Object Oriented Analysis and Design and Software Development Process Phases

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Why object oriented?

- **Because of growing complexity!**
  - How do we deal with it?

1. **Divide and conquer**
2. **Iterate and increment**
3. **Reuse and recycle**
4. **Strong cohesion and low coupling**
   - Among different entities

Principles of OO

- **Abstraction**
  - Identify essential characteristics
  - 1,2,3
- **Hierarchy**
  - Order of abstractions
  - 1,2
- **Encapsulation**
  - Need to know principle
  - 4,1
- **Classification**
  - Bring similar things together
  - 3,1,4
- **Polymorphism**
  - Classify related differences
  - 3,2

- **References**
  - **"Object Oriented …"**
  - **By UML guys**
    - Booch
    - Rumbaugh
    - Jacobson
  - **And many others**

OO-A/D/P and Processes

- Business modeling
- **Capture requirements**
- **Analysis**
- **Design**
- **Implementation**
- **Testing and validation**
- Deployment
- Configuration and change
- Project management

Before and after contract

- **Inception**
  - Elucidate requirements
  - Perform a rough OOA + OOD
  - Calculate resources and costs
    - Personnel, Time, COTS

- **Elaboration, construction, transition**
  - Detailed OOA & OOD
  - Test planning and testing
  - Lots of documents

Requirements

- **Functional**
  - What the system should do!
    - Client should be able to withdraw cash
    - Students should be registered
- **Non-functional**
  - How it should behave while doing it
    - portability
    - reliability
    - performance
    - testability
    - modifiability
    - security
    - cost
    - presentation
    - reusability
    - understandability
    - acceptance criteria
    - interoperability

Requirements

- **Satisfiability**
  - Normal
  - Expected
  - Exciting
- **Criticality**
  - Mandatory
  - Desirable
  - Non-critical
- **Stability**
  - Stable
  - Non-stable
- **User types**
  - Ones that order
  - Ones that use

Requirements Specification

- **Correct. There should be no factual errors.**
- **One interpretation only. We have seen a few examples of ambiguous statements above.**
- **The SRS should be complete.**
  - But requirements do change. So the format should allow changes
- **All requirements must be verifiable (testable).**
- **All requirements must be consistent and non-conflicting.**

- **The requirements specification should be design neutral**
  - Concentrate on ***what*** the system should do not on ***how*** it should do it.

What should we do? (1)

- **Requirements**
  - Requirements specification
  - Construct use cases
    - Is any use case not described in the requirements specification?
    - Are there any conflicts between the descriptions and specification?

…Iterative

…Incremental

What should we do? (2)

- **Object oriented analysis**
  - Find objects and relations
    - Substantive
    - Brainstorm
    - Checklist
  - Delegate responsibilities of activities to objects
    - What should they do?
    - CRC cards
  - Create Class diagrams
  - Interaction diagrams
    - Sequence diagrams
    - Collaboration diagrams

What should we do? (3)

- **Object oriented design**
  - Detail class diagrams
  - Detail interaction diagrams
  - Detail statecharts and/or activity diagrams
- **Create test plans**
  - Unit tests
  - Integration tests
- **Implement and Test**

- **Note all the activities in the last 3 slides are**
  - **Iterative**
  - **incremental**

How to find objects

- **Substantives**
  - From requirements specification
  - From use cases
- **Brainstorming**
  - Free flow of ideas
- **Checklist**
  - Roles
  - Facts
  - Situations
  - Interactions
  - Concepts
  - Information
  - Controllers
  - Outer entities
- **Afterwards: classify, group, eliminate, relate them**
  - Design patterns are useful here

CRC

- **A standard (handy) way for describing classes**
- **Small cards are used**
  - Should not support too much text
  - A4 / 4

- ***Class name***
- ***Responsibilities***
- ***Collaborations***
- **Back side can be used for data attributes**

ResultRegister	
Set results	Result
Create results	Grade
Search results	Student

Testing

- **Can only show that errors exist, not that they don't exist**

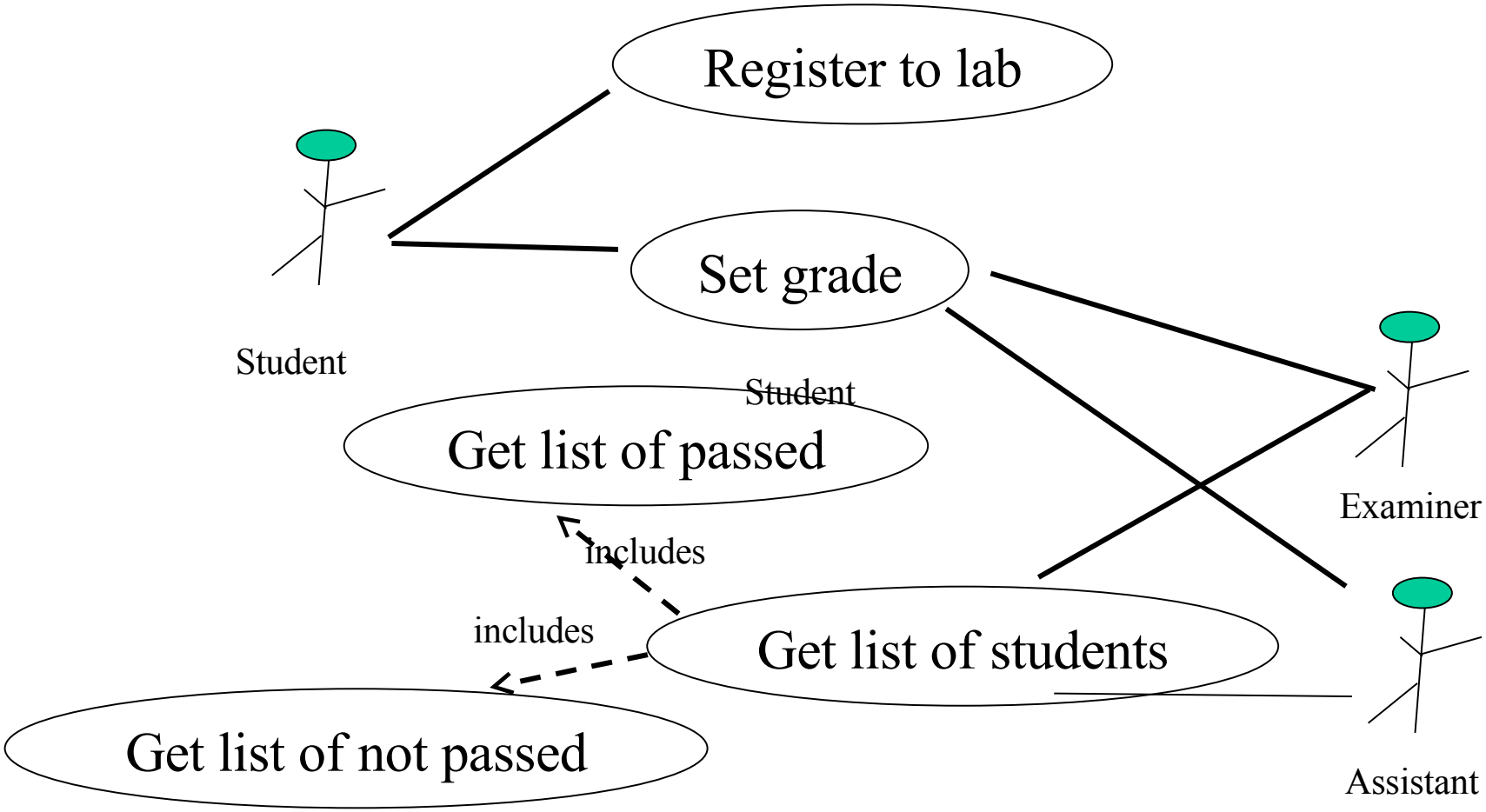
- **Unit test**
- **Module test**
  - Whitebox
  - Blackbox
  - Regression
- **Integration test**
  - Top down
  - Bottom up
- **System test**
  - Against requirements specification

- **Validation & Verification**

Example: Course management

- **Requirements**
  - Students should be able to register pairwise
    - Students data should be available in the system
  - A course should have different examination moments
    - Every moment has a status out of a grade scale
    - Every such scale should have a “passed” value
  - Assistants should be able to set grades
    - Data about assistants should be available in the system
  - Examiner + Assistants should be able to get a list of
    - Students that have successfully finished
    - Students that have not finished
    - All students

Use cases


Register to lab
Set grade
Student
Student
Get list of passed
Examiner
includes
includes
Get list of students
Get list of not passed
Assistant

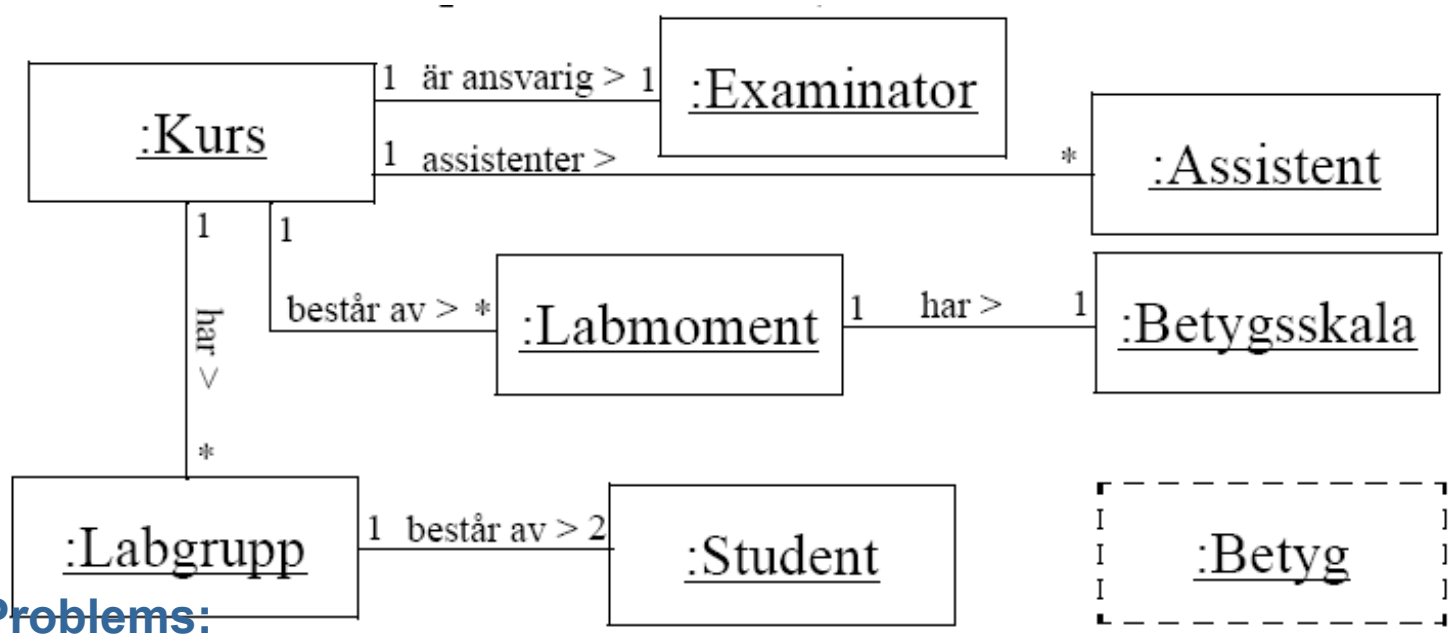
Find objects

- Student
- Assistant
- Examiner
- Lab group
- Lab moment
- Grade scale
- Result list
- Course

- Result register
- Person register,
- Student register

A initial class diagram

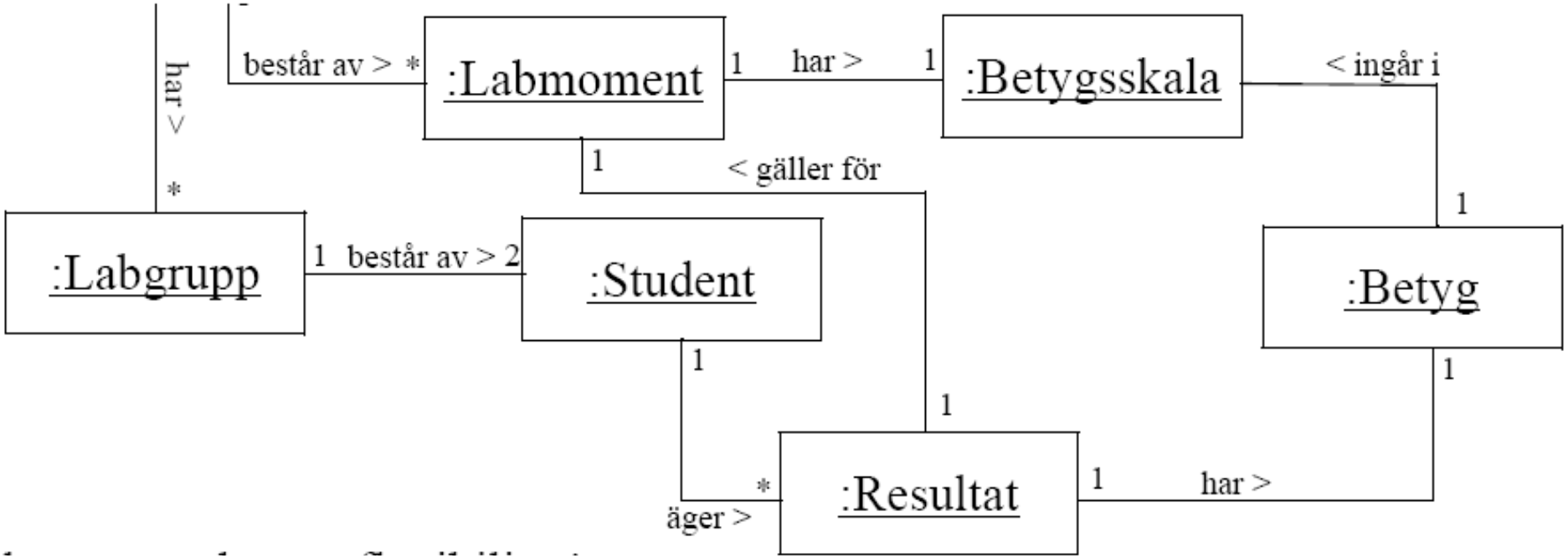
- **Define relations**
- **Set multiplicity**



- **Problems:**
  - Grade for group or individual?
  - How do I link moment and grade?
  - Did we find all objects?

More objects to add

- **A result links a student a grade and a moment**
  - Grade follows even if moved to another group
  - If a group member resigns – the other has the grade

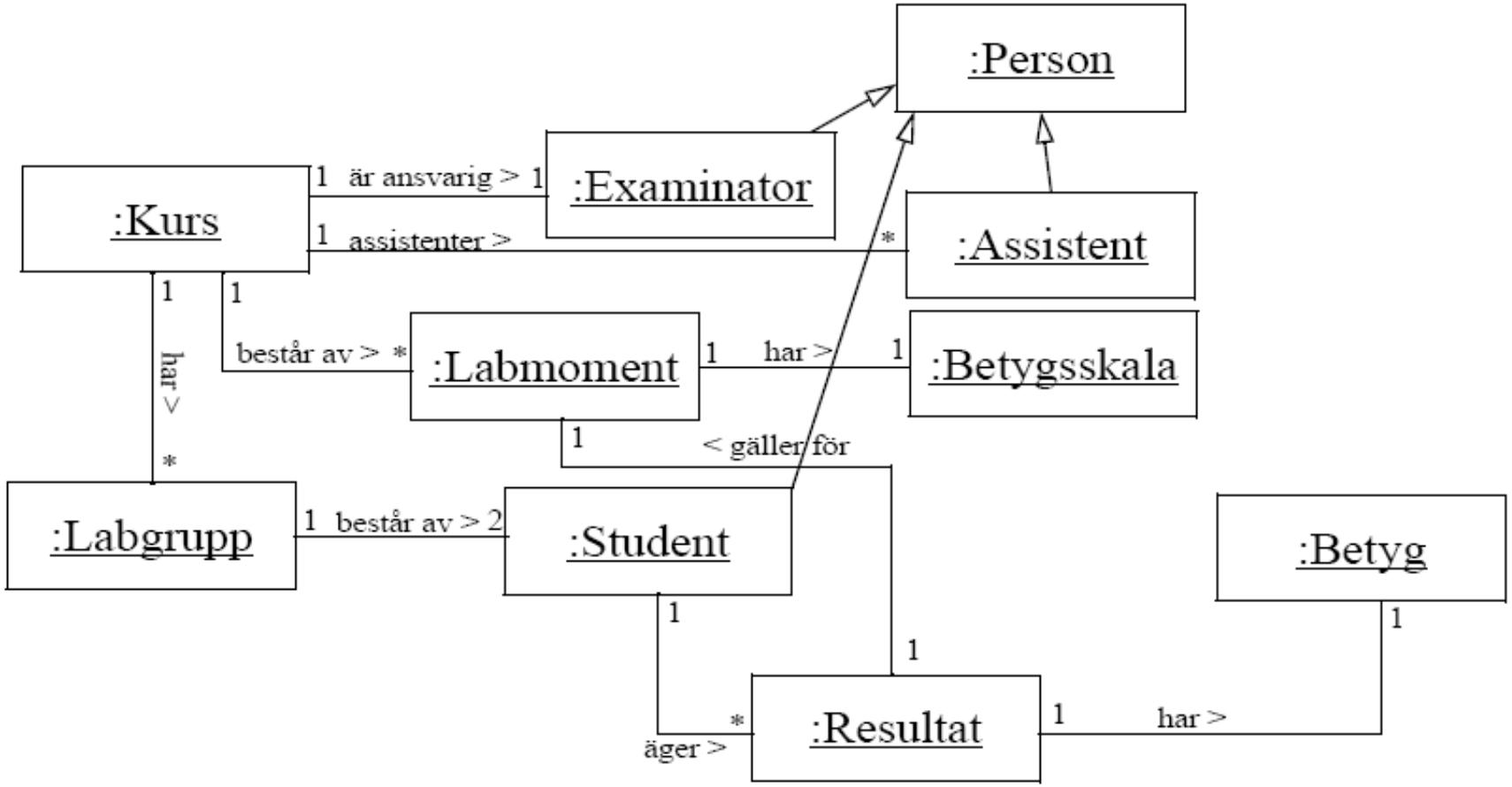


Do an assessment

- **Do we still need some objects?**
- **Do we have not necessary ones ?**
- **Do we still have some new relationships?**
- **Do we have some not necessary relationships?**

- **Remember**
  - Association
  - Generalisation
  - Aggregation
  - Composition

Specialisations of person



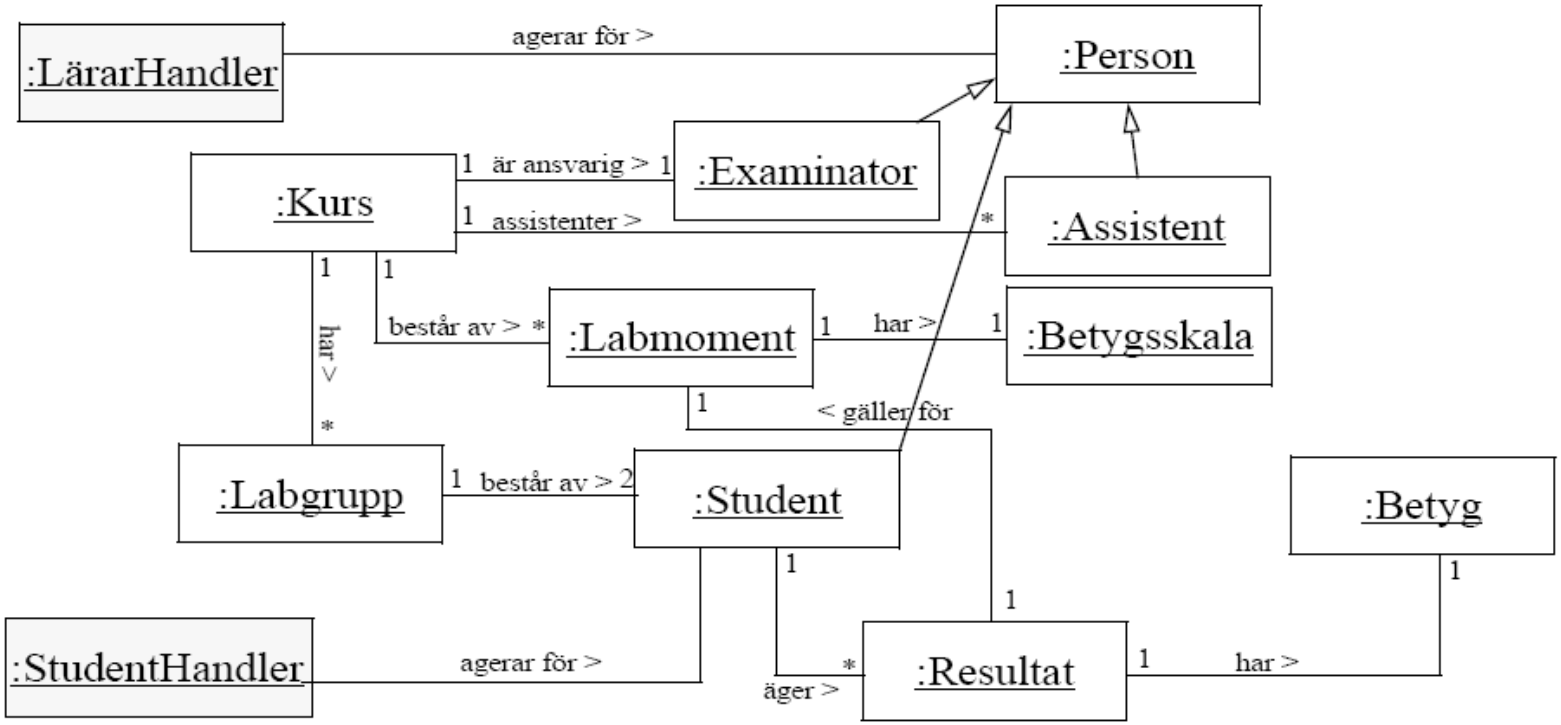
Define responsibilities for objects

- **Good objects do one (or a few) things well**
  - Otherwise we have to split the object
  - Remember divide and conquer
- **It can be a more complex task**
  - That needs several operations
  - Needs collaboration with other objects
- **Classes can have attributes and operations**
  - And they represent what?
  - Remember
    - low coupling among objects
    - Strong cohesion within object

Some rules of the thumb

- **The expert**
  - If a class has the knowledge to do something then let it do it
  - But not too many things
- **Who creates whom? – B creates A if**
  - B contains A
  - B is responsible for storing A
  - Uses A (strongly coupled)
  - B has the initialisation data for A
  - Factory? Anyone?
- **Who deals with system functions?**
  - The objects used until now are descriptive (contain data)
  - Should we use “Course” to get the lab registration, set grade, write lists – what if a course disappears?
  - Or should we use a controller?
    - Remember design patterns?
    - E.g. “StudentHandler”

After adding some controller objects



More responsibilities

- **Look at he requirements**
- **Look at the use cases**
  - “assistant sets the grade for a student at a certain moment”
    - Handled by assistant handler
  - Who should manipulate the grade?
    - Should the assistant handler create it and send to student?
    - Should the student create it?

Cohesion and coupling again

- **For each communication with a new class the coupling increases**
  - Create, return, have as argument, call method…
- **Internal data should be private**
  - Use interfaces to provide only a part of the object
  - Or use private and protected modifiers
- **A class should not have several strong relationships with two other classes**
  - Increases coupling

Coupling example