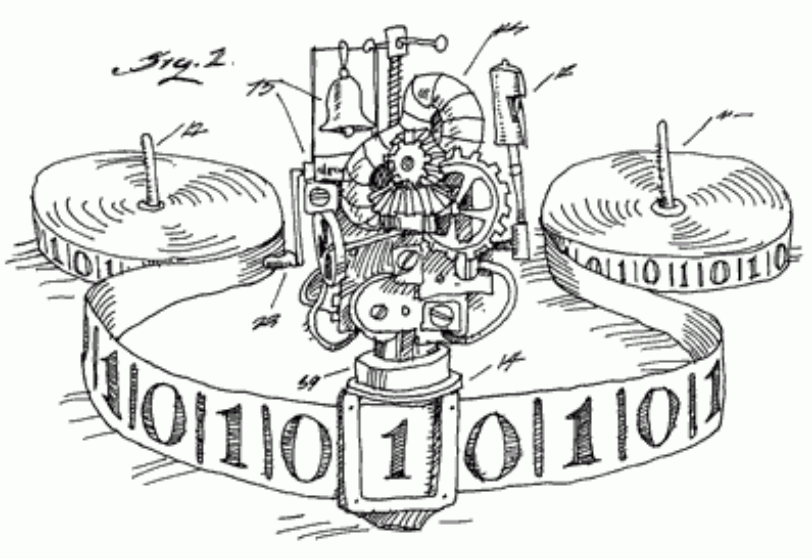
INFO 101 – Introduction to Computing and Security

[2019 - Week 3 / 2]



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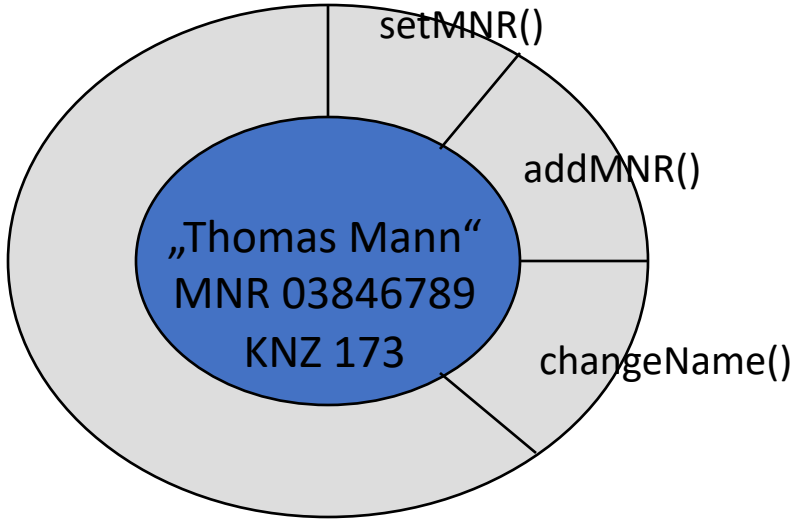
Class Diagrams

Foundations

- **Object**
  „*A discrete entity with a well-defined boundary that encapsulates state and behavior; an instance of a class*“
  [UML Reference Manual (Rumbaugh)]
- Properties
  - Objects are unique
  - Combination of data and functionality for analysis and design
  - Data hiding
    - Data is stored in attributes
    - Change of data via methods

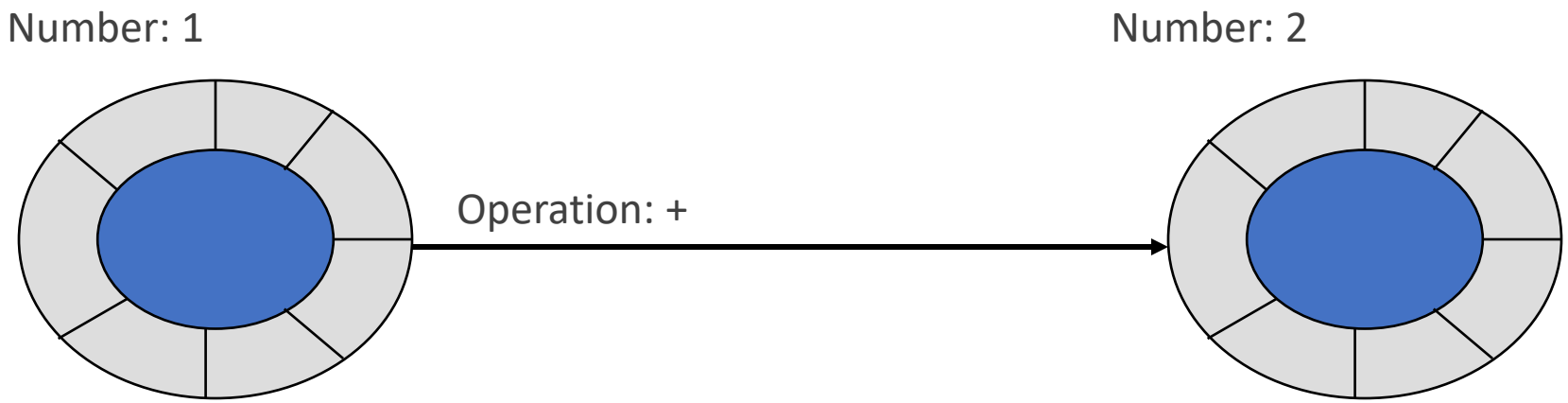
Encapsulation

- The state of the object is defined via its attributes and can only be changed via its functions.
- The functions (methods) define the behavior of an object

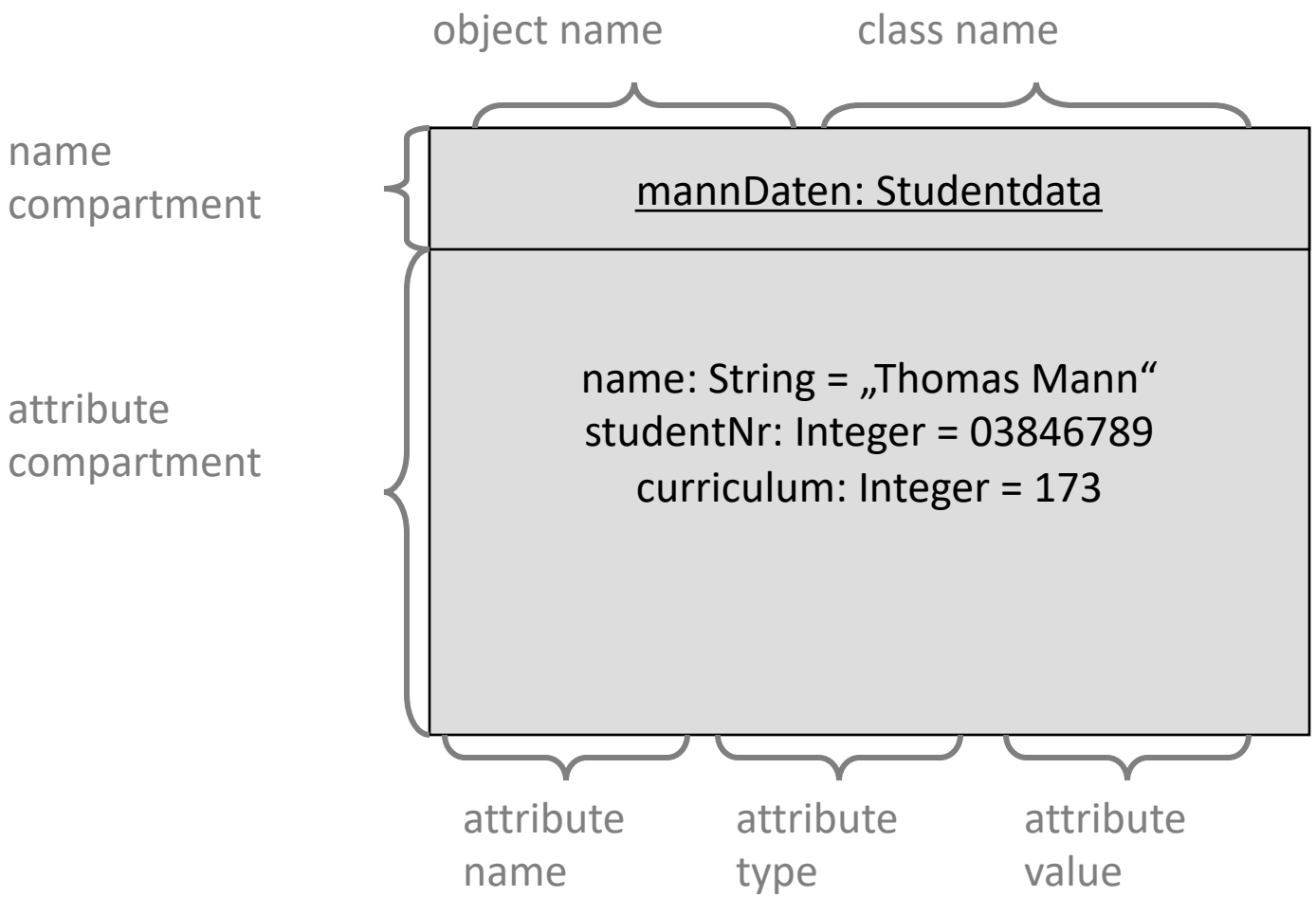


System‘s behavior

- The system‘s behavior is given via sending messages from one object to another using links between objects.



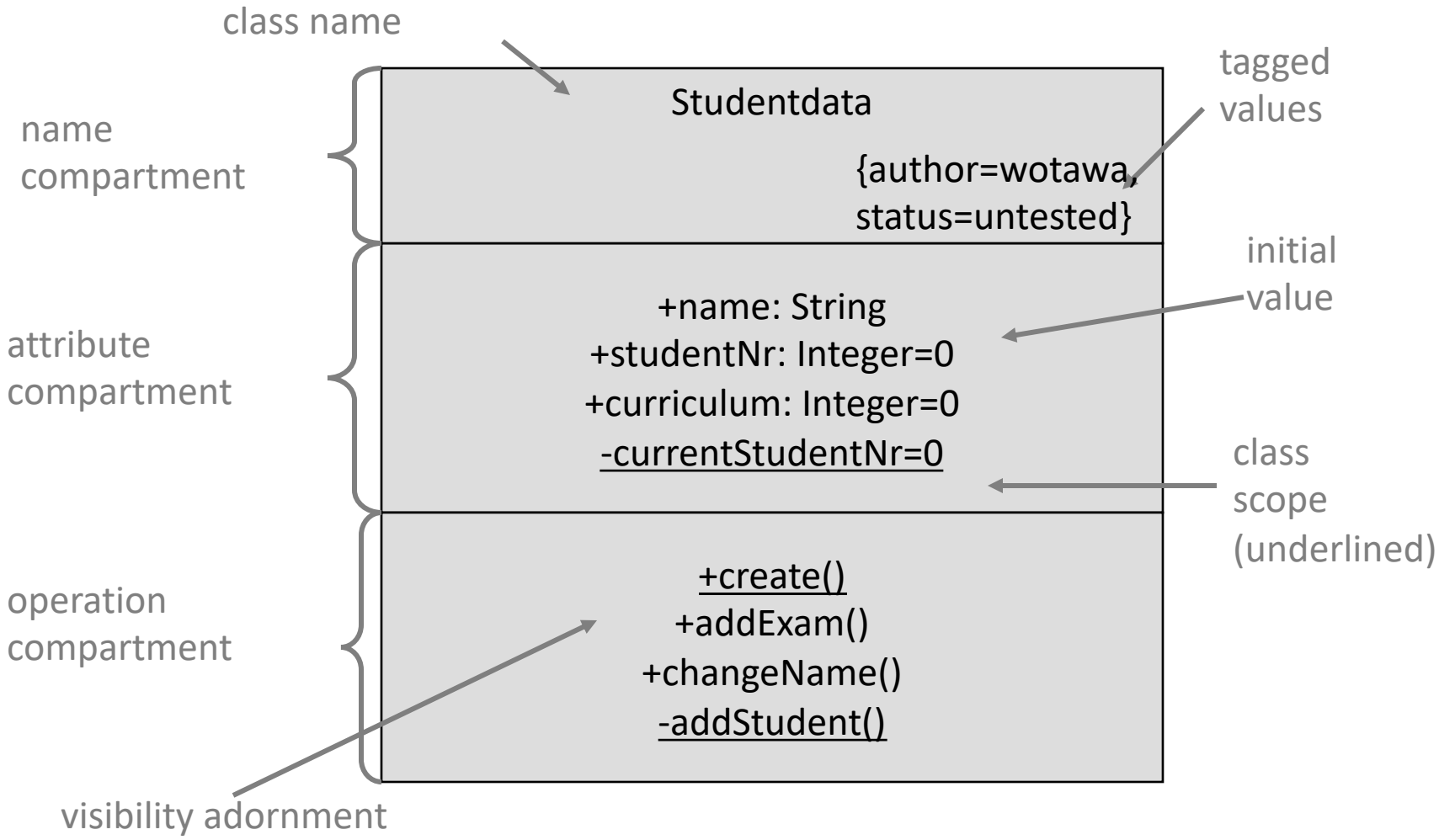
UML Object representation



Class

- A class summarizes the behavior of a set of objects:
- *„The descriptor for a set of objects that share the same attributes, operations, methods, relationships, and behavior“*
- An object is an **instance** of a class
- Identifying the right classes is the key to a successful object-oriented analysis of a software or system!

Classes in UML



Name Compartment

- There is no naming convention in UML!
- However, good names follow the 2 principles:
  - Classes always start with a captialized letter followed by letters.
  - Do not use abbreviations!

- **Examples**: StudentRecord, Account,.. but **NOT** StdRec or Acnt!

- UML diagrams should be readable even by non-experts!

Scope

- We distinguish two types:
  - Instance Scope
    Attributes and operations that are only for specific objects
  - Class Scope
    Attributes and operations that are only accessible for the class

- **Examples**: `add` is defined for every Integer object. A method that instantiates a new object (`create()`), is defined only for a class

Object Construction and Destruction

- Constructors are special methods defined for classes that return a new instance (object) of this class.

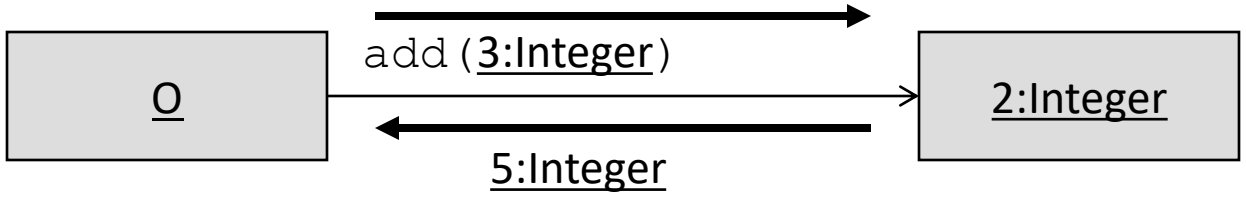
```
BankAccount()
create()
```

- Destructurs are special methods that are called, in cases an object has to be destroyed.

```
~BankAccount()
finalize()
```

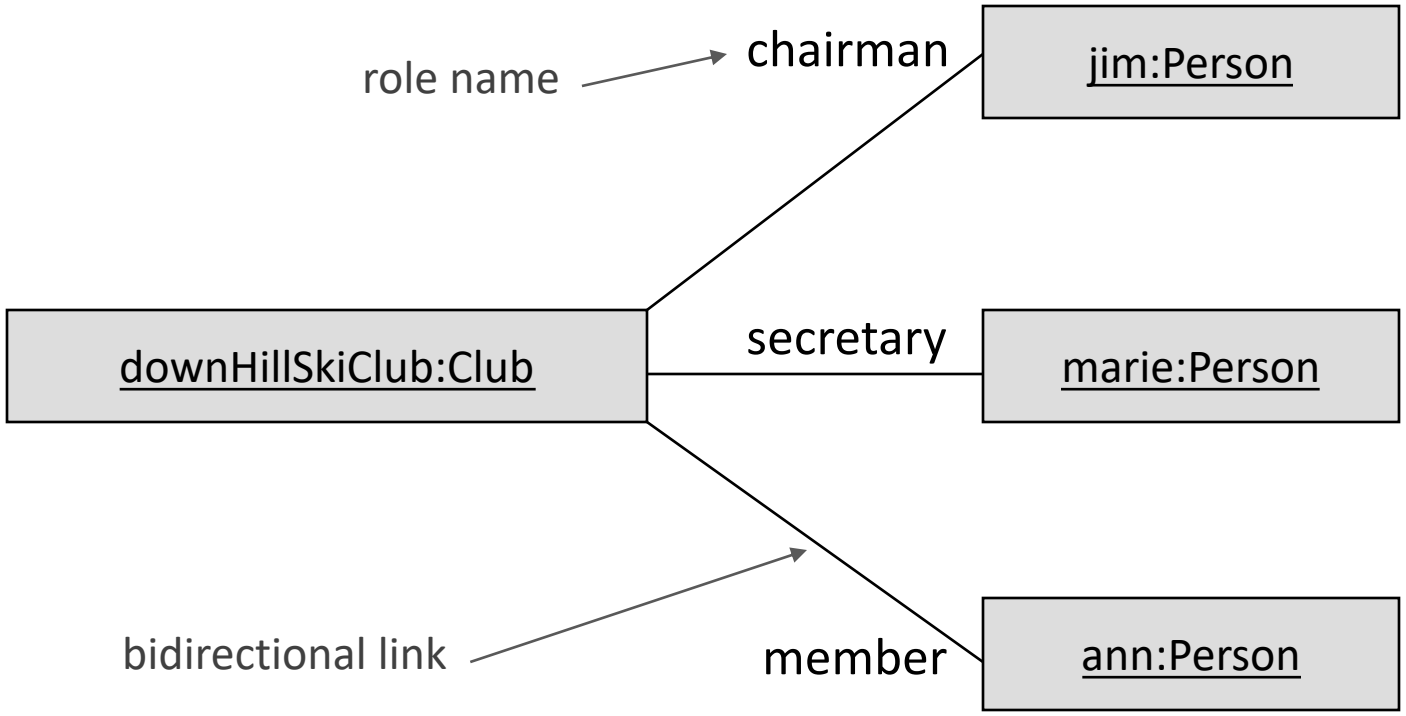
Relationships – Links

In a method m of object O there is the statement 2 + 3



1. Method `add` with parameter 3:Integer is sent to the object 2:Integer
2. The return value goes back to object O.

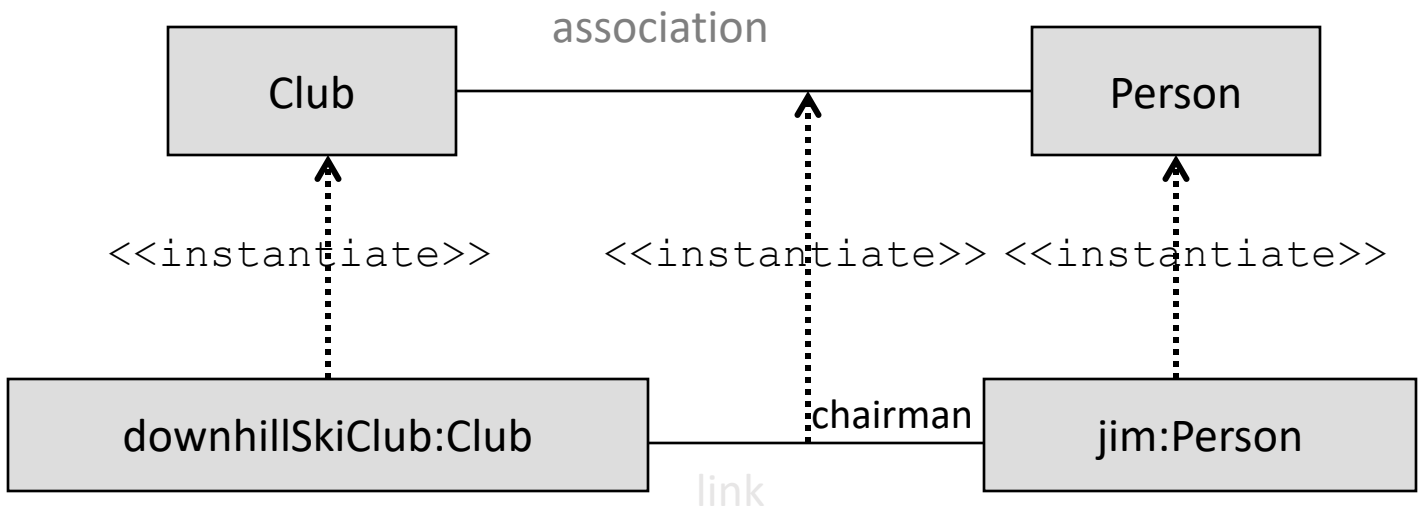
Example - Object Diagram



Snapshot of an executing OO system

Associations

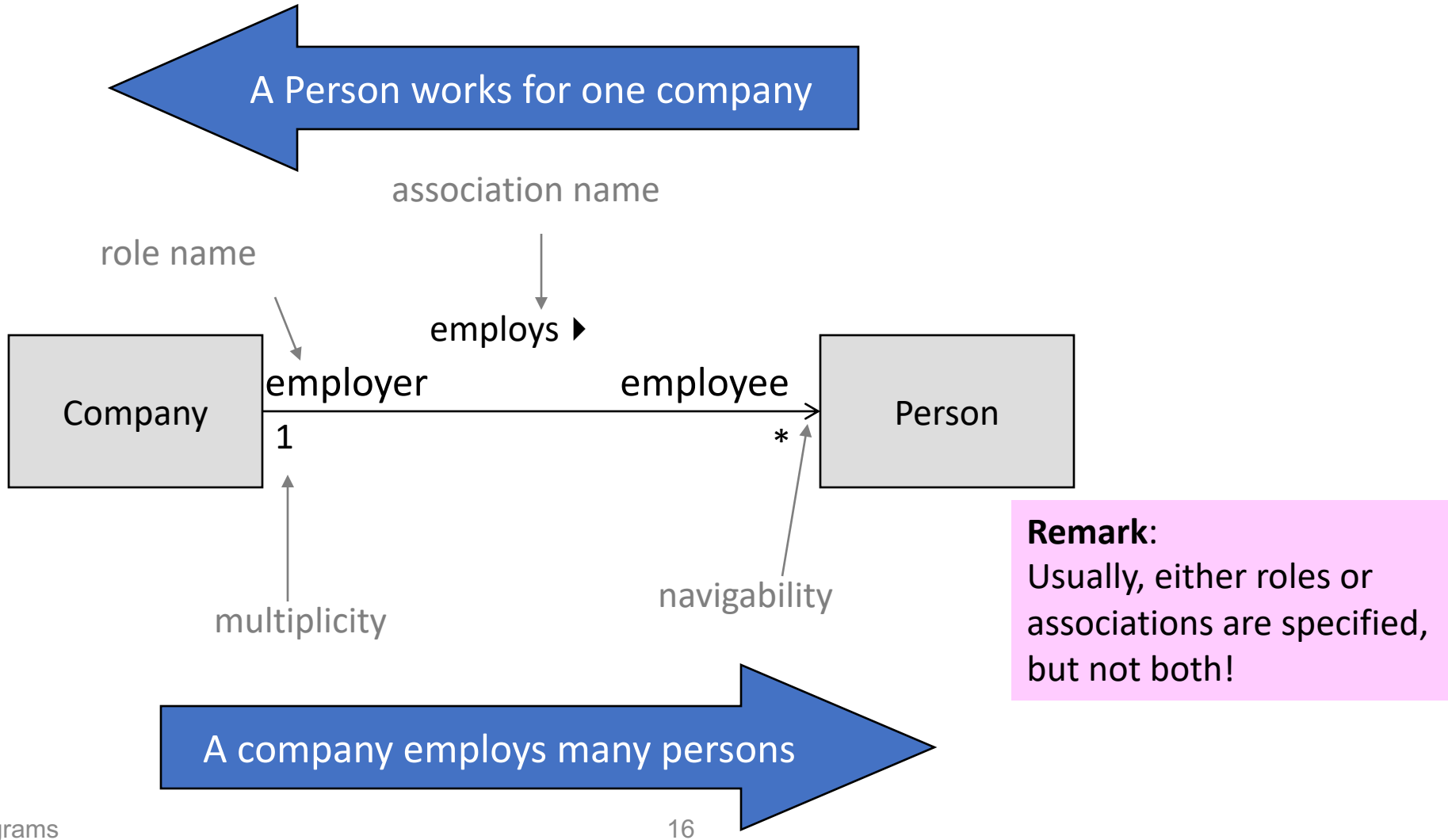
- Associations are connections between classes
- Links depend on associations



UML Syntax of associations

- An association is a line between classes and might include the following additional information:
  - Name
  - Role name
  - Multiplicity
  - Navigability

Example



Remark:
Usually, either roles or associations are specified, but not both!

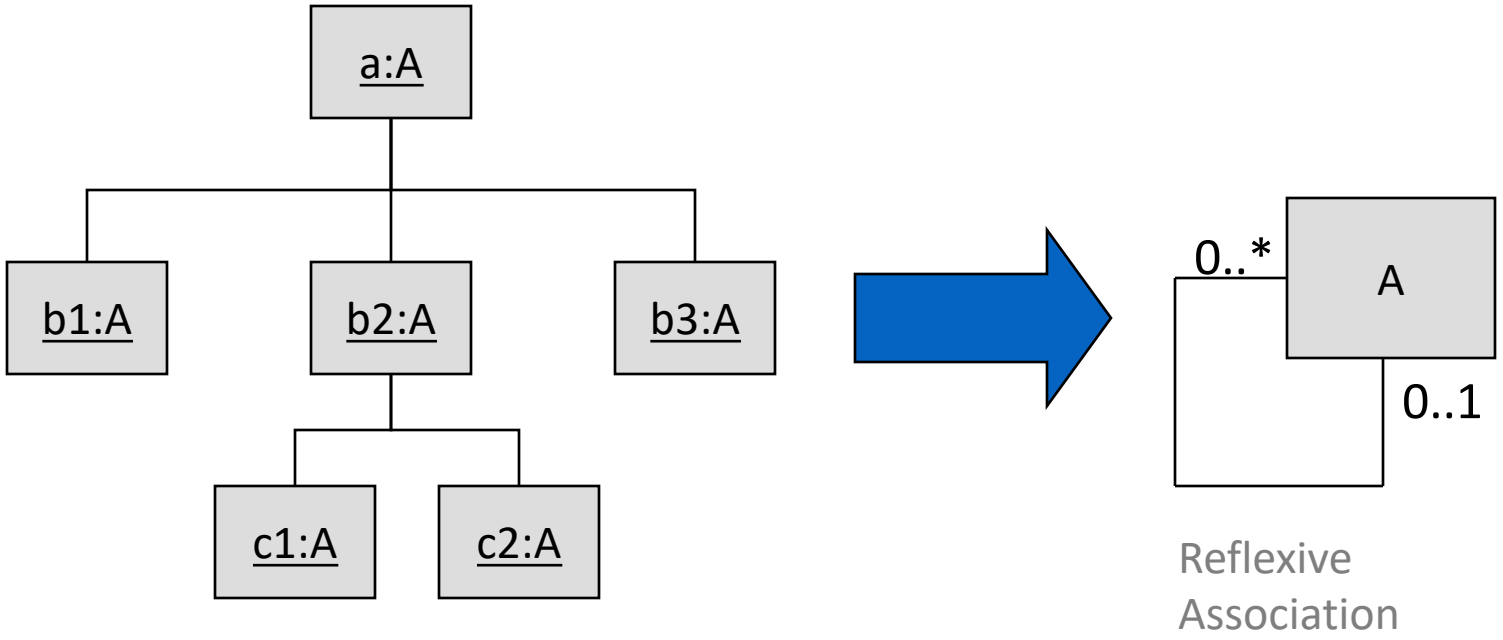
Multiplicity

- If not set, then the decision has not been taken

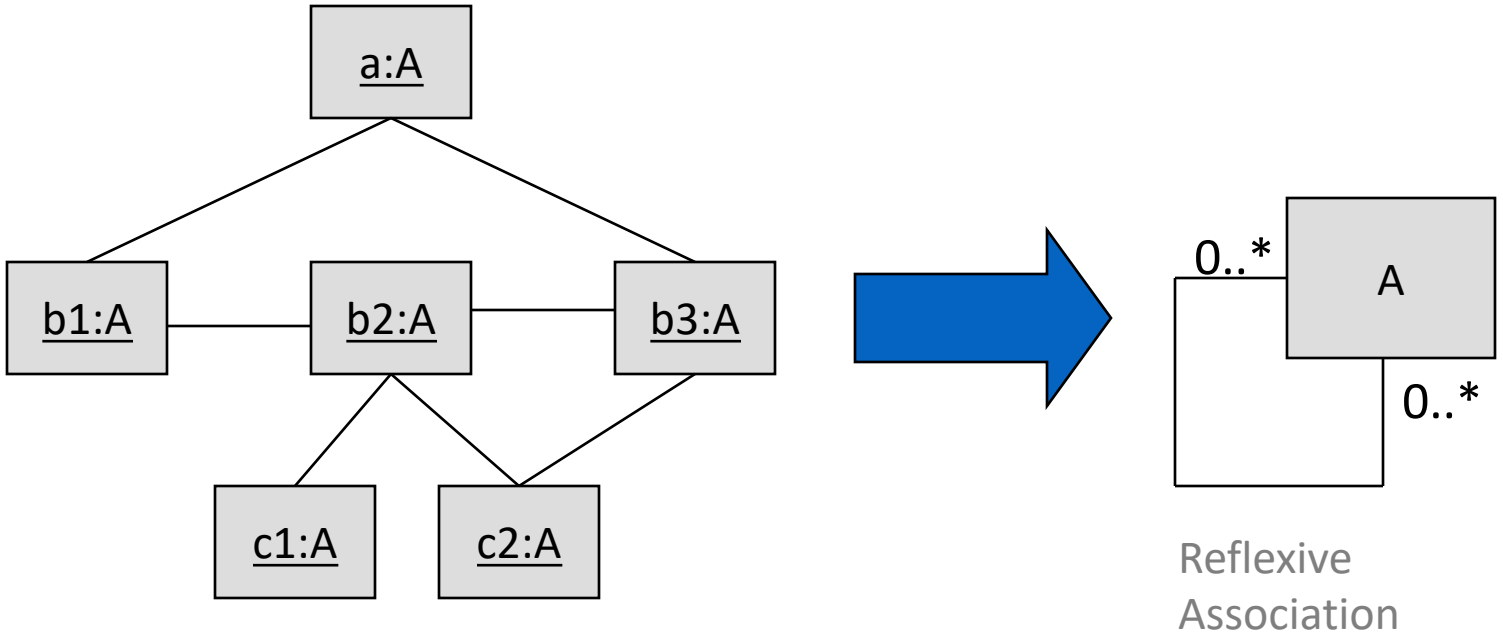
0..1	0 or 1	1..*	1 or more
1	Exactly 1	1..6	1 to 6
0..*	0 or more	1..3,7..10,15, 17,*	1-3,7-10, 15,17 or more
*	0 or more		

- UML diagrams should be read exactly as given!

Representation of hierarchies



Representation of networks

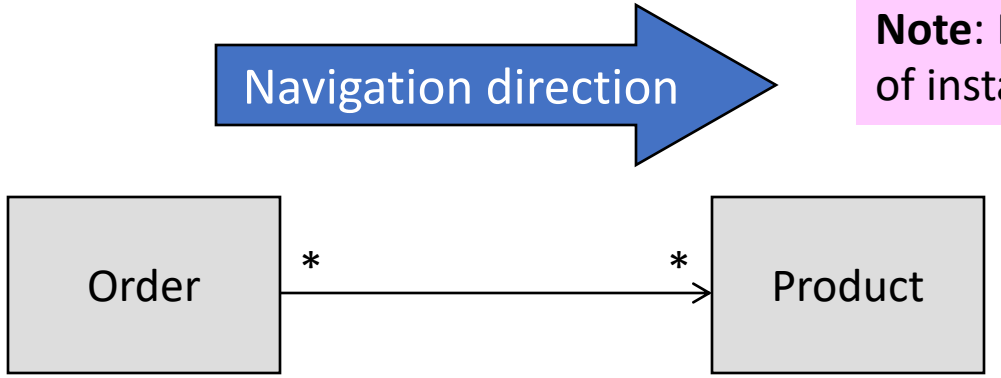


Notes to navigability

- Navigability defines how to come from one class to another.
- *„Messages can only be sent in the direction of the arrow“ (Source -> Target)*
- **Example**: `Order` objects are able to send data to `Product` objects but not vice versa!

Why Navigability?

- Minimizing coupling of classes

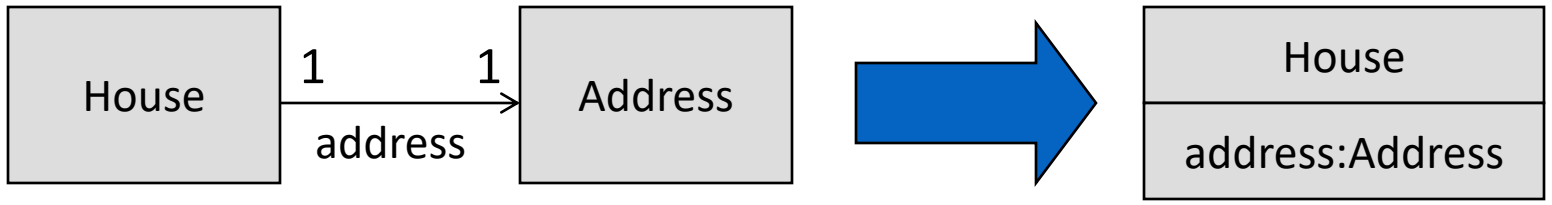


Note: Products do not store lists of instances of class Order.

In good OO designs the number of class couplings should be minimized.

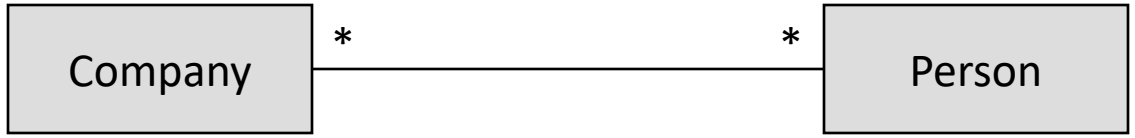
Associations and attributes

- If there is an association betwen a source and a target class, then this means that the source class can store an instance of the target class.
- Code generation does take care of this automatically!



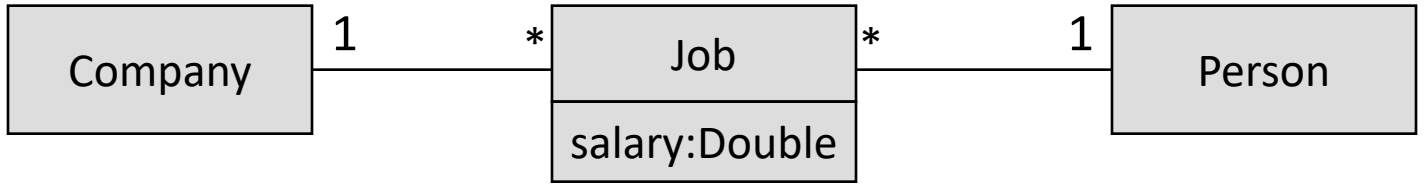
Association classes

- In case of Many-to-Many relationships there are problems that can only be solved via introducing a separate class.



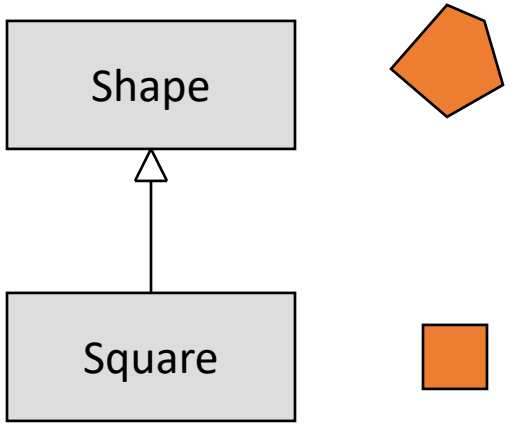
Problem: Where to store the income?

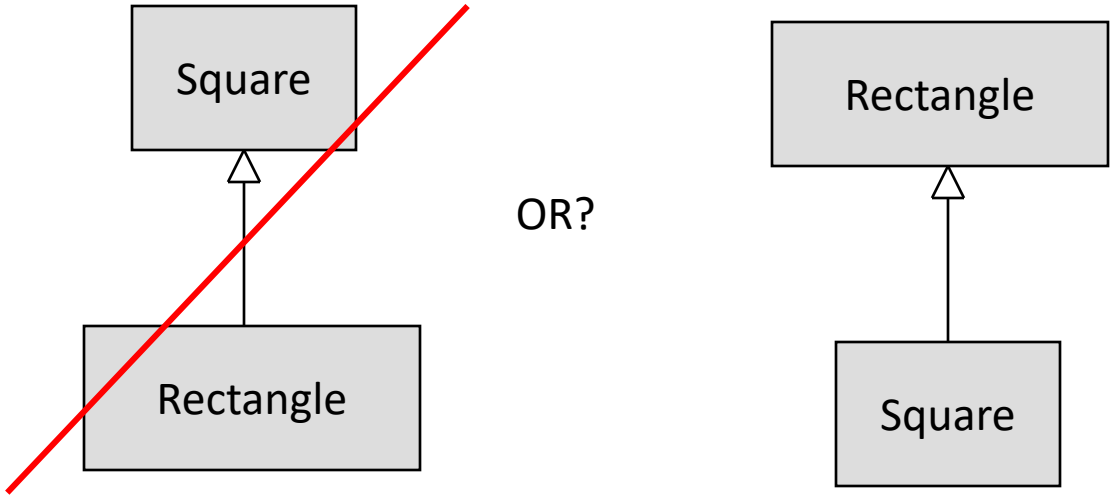
The income is a property of the association!



Inheritance

- Class hierarchies based on the concept of **generalization**!
- Generalization is a relationship between a more specific and a more general thing.





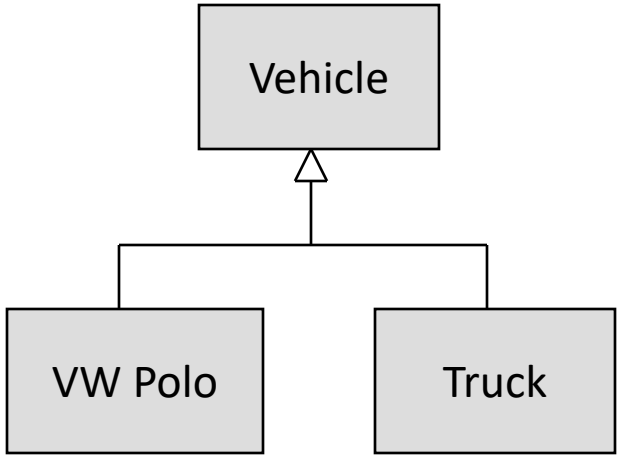
Inheritance

- Sub-classes inherite all features (attributes, methods) from its super-class

- All features can be overwritten by the sub-class

Notes

- Things at the same (graphical) abstraction level should represent the same kind of abstraction!
- **Example**: (bad to not use)



Finding classes

- Analysis Goal: To find an appropriate description of problem domain
  - The classes
  - Their relationships
  - Thinking about implementation not allowed!
- Think about the user, about the interfaces to external world. Everything else is implementation.
- Close connection to use cases

Finding Classes

1. Brainstorming
2. Noun method

- A creative process…

Classes

- Common types of classes:
  - Physical Objects (Calendar, Display, Page)
  - Conceptual Entities (Appointment, Reminder)

Finding classes: Brainstorming

- Think of terms relevant to problem
  - e.g., Terms often used by experts
- Good classes
  - Encapsulate data
  - *Are* something, not just *do* something
  - Different in behavior from other classes
- Bad classes
  - Outside the system boundary
  - “Manager” classes

Finding Classes: Noun Method

- Underline all nouns in requirement document
- Finds important terms
- Criticism: grammar decides your design!
  - *For every entry of an appointment, a database record is made*
  - *For every appointment that is entered, a database entry is made.*
- The noun method is good, but be critical!

Refining Classes

- After classes have been found, refine by
  - Constructing class diagrams
  - Discussion of use cases
    - *Can use cases be explained using the class diagram?*

Class Diagrams

- A useful tool for visualizing an analysis or design.
- Goal: capture important objects and their relations
- Don’t be too formal about UML in early stages! Make notes, shift things around, create different possibilities, different views.
- For initial deliberations, a black board is much easier than Rose
  - For later refinement and for presentation, tools are helpful

Example

UseCase: Insert Appointment

ID: UC1.1

Actors: owner

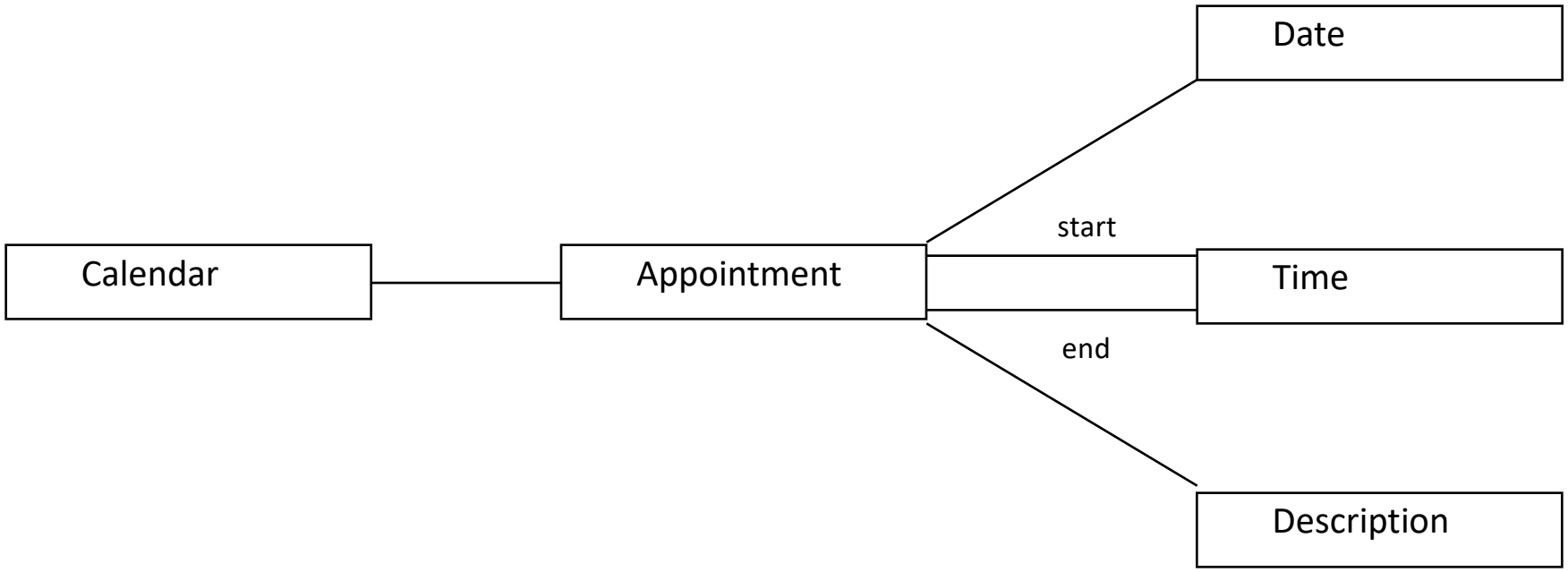
Preconditions:

Flow of events:

1. The user specifies date, beginning time, end time, and description of appointment
2. The calendar warns about conflicting appointments
3. The appointment is entered in the calendar

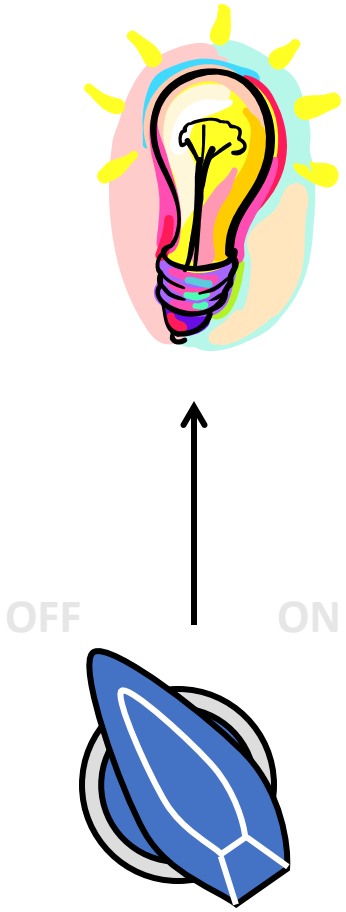
Postconditions: The appointment is in the calendar

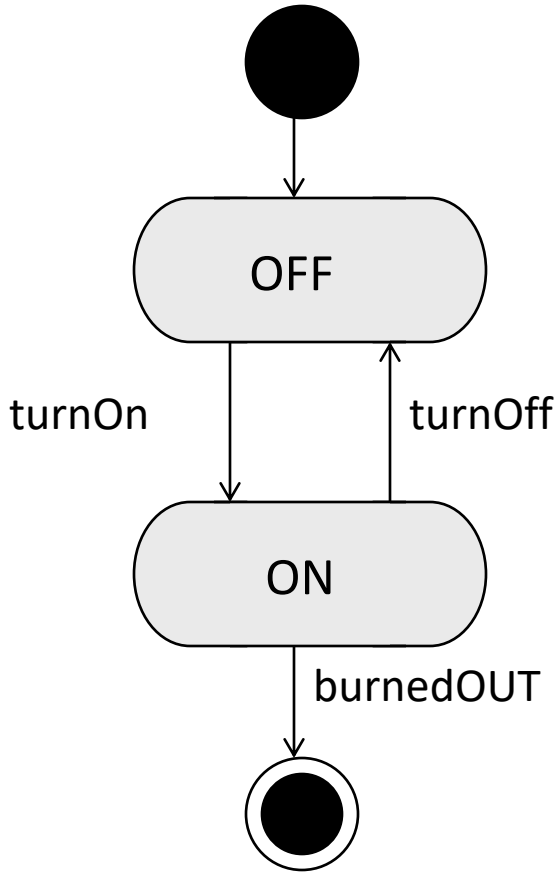
Class Diagram



State Chart Diagrams

Example





States

- *„..a condition or situation during the life of an object during which it satisfies some condition, performs some activity, or waits for some event.“*

- State of an object is given by:
  - Its attribute values
  - Its relationship to other objects
  - Actions taken by the object.

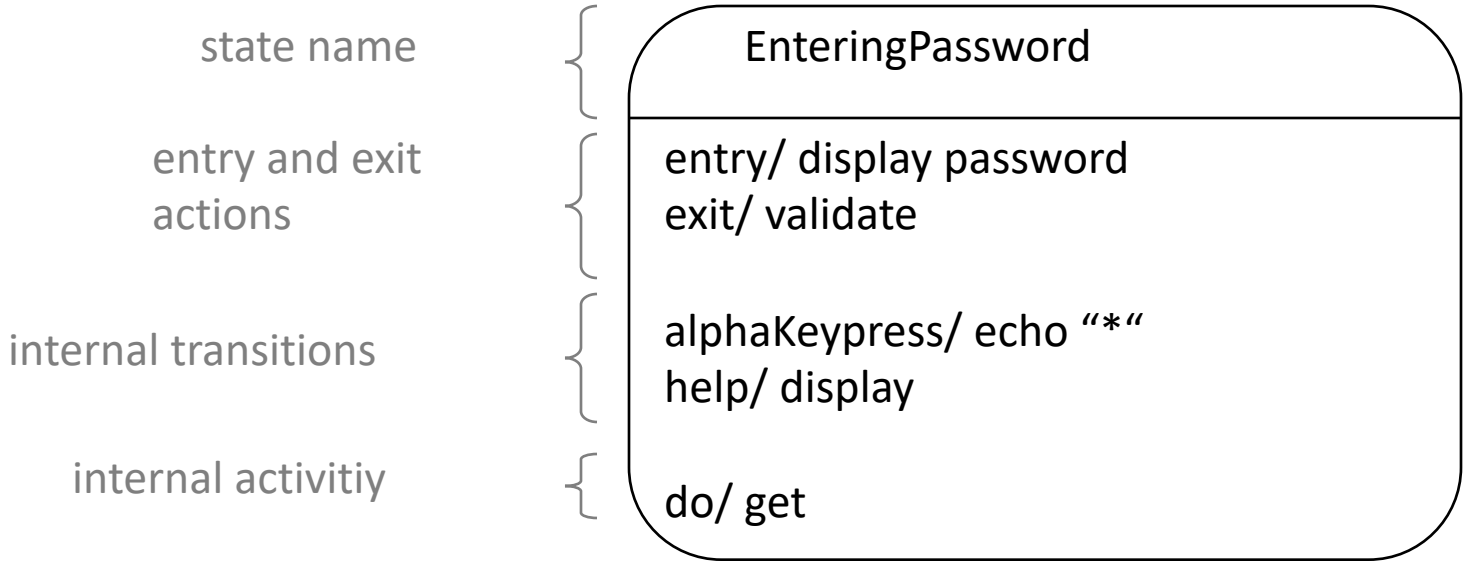
What are states of objects?

- State = semantically significant configuration of an object
- Identify states of an object that are important to distinguish!
- **Example**:

```
class Color
{
        int red;
        int green;
        int blue;
}
```

Are here any states?

State Syntax

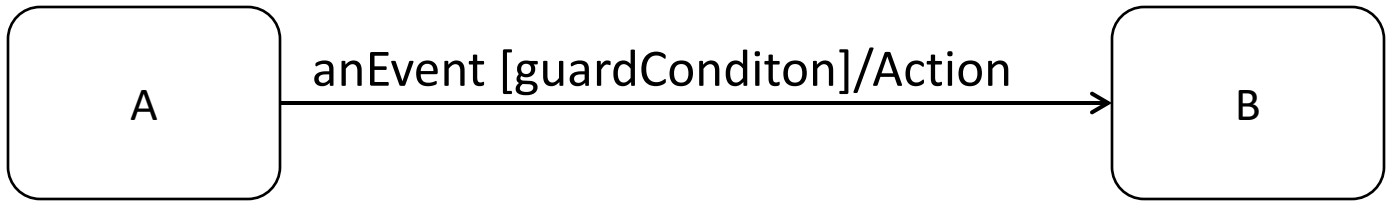


Actions cannot be terminated and do not require time

Activities can be terminated and need a finite amount of time.

Transitions

- Event: External or internal, a trigger for transition
- Guard Condition: Boolean sentence that has to be evaluated to true.
- Action: Will be exectuted when the transition fires. This is the case when an event occurs and the guard condition evaluates to true.

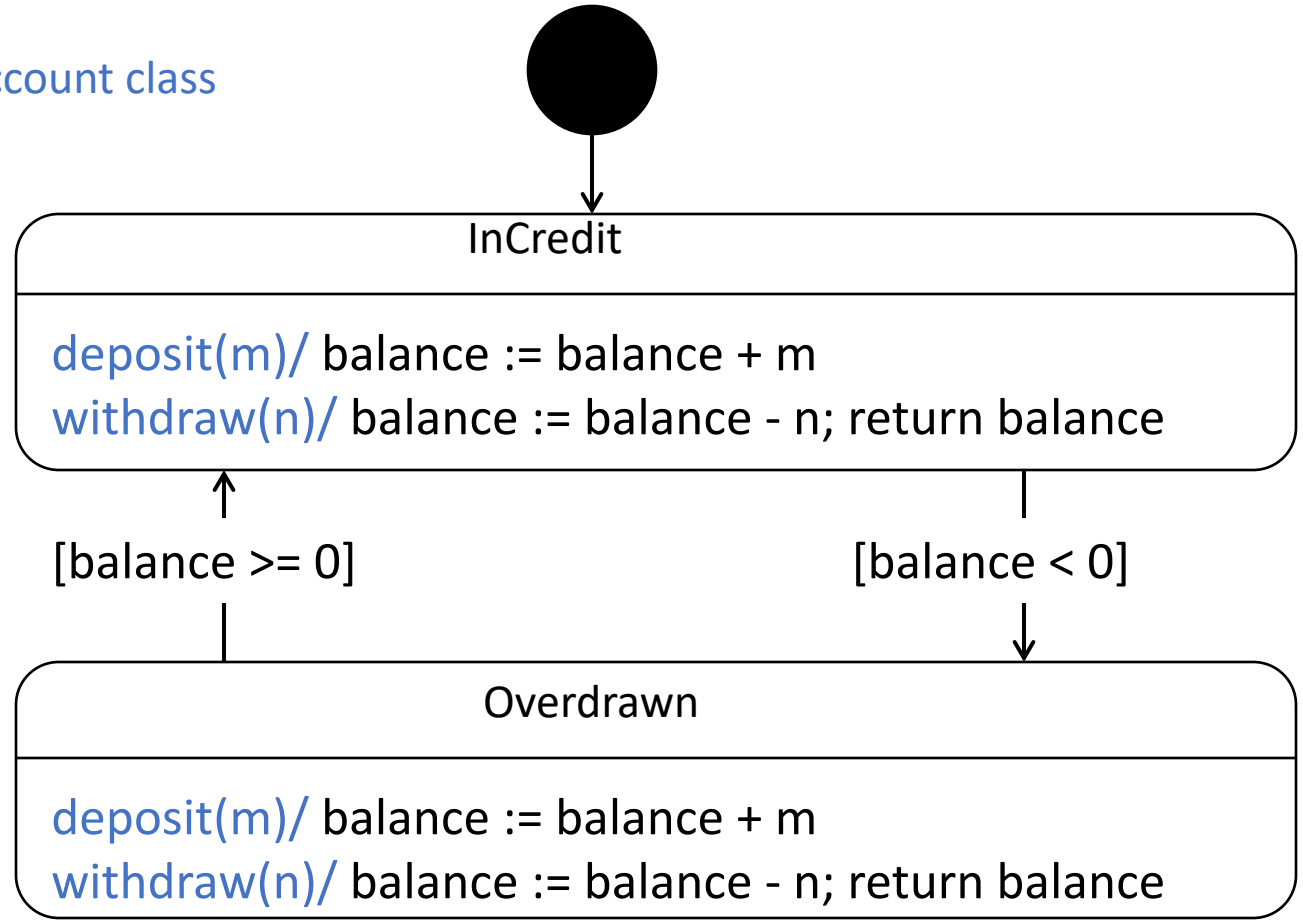


Events

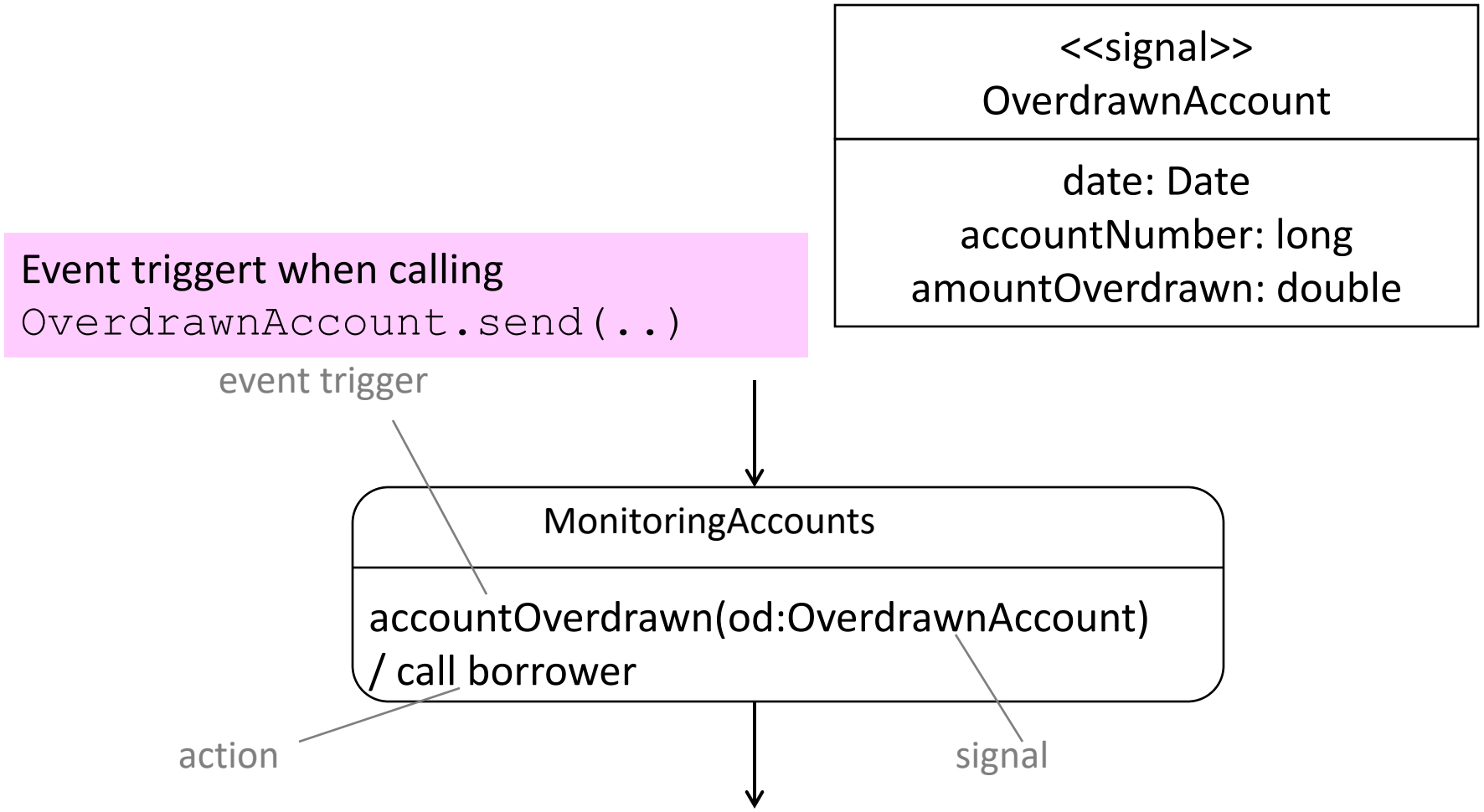
- 4 kind of events:
  - Call events: caused by executing a method of a class.
  - Signal events: One way, asynchrone communication between objects.
  - Change events: actions that are associated with an event. Executed when a condition evaluates to true.
  - Time events

Example - Call Event

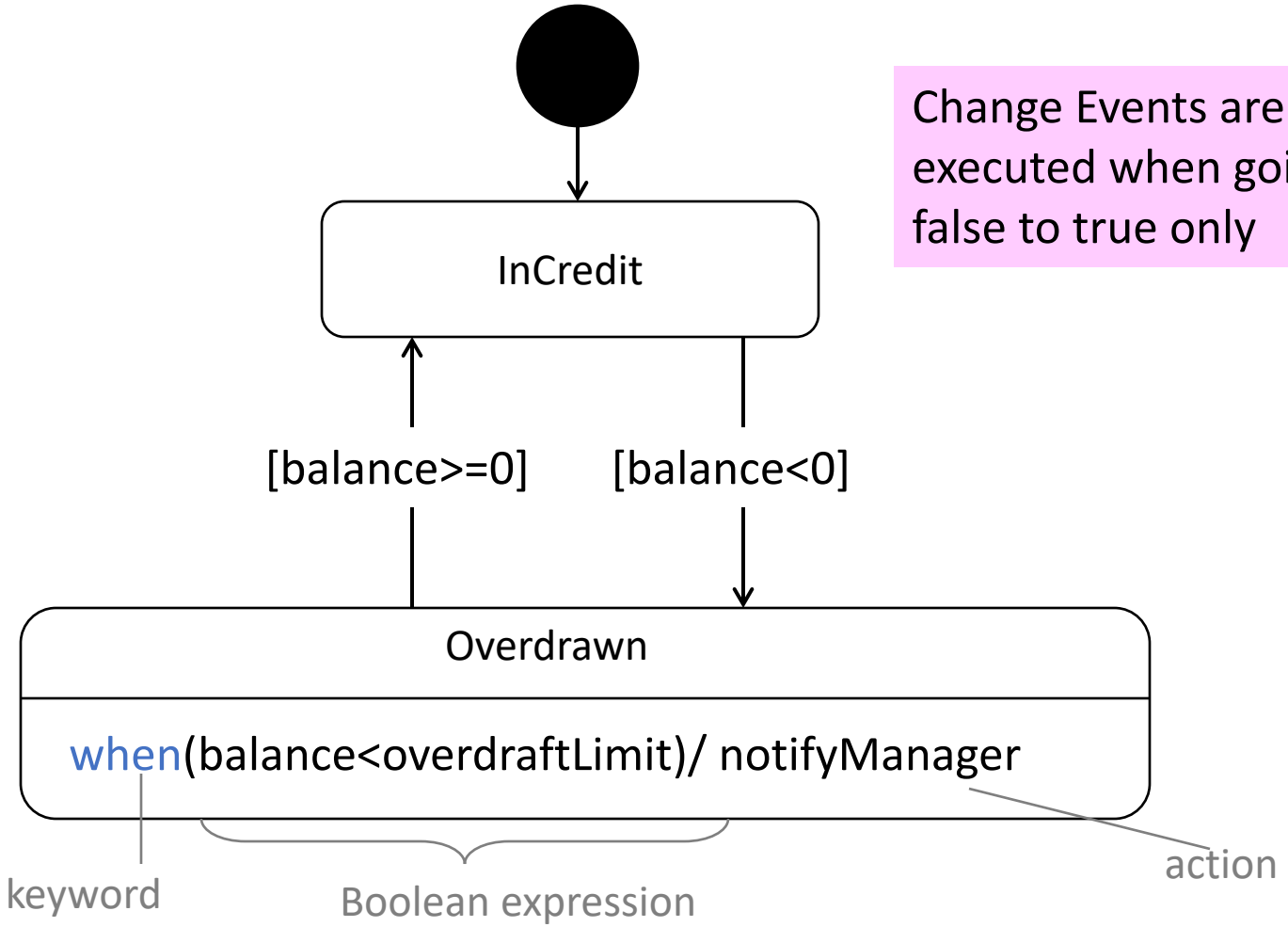
Context: BankAccount class



Example - Signal Event

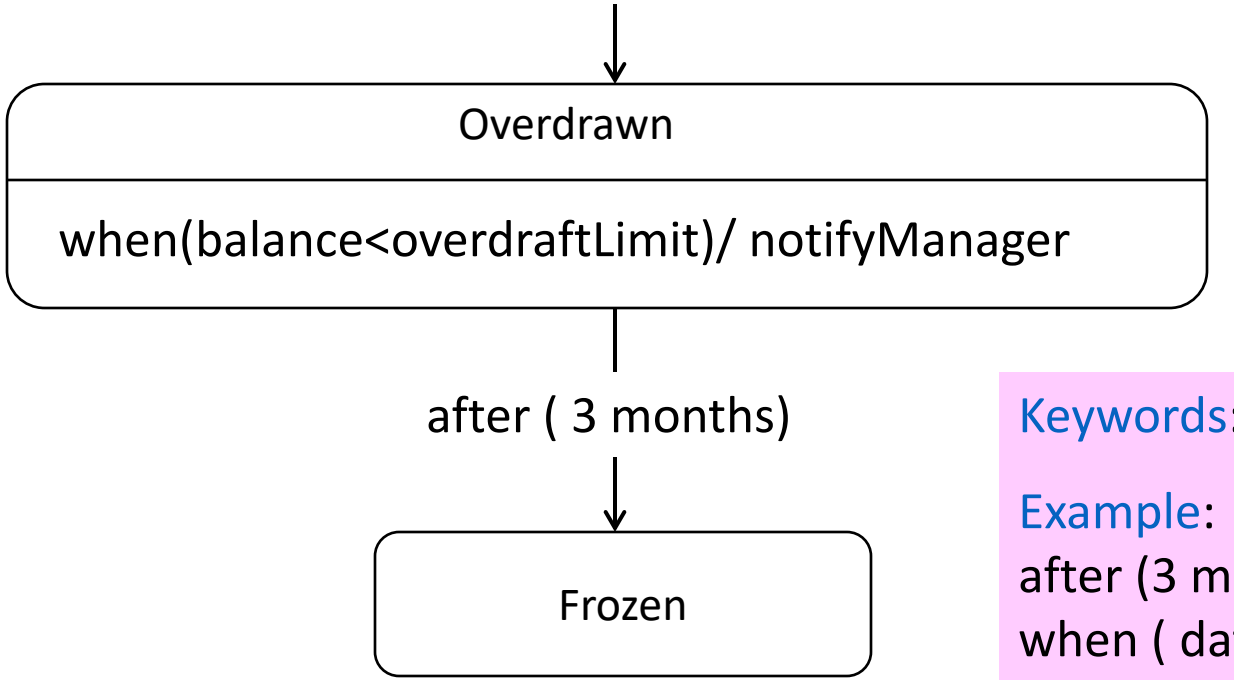


Example - Change Event



Change Events are executed when going from false to true only

Example - Time Events

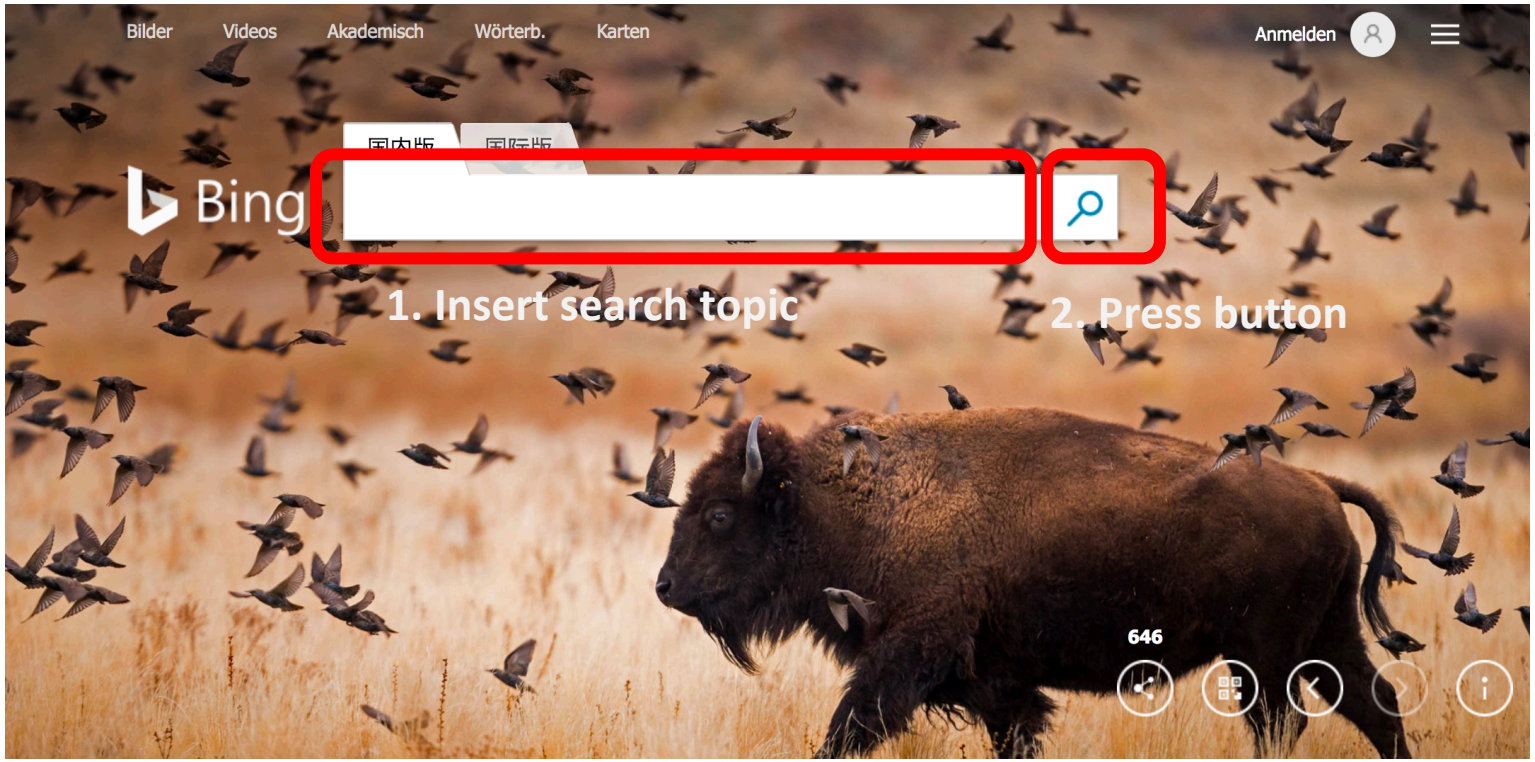


Keywords: after, when

Example:
after (3 months)
when (date = 1.1.2004)

State chart diagrams – Summary

- Are used to define how a system works internally.
- Can be used to specify a graphical user interface!



Bing search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Initial screen
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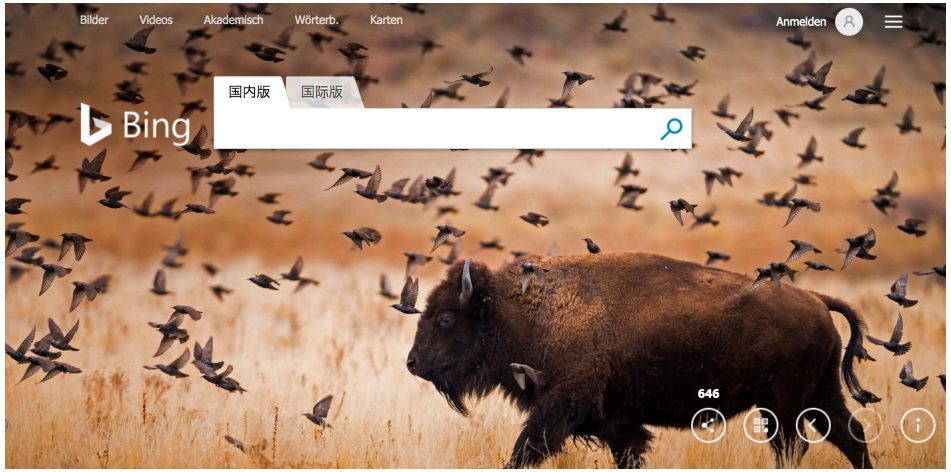
Search result screen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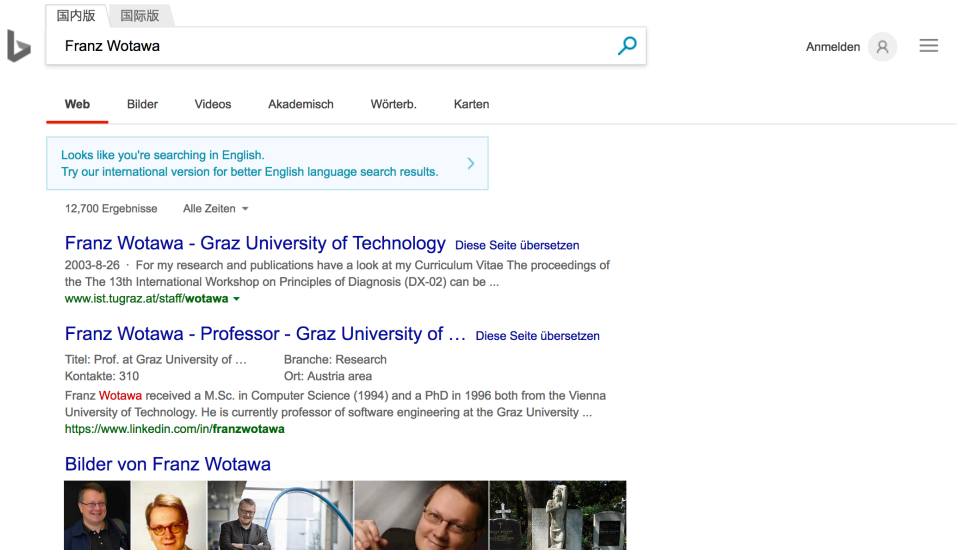
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