEGER

        first_solution, second_solution: REAL
end
```

I like these better!

```
class QUADRATIC_EQUATION_SOLVER
feature
        solve (a, b, c: REAL) do ... end

        discriminant (a, b, c: REAL): REAL do ... end

        solution_count: INTEGER

        first_solution, second_solution: REAL
end
```

Exporting features

```
class
        A

feature
    f ...
    g ...

feature {NONE}

    h, i ...

feature {B, C}

    j, k, l ...

feature {A, B, C}

    m, n...
end
```

Status of calls in a client with *a1: A*:

- *a1.f*, *a1.g*: valid in any client
- *a1.h*: invalid everywhere (including in *A*'s own text!)
- *a1.j*: valid only in *B*, *C* and their descendants (not valid in *A*!)
- *a1.m*: valid in *B*, *C* and their descendants, as well as in *A* and its descendants.

Compilation error?


```
class PERSON
feature
        name: STRING
feature {BANK}
        account: BANK_ACCOUNT
feature {NONE}
        loved_one: PERSON
        think
                do
                        print ("Thinking of" + loved_one.name)
                end
        lend_100_franks
                do
                        loved_one.account.transfer (account, 100)
                end
end
```

OK: unqualified call

OK: exported to all

Error: not exported to PERSON

OK: unqualified call

The export status does matter!

```
class PROFESSOR

create
        make
feature
        make (a_exam_draft: STRING)
                do
                        exam_draft := a_exam_draft
                end
feature
        exam_draft: STRING
end
```

The export status does matter!

```
class ASSISTANT

create
        make
feature
        make (a_prof: PROFESSOR)
                do
                        prof := a_prof
                end
feature
         prof: PROFESSOR
feature
        review_draft
                do
                        -- review  prof.exam_draft
                end
end
```

The export status does matter!

```
class STUDENT

create
        make
feature
        make (a_prof: PROFESSOR; a_assi: ASSISTANT)
                do
                        prof := a_prof
                        assi := a_assi
                end
feature
        prof: PROFESSOR
        assi: ASSISTANT
feature
        stolen_exam: STRING
                do
                        Result := prof.exam_draft
                end
end
```

The export status does matter!

you: STUDENT
your_prof: PROFESSOR
your_assi: ASSISTANT
stolen_exam: STRING

create *your_prof.make (*"top secret exam!"*)*
create *your_assi.make (your_prof)*
create *you.make (your_prof, your_assistant)*

stolen_exam := you.stolen_exam

The export status does matter!


```
class PROFESSOR
create
        make
feature
        make (a_exam_draft: STRING)
                do
                        exam_draft := a_exam_draft
                end
feature {PROFESSOR, ASSISTANT}
        exam_draft: STRING
end
```

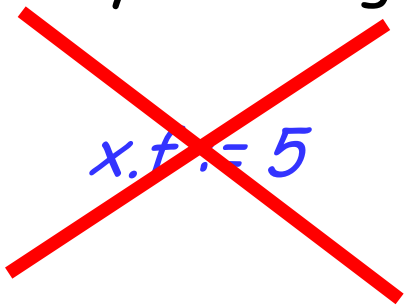
The export status does matter!

```
class STUDENT
create
        make
feature
        make (a_prof: PROFESSOR; a_assi: ASSISTANT)
                do
                        prof := a_prof
                        assi := a_assi
                end
feature
        prof: PROFESSOR
        assi: ASSISTANT
feature
        stolen_exam: STRING
                do
                        Result := assi.prof.exam_draft
                end
end
```

Invalid call!

Exporting attributes

Exporting an attribute only means giving read access



Attributes of other objects can be changed only through commands

- protecting the invariant
- no need for getter functions!

Exporting attributes

```
class  TEMPERATURE
feature
        celsius_value, kelvin_value: INTEGER

        set_celsius (a_value: INTEGER)
            require
              above_absolute_zero: a_value >= -273
            do
               celsius_value := a_value
               kelvin_value := celsius_value + 273
            end
invariant
        above_absolute_zero: celsius_value >= -273
        correspond: kelvin_value = celsius_value  + 273
end
```

Assigners

If you like the syntax

x.f := 5

you can declare an assigner for *f*

- In class *TEMPERATURE*
  celsius_value: INTEGER **assign** *set_celsius*
- In this case

  t.celsius_value := 36

  is a shortcut for

  t.set_celsius (36)
- ... and it won't break the invariant!