Ontwerp van SoftwareSystemen

1 Introduction

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OSS 2013-2014

People

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About me...

Doelstellingen

"In deze cursus komt het ontwerpen van software systemen aan bod. De nadruk ligt op objectgerichte methodes. Een belangrijke doelstelling is het leren nemen van ontwerpbeslissingen op een gefundeerde manier, met het afwegen van voor- en nadelen van verschillende oplossingen met betrekking tot de analyse en vereisten, het ontwerp, de implementatie, en de organisatie. Dit alles wordt toegepast in een groepsproject dat uitbreidingen maakt op een niet-triviale, en voor de studenten nieuwe, applicatie."

Begintermen

"Grondige kennis van een objectgerichte programmeertaal en objectgeoriënteerde concepten. Praktische vaardigheden bij het ontwikkelen van programma's, i.c. het gebruik van een IDE (integrated development environment) zoals Eclipse en versiebeheer software zoals svn."

Inhoud Hoorcollege

- Overzicht van software ontwikkelingsprocessen.
- Objectgerichte analyse en ontwerp gebruikmakend van de modeleertaal UML.
- Studie, evaluatie en gebruik van GRASP patronen en van ontwerp patronen.
- Technieken voor het realiseren van kwalitatieve objectgerichte ontwerpen en implementaties.
- Technieken voor het inschatten van de kwaliteit van het ontwerp en de implementatie van software systemen.

Course Material

- Slides and links on the website of the course

  http://roelwuyts.be/OSS-1314/

- Material
  - Applying UML and Patterns (3rd ed.), *Craig Larman*.
  - Design Patterns: Elements of Reusable Object-Oriented Software, *E. Gamma, R. Helm, R. Johnson, J. Vlissides*.
  - Refactoring: Improving the Design of Existing Code, *M. Fowler, K. Beck, J. Brant, W. Opdyke, D. Roberts*.
  - "No Silver Bullet: Essence and Accident in Software Engineering ", *F.P. Brooks*.

Project: applying the theory in practice

- Group Project
  - Number of persons in a group not yet known!
- Three iterations:
  1. Investigate and evaluate an existing implementation

     Analysis of an existing system
  2. Extend it (Trade-offs!)

     Decide what to modify to realize the extension
  3. Refactor it

     Clean up and realize a smaller extension

Project Effort

- Effort of 90 hours / student.
- It is possible that you spend more or less !
  - notify me in time of possible discrepancies

Escalation Policy

- Groups do not always function smoothly
  - But dealing with this is part of your education
- In case of problems:
  - discuss within group.
  - if it cannot be resolved: mail to your assistant (with me in cc) to describe the problem.
  - assistant may decide to involve me if necessary.
- In case of problems with assistant: contact me.
- In case of problems with me: contact MA1 responsible.

Course grading: First session

- Project defense after iterations (grades P_1,P_2,P_3)
- Individual defense after final iteration (grade I)
- Grading Algorithm:

If ∃ P_i <= 5, 1<=i<=3 : final grade = min(P_1, P_2, P_3)

elif I <= 8: final grade = I

else final grade = (avg (P_1, P_2, P_3) + I) / 2

- If we find large work discrepancies within a group, specific grades for that group/person can be given

0 is possible when not collaborating !

Course grading: Second session

- Second session
  - Continuing project individually
  - Grade on project (P_4) and project defense (I')
    - Grading algorithm from first session:
      - lowest score replaced by P_4
      - I replaced with I'

Project Defense

- Each of you gets questions and answers. Then other group members can provide more information.
- Questions originate from your report, design and implementation.
- You get two kinds of feedback:
  - during the defense:our questions and comments
  - right after the defense:

Grades

- 1st session:
  - Final grade ≥ 10 : done!
  - Final grade < 10 : redo in second session
- 2nd session:
  - Final grade ≥ 10 : done!
  - Final grade < 10 : credit not obtained

Questions ?

About You

- Let’s do an interactive “quiz”
  - there is no right or wrong for most of the questions here; goal is for me to learn your reflexes when faced with questions related to programming language, design, or implementation.

- Is the following correct:

"A message sent to super is sent to the parent of the object"

What is the result of the following expression?

```
    class A {
    public void m(A a) { System.out.println("1"); }
}

class B extends A {
    public void m(B b) { System.out.println("2"); }
    public void m(A a) { System.out.println("3"); }
}


B b = new B();
A a = b;
a.m(b);
```

What do you think of the following implementation?

```
      // Return null to signify end of file
protected IToken fetchToken() throws EndOfFileException {
    ++count;
    while (bufferStackPos >= 0) {
        // Tokens don't span buffers, stick to our current one
        char[] buffer = bufferStack[bufferStackPos];
        int limit = bufferLimit[bufferStackPos];
        int pos = bufferPos[bufferStackPos];

        switch (buffer[pos]) {

        case '_':
            t = scanIdentifier();
            if (t instanceof MacroExpansionToken)
                continue;
            return t;

        case '#':
            if (pos + 1 < limit && buffer[pos + 1] == '#') {
                ++bufferPos[bufferStackPos];
                return newToken(IToken.tPOUNDPOUND);
            }

            // Should really check to make sure this is the first
            // non whitespace character on the line
            handlePPDirective(pos);
            continue;
```

…

(390 lines of code in total)

Reuse versus hack

- Suppose you are responsible to add a new feature to an existing piece of software. The design of the existing software makes this hard. How do you decide whether to rewrite the existing software or whether to “hack in” the new feature ?

Object-Oriented Software Design Question

- A restaurant menu consists of dishes, e.g. “Flemish stew”, “Blood sausage with apples” and “Chicken Royale with Champaign”. Each dish consists of a number of ingredients and is either a starter, a main course or a dessert. The menu shows for each dish an authenticity score (1, 2 or 3), a calory score, as well as the price. Menus need to be printed in a variety of languages (dutch, french, english, japanese, arabic; some left-to-right and some right-to-left) and needs to be available on an interactive website (where a picture is shown of the dish). The menus change frequently with the seasons.

Why Software Engineering?

- Problem Specification → Final Program
- But ...
  - Where did the specification come from?
  - How do you know the specification corresponds to the user's needs?
  - How did you decide how to structure your program?
  - How do you know the program actually meets the specification?
  - How do you know your program will always work correctly?
  - What do you do if the users' needs change?
  - How do you divide tasks up if you have more than a one-person team?

What is Software Engineering? (I)

- Some Definitions and Issues
  - "state of the art of developing quality software on time and within budget"
- Trade-off between perfection and physical constraints
  - Software engineering deals with real-world issues
- State of the art!
  - Community decides on "best practice" + life-long education

What is Software Engineering? (II)

- "multi-person construction of multi-version software"

  ☐Parnas

- Team-work
  - Scale issue ("program well" is not enough) + Communication Issue
- Successful software systems must evolve or perish
  - Change is the norm, not the exception

Communication and Modeling

- Team-effort requires communication
- Results have to be communicated externally

UML

- Unified Modeling Language
- De-facto standard that I expect everybody to know and follow
  - working knowledge of at least the *use case*, *class*, *sequence* and *communication* diagrams
  - use throughout course (theory, practice, project)
- Self-study
  - I give a short overview
  - You do the study

General Goals of UML

- Model systems using OO concepts
- Establish an explicit coupling to conceptual as well as executable artifacts
- To create a modeling language usable by both humans and machines
- Models different types of systems (information systems, technical systems, embedded systems, real-time systems, distributed systems, system software, business systems, UML itself, ...)

11 diagrams in UML 2

- Class diagram
- Internal Structure Diagram
- Collaboration diagram
- Component diagram
- Use case diagram

Structural

- State machine diagram
- Activity Diagram
- Sequence diagram
- Communication Diagram

Dynamic

- Deployment diagram

Physical

- Package diagram

Model Management

Requirements Engineering and Use Cases

- Requirements: documented need for what a system or project should do
  - 37% of problems with software projects have to do with requirements
  - 25% of the requirements change during the project (and 35-50% in large projects)
- Therefore: embrace change!

Types of Requirements: FURPS+ categorization

Functional

features, capabilities

Use Cases

Usability

human factors, help, documentation

Reliability

frequency of failure, recoverability

Performance

Response times, throughput, accuracy, resource usage

Supportability

Adaptability, maintainability, configurability

+

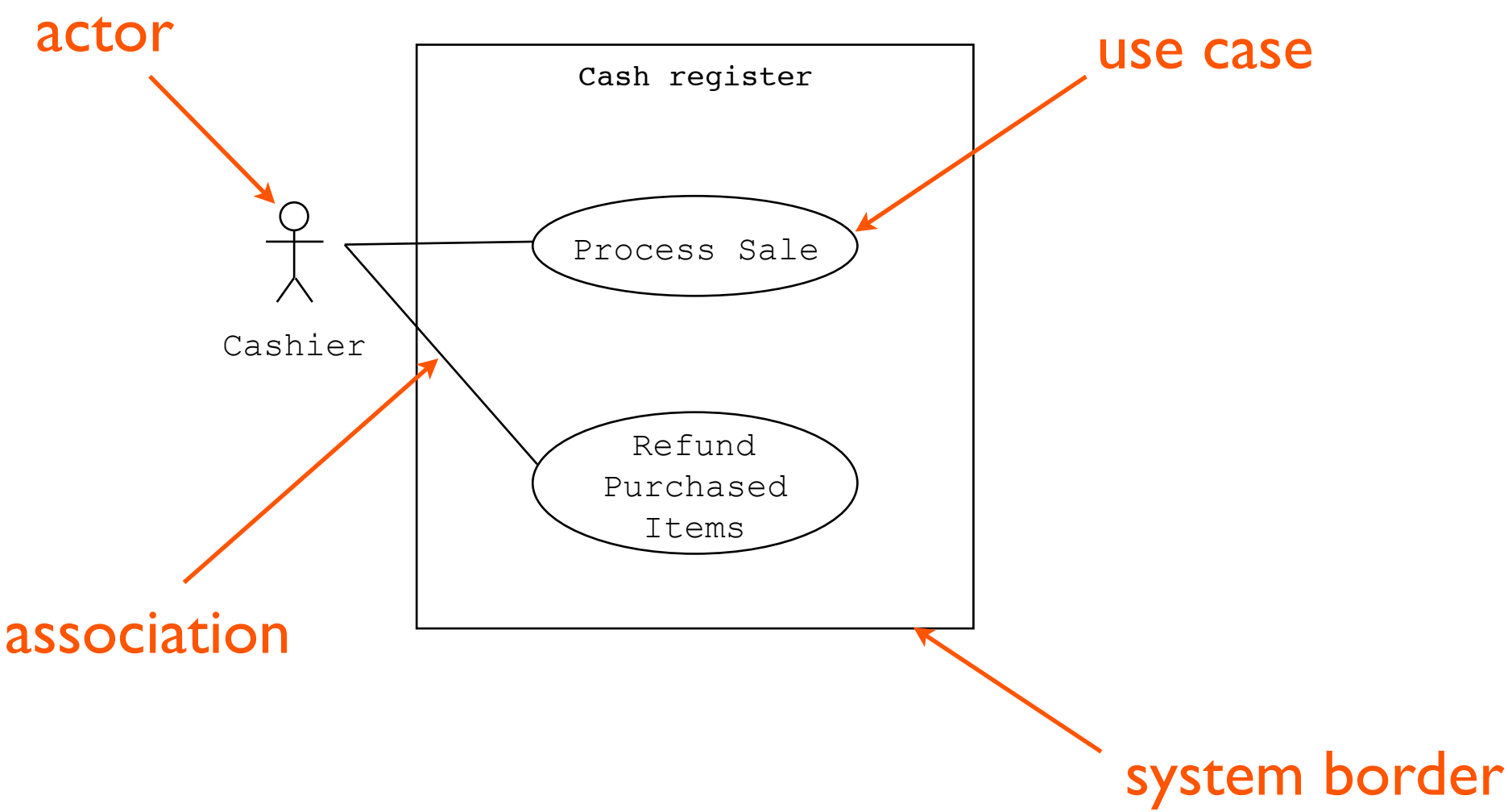
implementation, interface, operations, packaging, legal

Non-functional

Use Cases

- Stories that describe usage of the system
  - describe sequence of actions with an observable result for a specific actor
  - used by all kinds of stakeholders
- It does not describe the internal working of the system
  - What, not How
  - Responsibilities of the system are described

Use Case Diagram



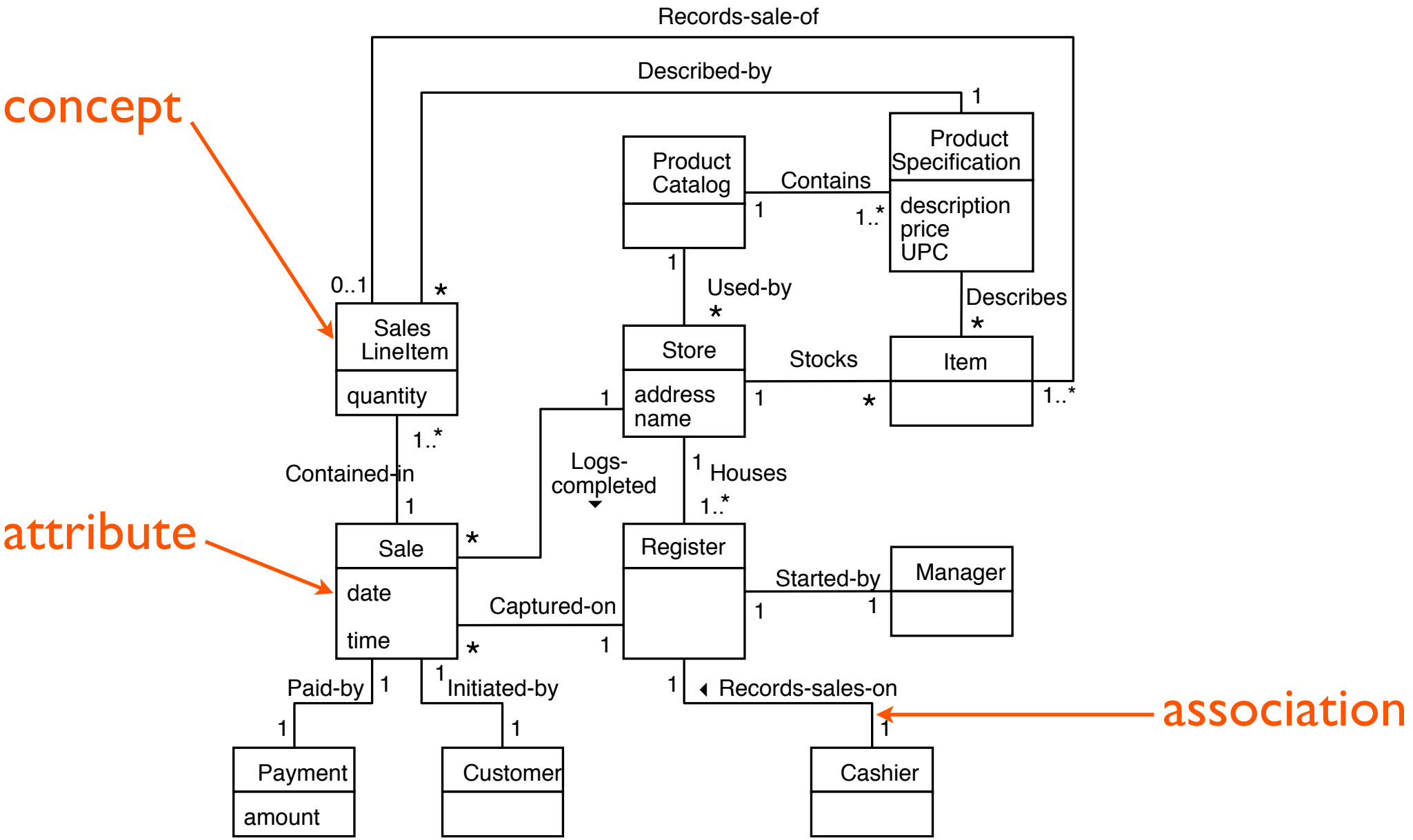
Fully Dressed Use Case Description

Use case:	**Process Sale**
Primary Actor:	Cashier
Stakeholders and interests:	• Cashier: wants accurate, fast entry, and no payment errors, as cash drawers shortages are deduced from his/her salary • Customer: wants purchase and fast service with minimal effort. Wants easily visible display of entered items and prices. Wants proof of purchase to support returns. • Manager, Government, Payment Company, ...
Precondition:	Cashier is identified and authenticated
Success Guarantee (postcondition)	Sale is saved. Tax is correctly calculated. Receipt is generated. Accounting and inventory are updated. Payment info is recorded.

Domain Modeling

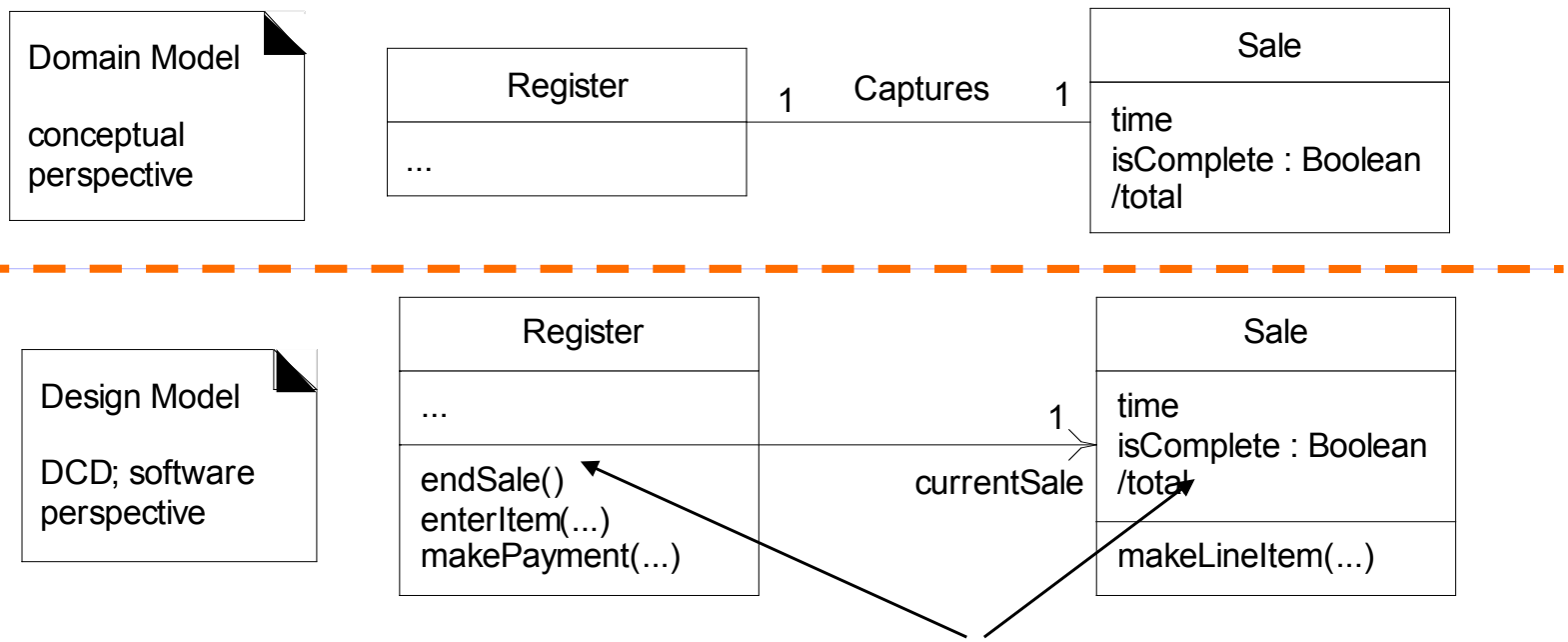
- A domain model describes meaningful concepts in the problem domain
  - again about the what, not the how
  - does not model design artifacts (how), but models conceptual artifacts, real-world things

Domain model for the Cash Register example



Class Diagrams

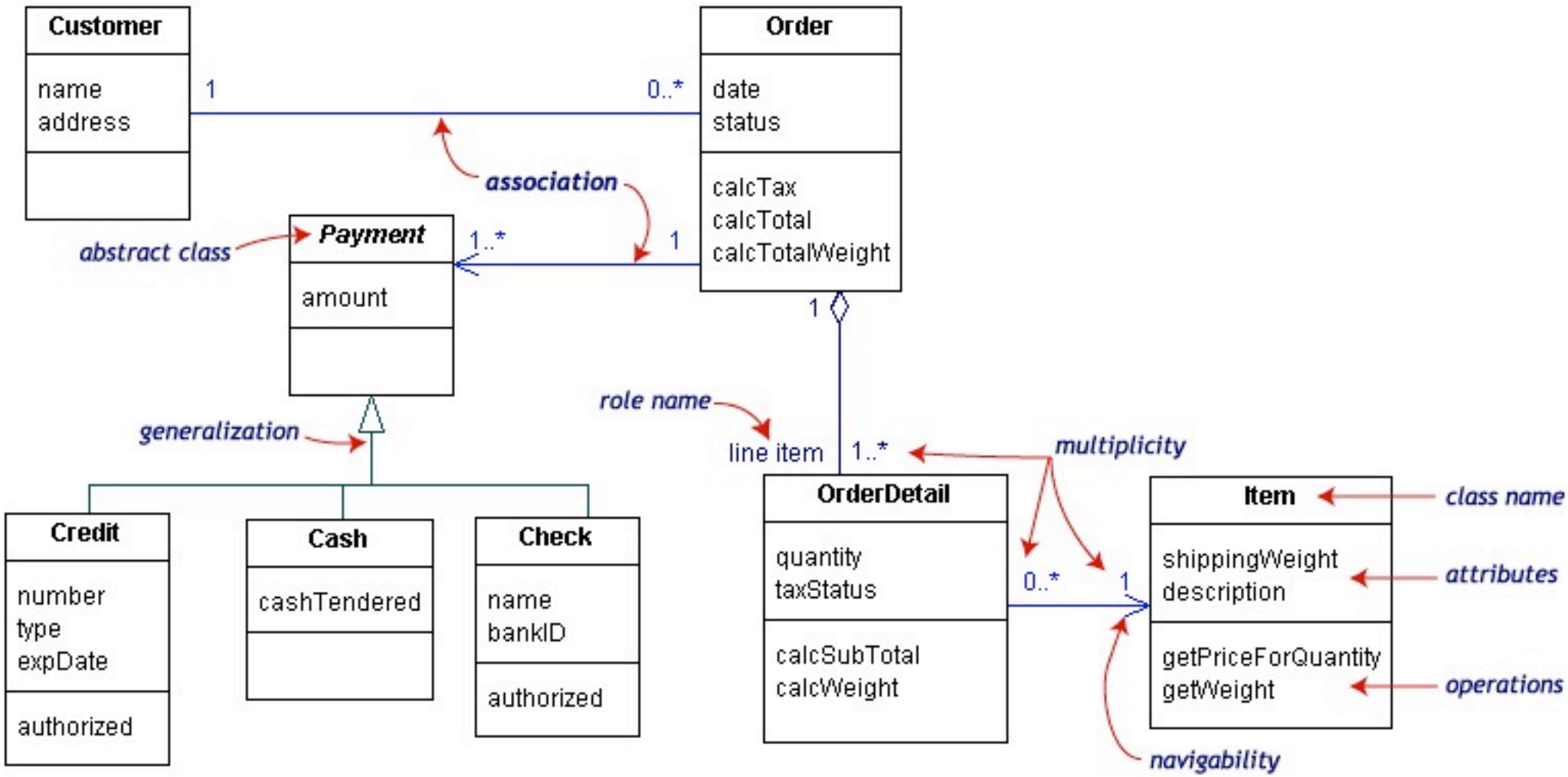
Domain model is the analysis *class diagram*
Don't show methods



Avoid showing no-argument constructors & getters/setters

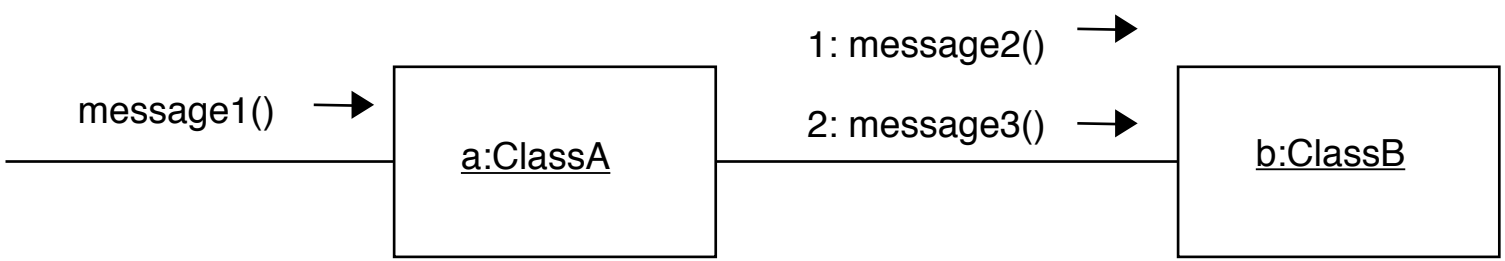
Design model *class diagrams* shows methods and visibility (arrowhead on association)
Register has reference to Sale; Sale does not have reference to Register

Class Diagrams



Interaction diagrams

- UML Interaction diagrams
  - model message-exchange between objects
- 2 kinds:
  - Communication Diagrams – focus on interactions
  - Sequence Diagrams – focus on time



Interaction diagramma's

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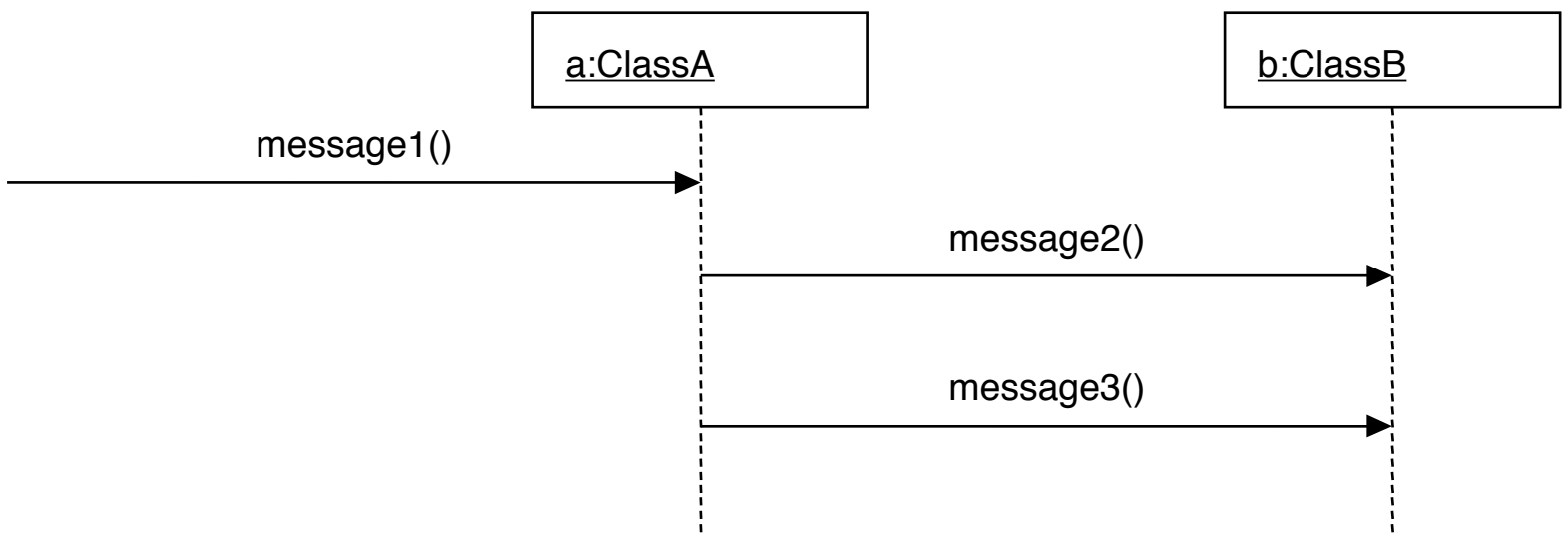
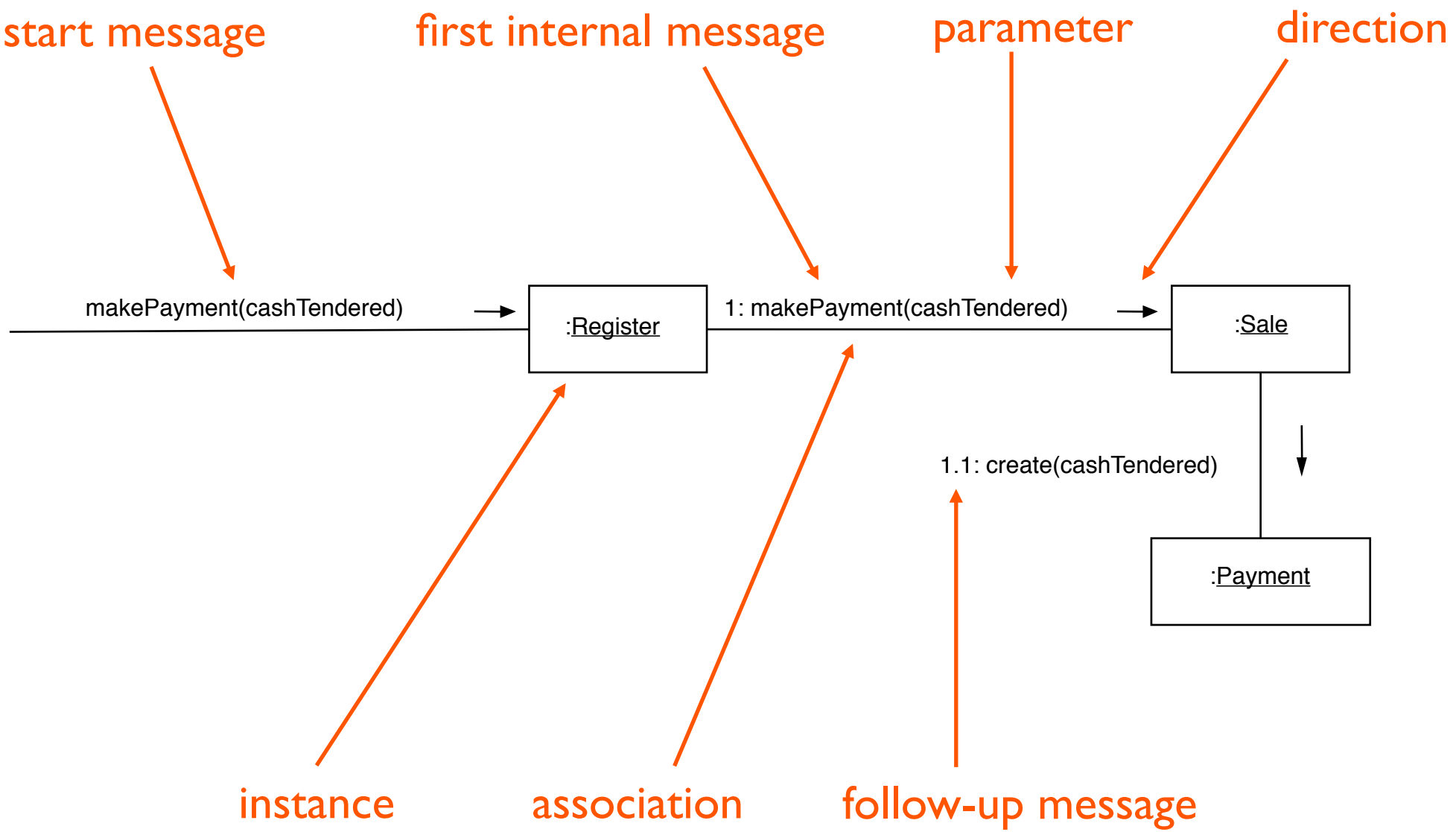
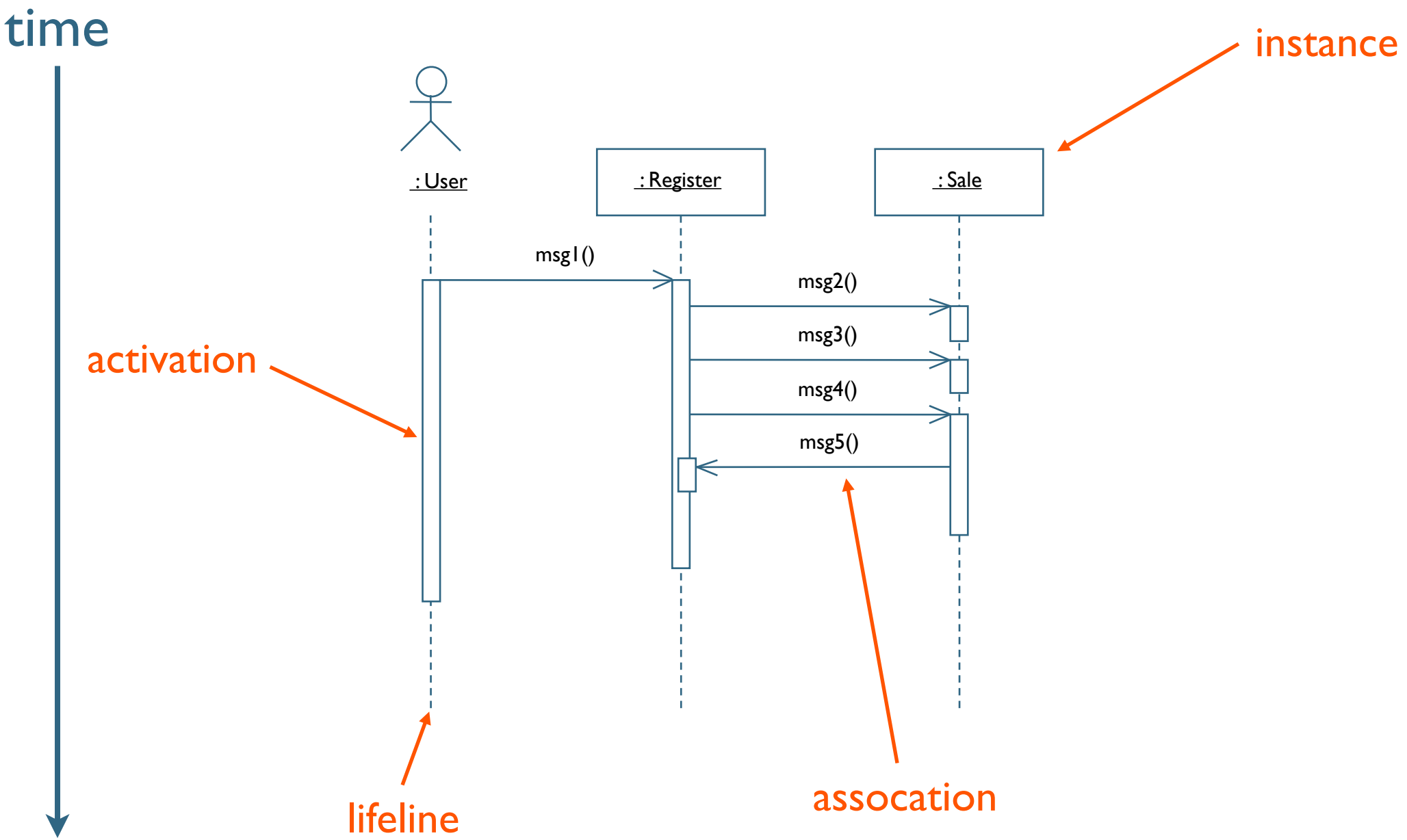


Communication Diagram Example



Sequence Diagram Example



Conclusion

- This course is about (OO) software design
  - Understand quality design and implementation
  - Make reasoned design decisions
  - Make trade-offs that balance quality, effort, design, and implementation
  - Be able to communicate your decision

http://roelwuyts.be/OSS-1213/

Sample Questions Individual Oral Examination

- Waarom heb je een visitor patroon nodig als je een taal hebt die open classes/class extensies ondersteunt ?
- Wanneer heeft het zin om het Iterator en het Composite patroon samen te gebruiken ?
- Kan je kort zeggen wat de Decorator en Strategy Patronen zijn, en aangeven wanneer je welke zou gebruiken ?
- Wat is een software development methodologie, en geef 2 voorbeelden. Wanneer zou je welke aanpak gebruiken ?
- Wat is refactoring ? Geef een voorbeeld van een refactoring.
- Wanneer refactor je in een XP project ?
- Wat is de bedoeling van de Overview Pyramid ?
- Hoe kan je weten of de controller in de GRASP Controller Pattern goed ontworpen is ?
- Wat is overriding en overlading? Pas ze beiden toe op een visitor design patroon en weeg de voor- en nadelen af.
- Welke design patronen kunnen nuttig zijn in een Unit Testing Framework ontwerp ?
- Bespreek de Law of Demeter.
- Wanneer is een verzameling unit tests goed te noemen ?
- Wat is double dispatch. Geef een voorbeeld. Bespreek een design patroon waar double dispatch gebruikt wordt.