CHRISTIAN HUEMER
MARION SCHOLZ

Object-Oriented Modeling with UML
Part V – Use Case Diagram

Use Case Diagram

The Use Case Diagram

Christian Huemer und Marion Scholz

Presented by Nicholas Bzowski

Use Case (1/3)

- Use cases are the starting point for many object-oriented development methods.
- Often also the core concept that spans the entire analysis and design process.
- Initial questions for the implementation of use cases:
  - Why use use cases?
  - What do use cases look like?
  - What do you do with use cases once you have identified them?
- Use cases focus on the fundamental problem when developing a system: developing a solution for customers or users who have requested it.

Use Case (2/3)

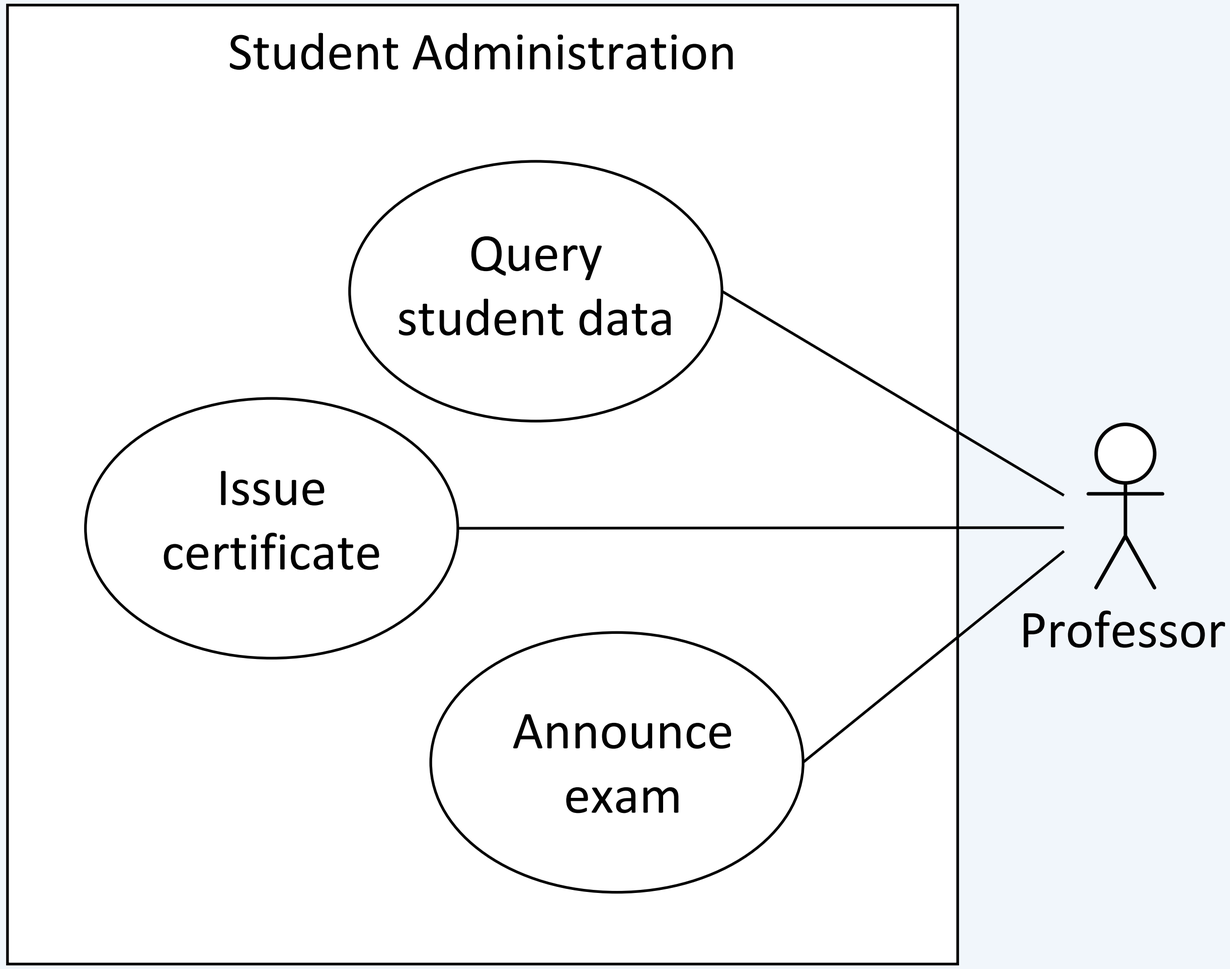
- Use cases represent the requirements of customers
- “A use case is a sequence of transactions within a system whose task is to generate an identifiable benefit for individual actors (users).” [Ivar Jacobson]
- Actors interact with the system in the context of the use cases
- Actor:
  - Role that someone or something assumes and that is related to the business area, or
  - Anything that interacts with the system

Use Case (3/3)

- Transactions within a system imply that actors are offered a range of opportunities to communicate with the system and that a measurable benefit is generated through them.
- A measurable benefit implies that the execution of a transaction has a visible, quantifiable and/or qualifiable impact on those things that lie outside the system, specifically on actors.

Example: Student Administration

- **System** (What is being described?)
  - **`Student Administration`**
- **Actor** (Who is using the system?)
  - **`Professor`**
- **Use cases** of **`Professor`**
  (What do the actors do?)
  - Query student data
  - Issue certificates
  - Announce exams



Use Case Diagram
Gumball Machine Example

Christian Huemer und Marion Scholz

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DOLLY
FRUITS
10 Cent
BUBBLE GUM

Use Case Diagram

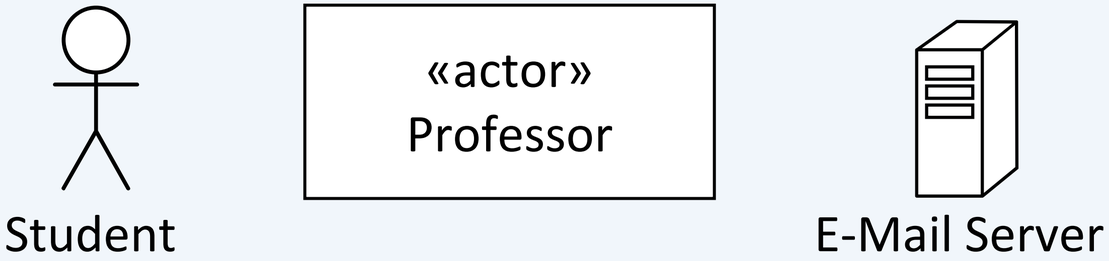
The Actor and The Use Case

Christian Huemer und Marion Scholz

Presented by Nicholas Bzowski

Actor

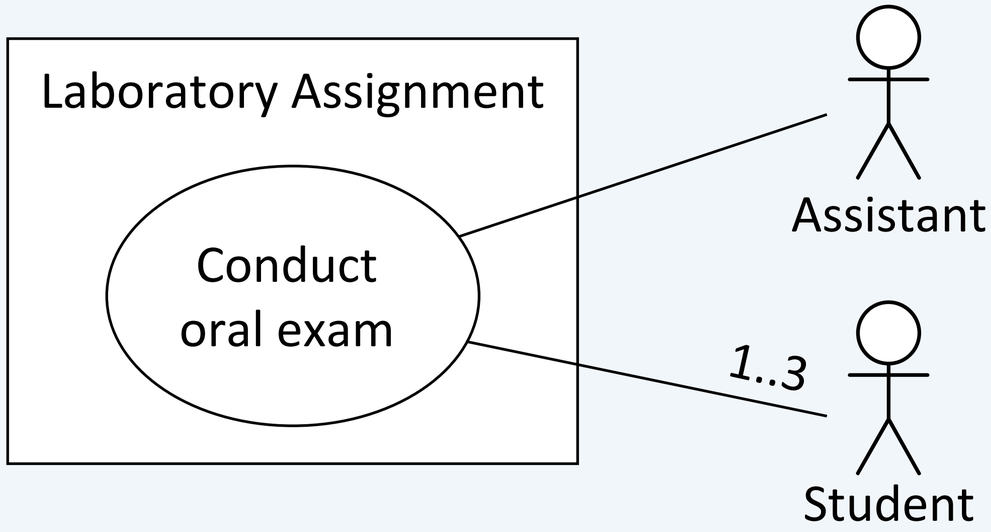
- Actors **interact** with the system…
  - by **using** the **System**,
  - by being **used by the System**
- Actor is **connected to use cases through associations,**
  i.e. he/she “communicates” with the system
- Each actor must communicate with
  at least one use case
- The association is binary and can have **multiplicities**
- Notation variants:



Actor - Characteristics

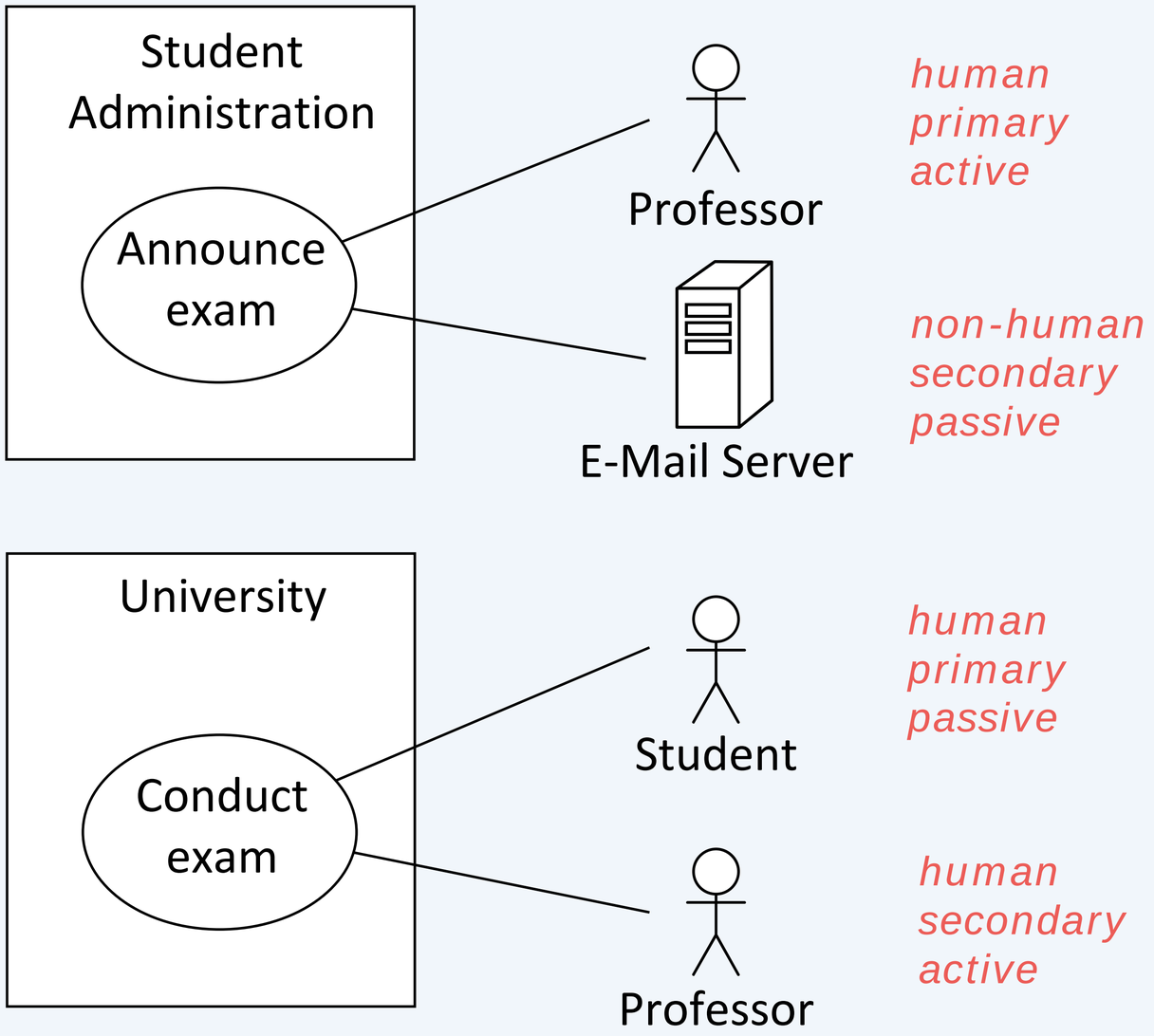
- Actors represent the **roles of the users**
  - Concrete users can play, accept and discard several roles at the same time
- Actors are **clearly outside** of the system boundaries
- User data is usually also managed within the system. These are modeled as objects or classes within the system.

- Example: **`Laboratory Assignment`**
  - Actor **`Assistant`** interacts with the system **`Laboratory Assignment`** by using it
  - The class **`Assistant`** comprises objects that contain the user data (name, social security number, ...)



Actor - Classification

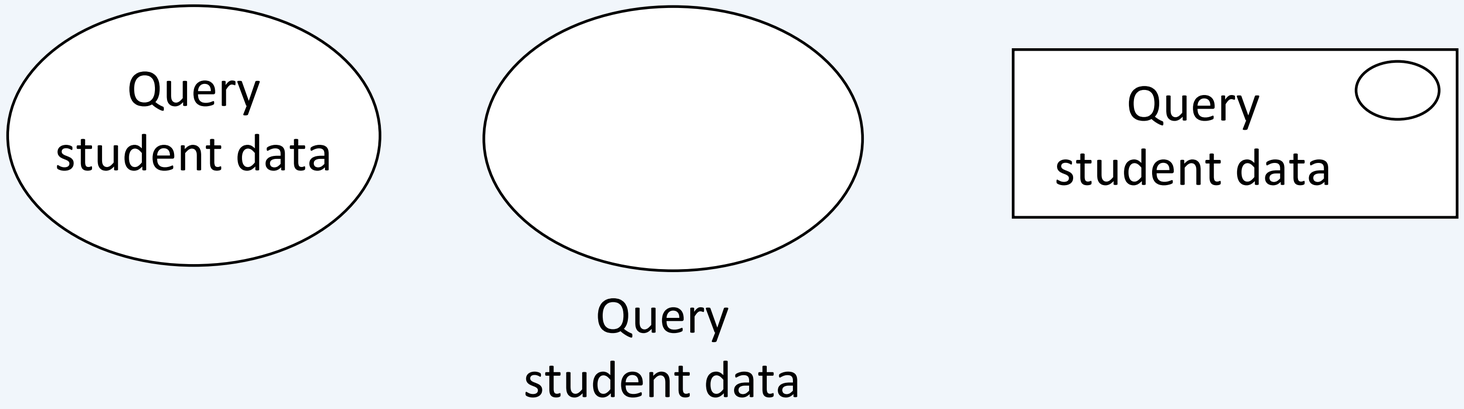
- **Human**
  - ex. **`Student`**, **`Professor`**
- **Non-human**
  - ex. **`E-Mail Server`**
- **Primary**: main beneficiary of the application
- **Secondary**: necessary for the system to function
- **Active**: initiates use cases itself
- **Passive**: does not initiate any use cases itself



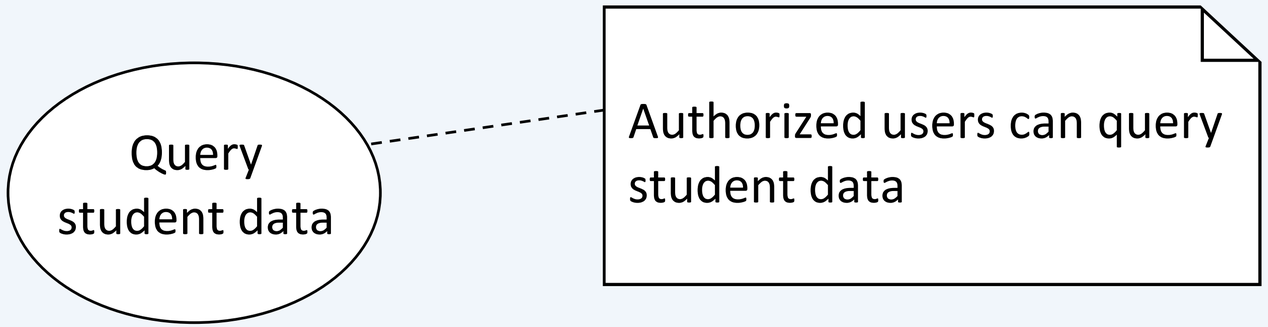
Use Case

- Use cases describe the **behavior** that is **expected** of the system to be developed

- Notation variants



- Short description as a note



Use Case Diagram

Relationships Between Use Cases

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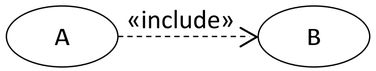
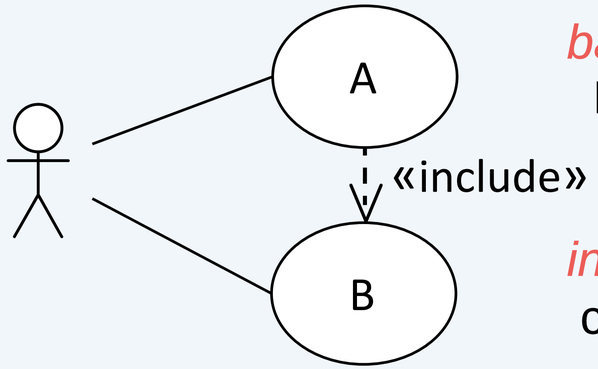
«include» - Relationship



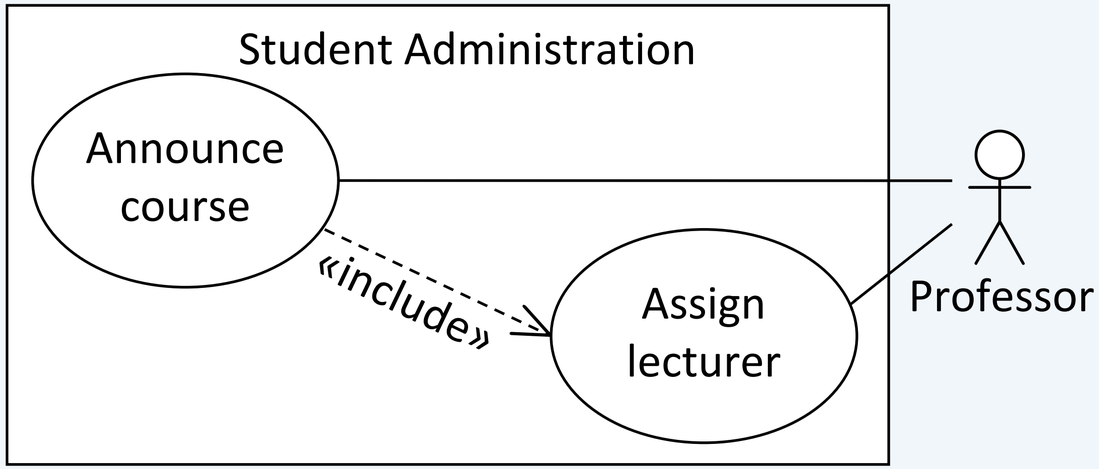
- The **behavior** of the used use case (included use case) is **integrated** into the using use case (base use case)

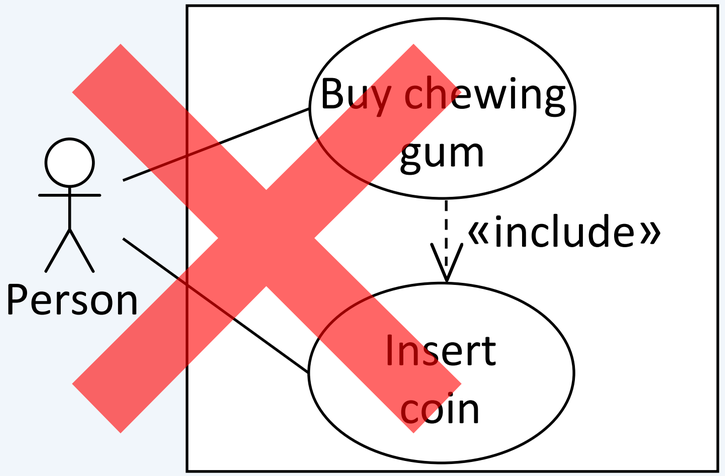


base use case
B required to ensure functionality

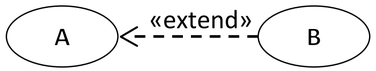
included use case
can also be executed separately

- Ex:

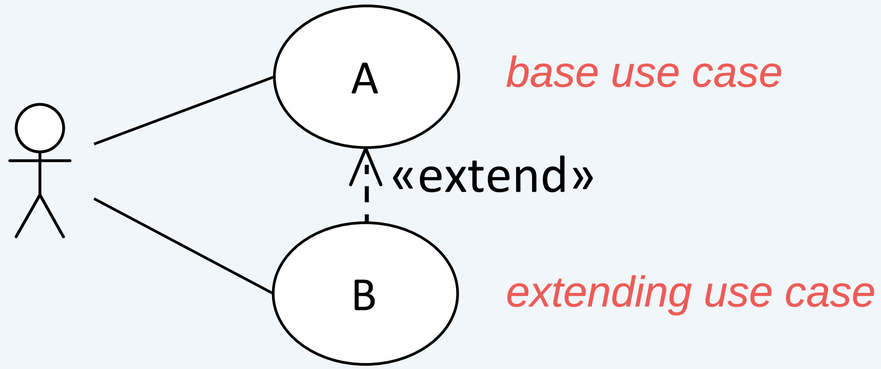




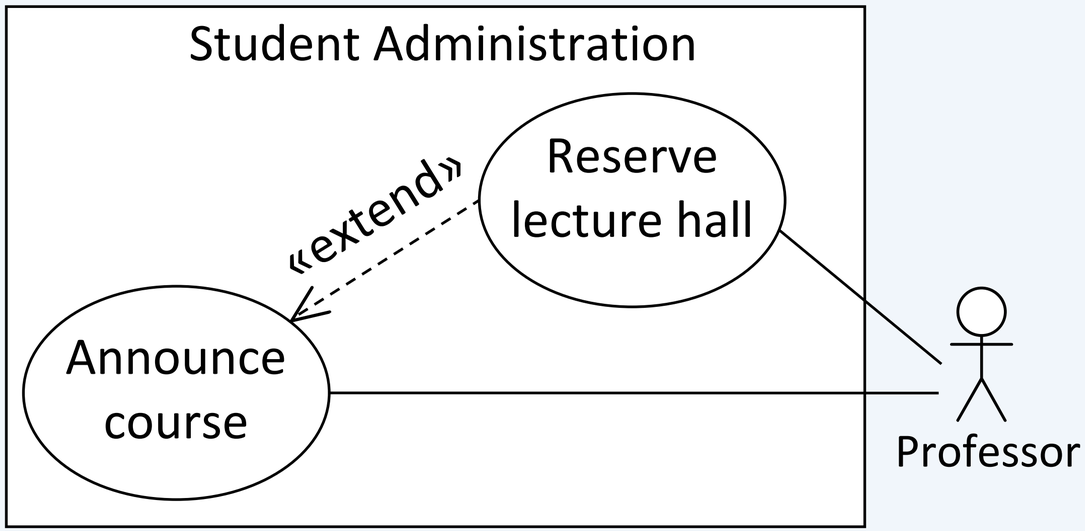
«extend» - Relationship



- The behavior of **B can be included** in **A**
  - **A** decides whether **B** is executed
- **A** and **B** can also be executed separately
- Indication of the “Where” by extension points in **A**
- Specification of the “when” by condition in **A** or as part of the **«extend»** relationship



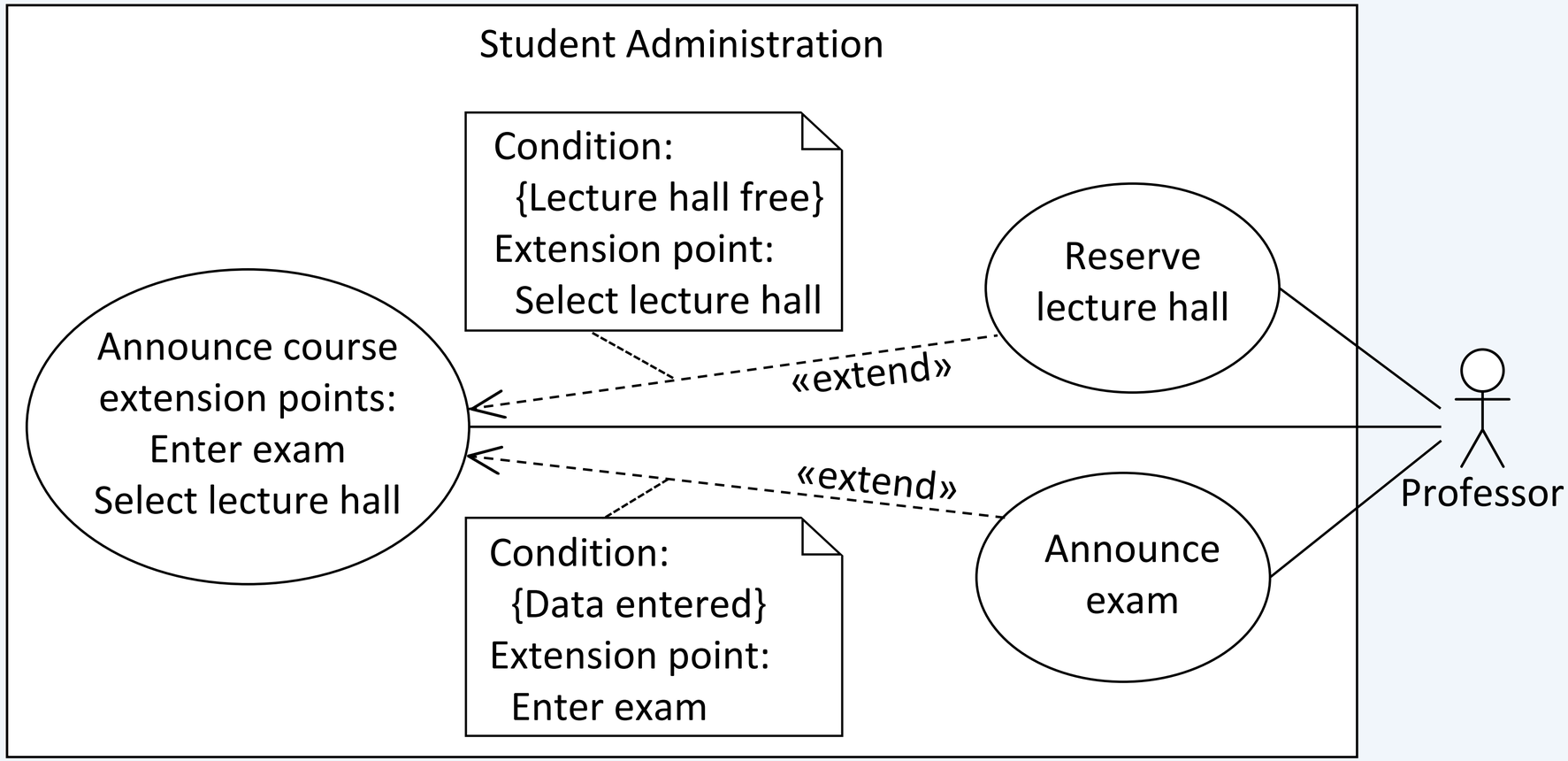
- Ex.:



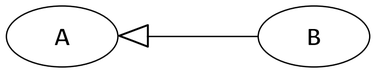
«extend» - Relationship: Extension Points

- Several extension points possible for each application
- Names of extension points must be unique

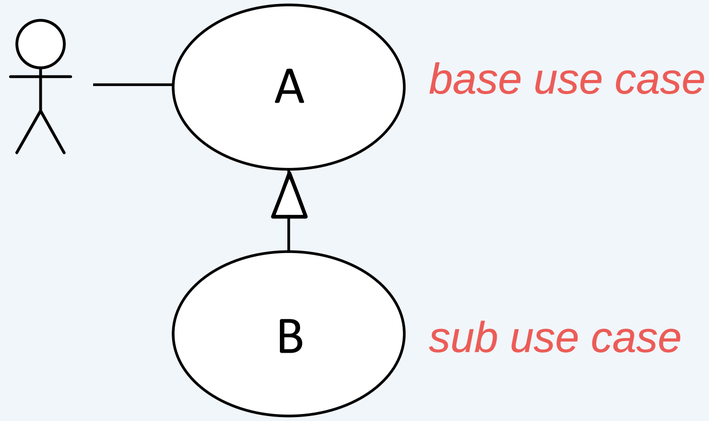
- Ex.:



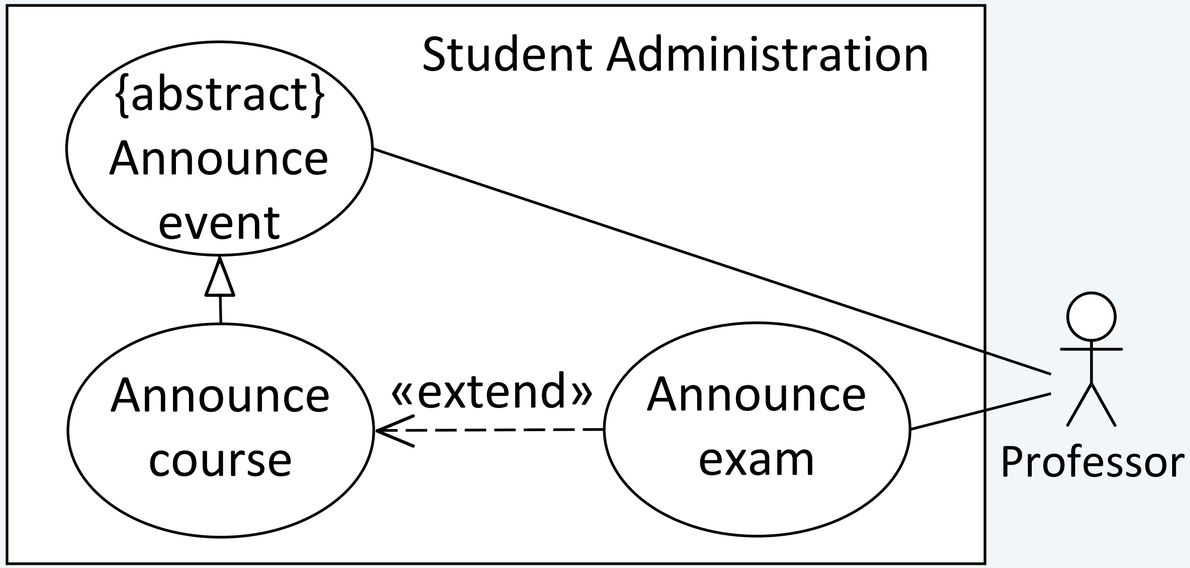
Generalization of Use Cases



- **B** inherits the behavior of **A** and can overwrite or augment it
- **B** inherits all relationships of **A**
- **B** takes over basic functionality of **A**
- **B** decides what is executed or changed by **A**



- Modeling of abstract use cases possible:
  `{abstract}`
  - abstract use cases cannot be executed!



Use Case Diagram
Relationships Between Actors

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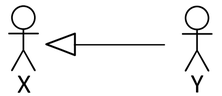
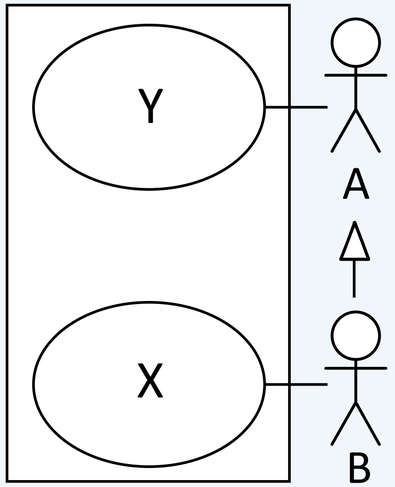
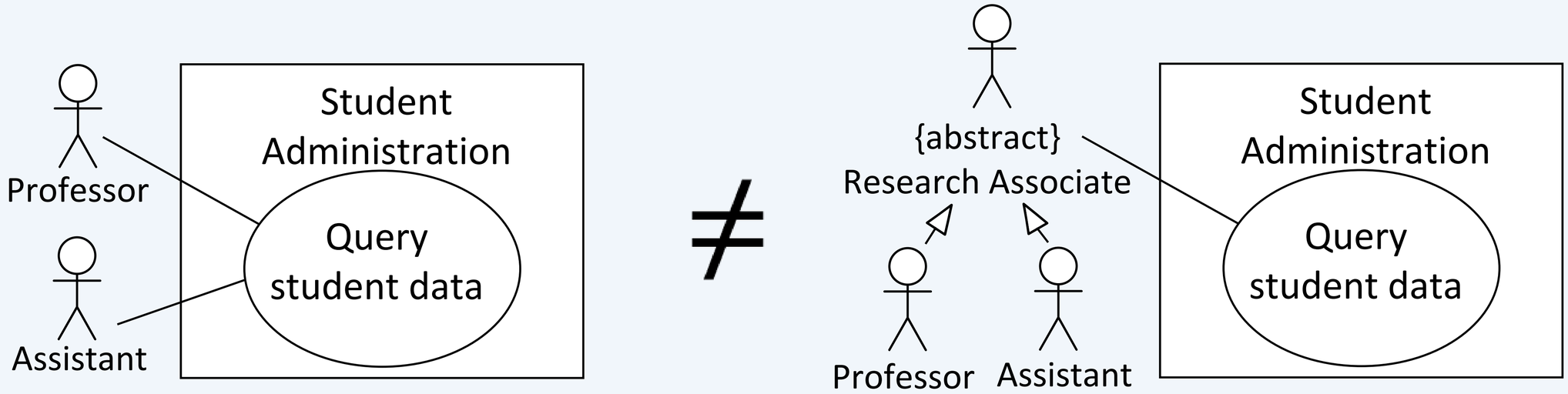
Generalization of Actors (1/2)



- Actor **B** inherits from actor **A**
- **B** can communicate with use cases **X** and **Y**
- **A** can only communicate with **Y**
- Multiple inheritance is allowed

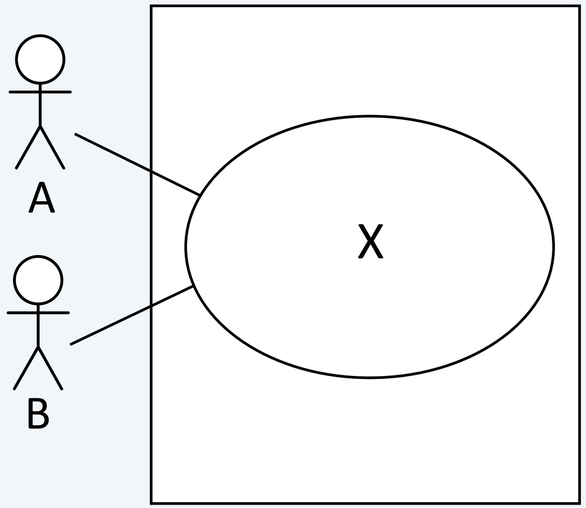


- Ex.:

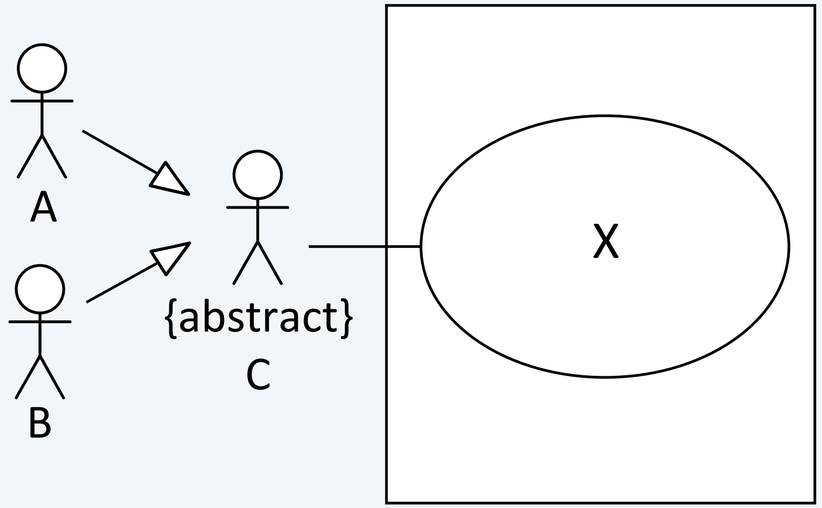


Generalization of Actors (2/2)

- Distinction as to whether several actors can or must communicate together with a use case.



A and B communicate with **X**



A or B communicate with **X**

Use Case Diagram
Examples

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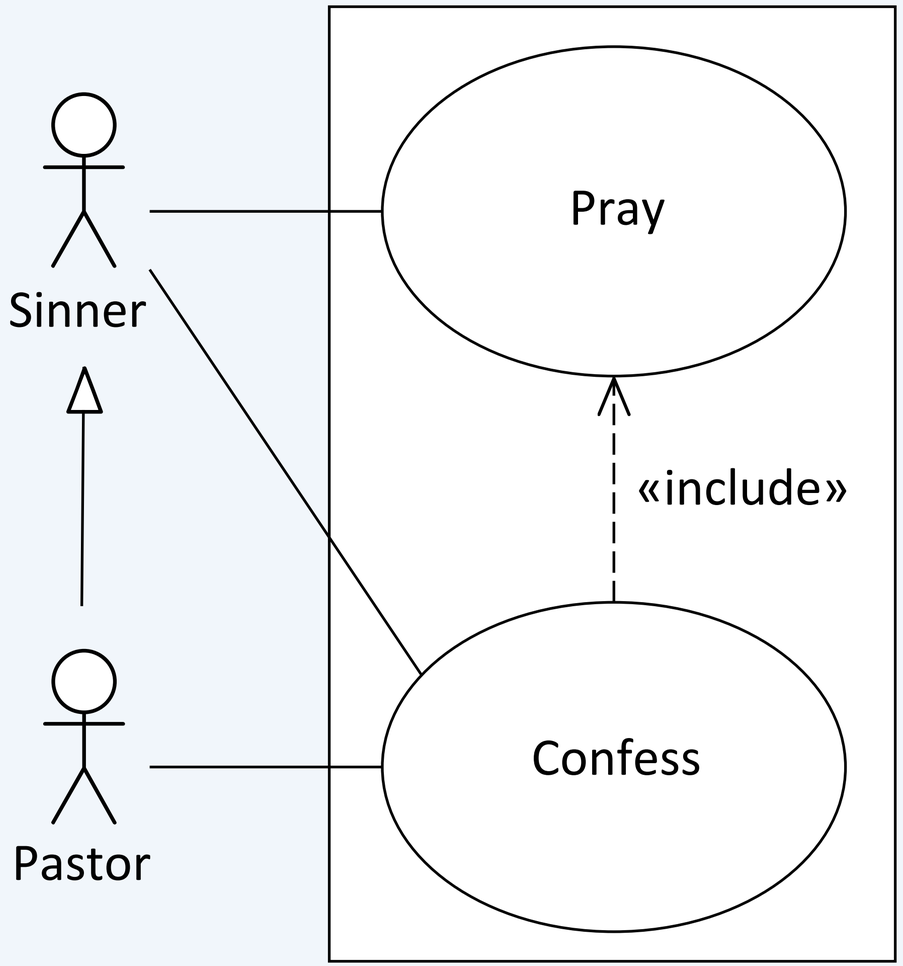
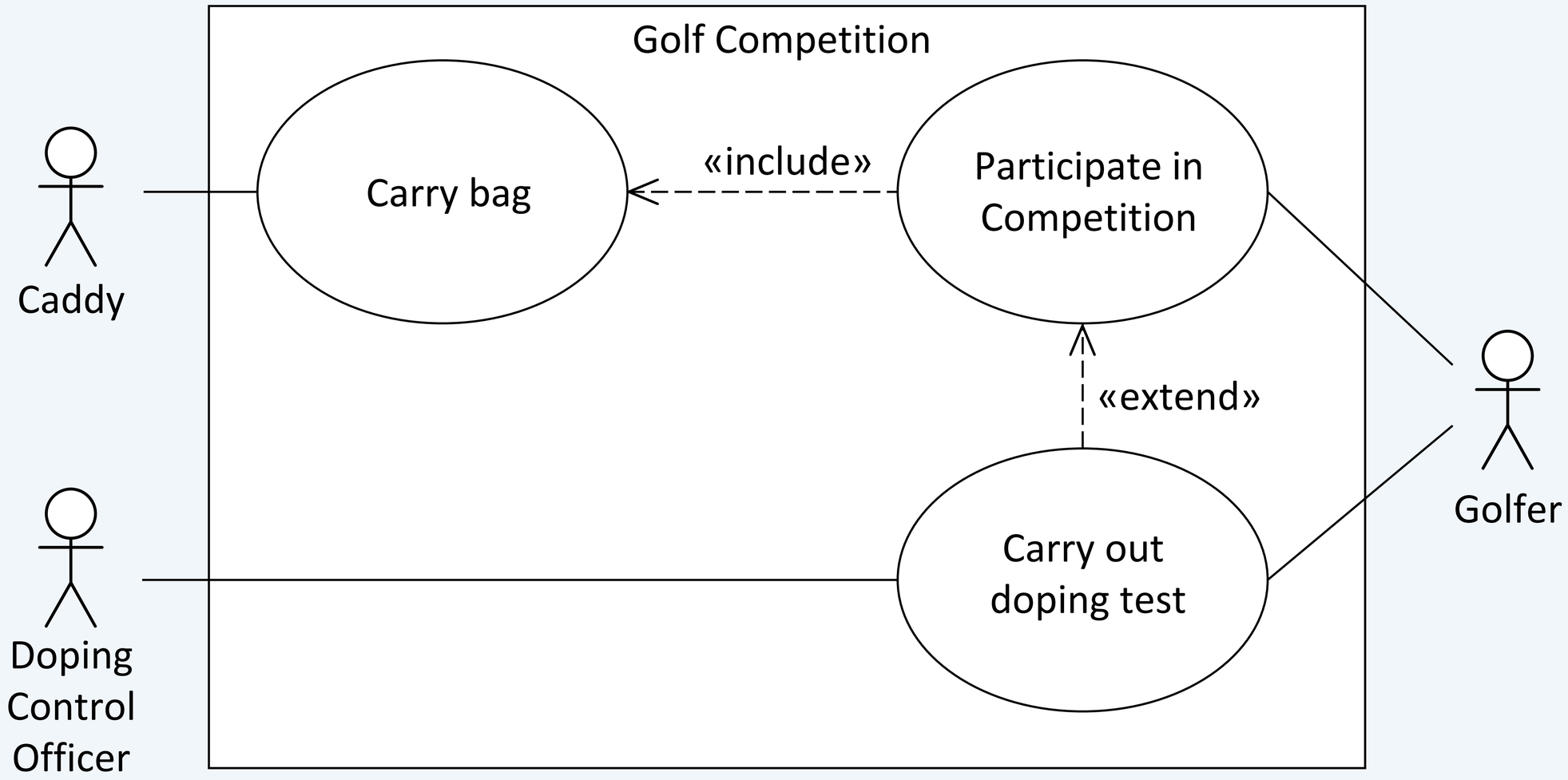
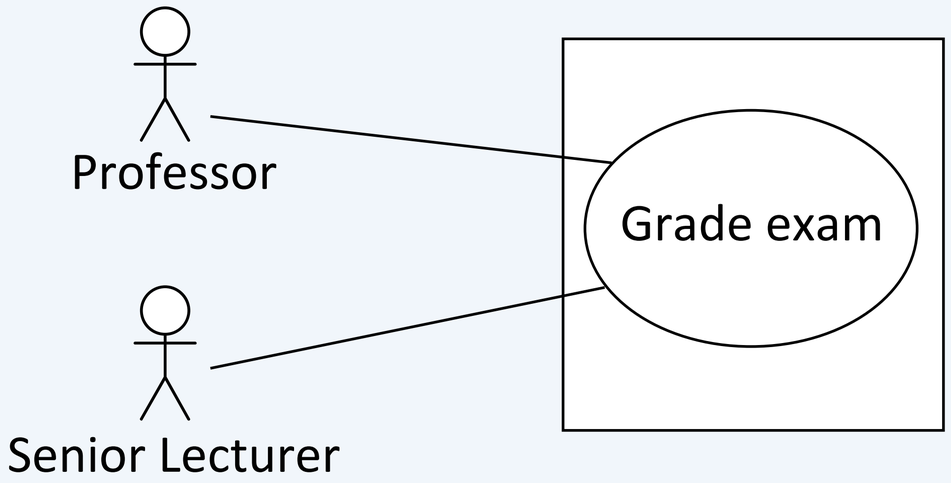
Example: Confession

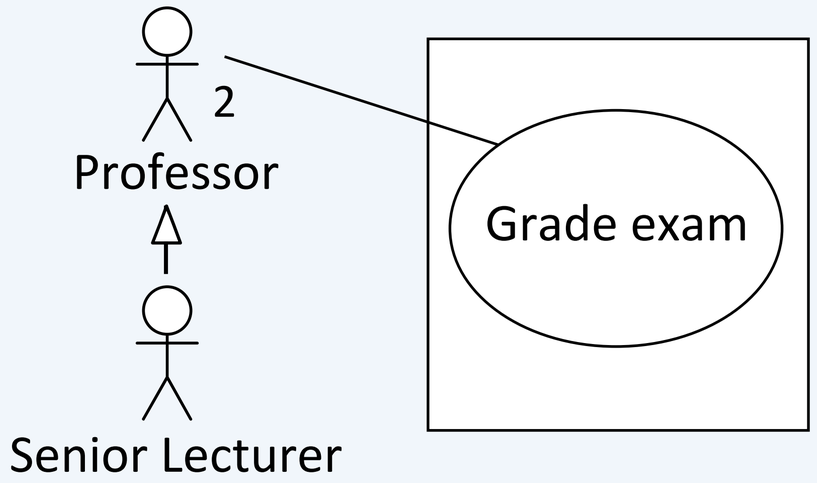


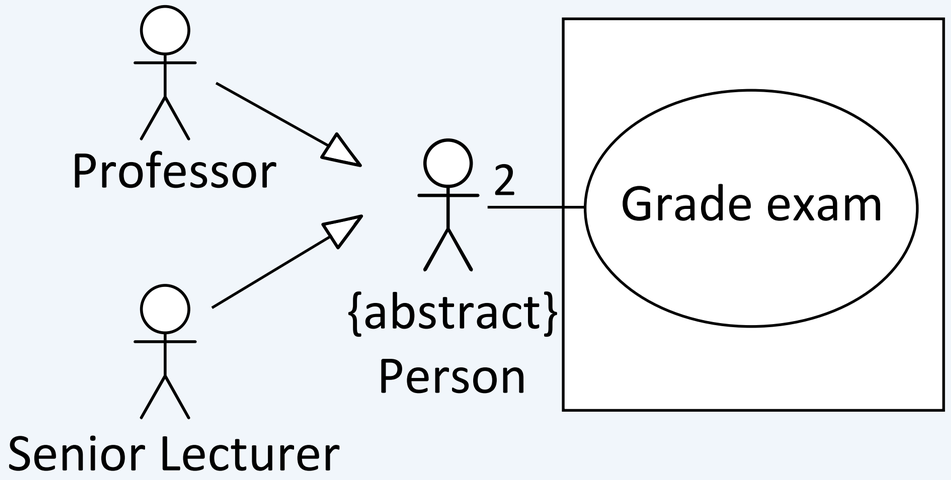
Example: Participating in a golf competition

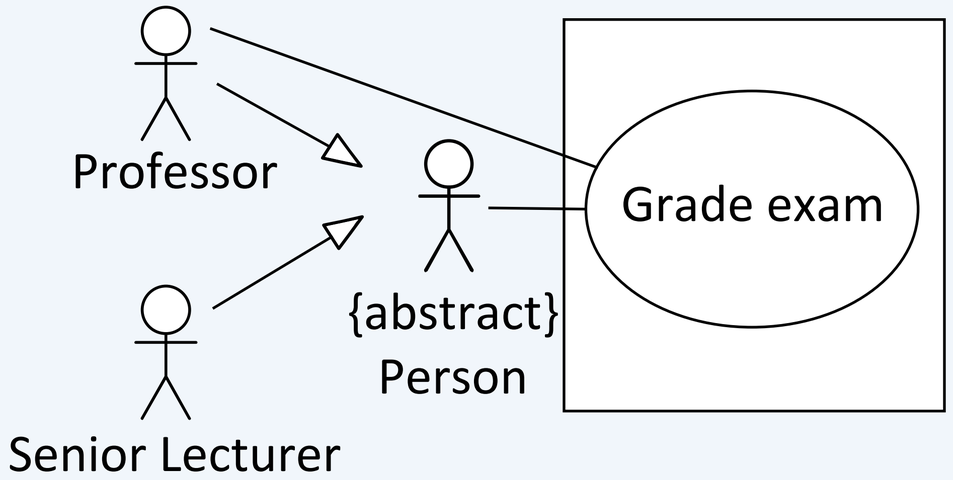


Example: Different types of exam grading









Use Case Diagram

Use Case Modeling in Practice

Christian Huemer und Marion Scholz

Presented by Nicholas Bzowski

Identification of Actors

- Who **uses** the main use cases?
- Who needs the system to support their **day-to-day work**?
- Who is responsible for **system administration**?
- Which external **devices / (software) systems** must the system be able to communicate with?
- Who or what is interested in the **results** of the system?

Identification of Use Cases

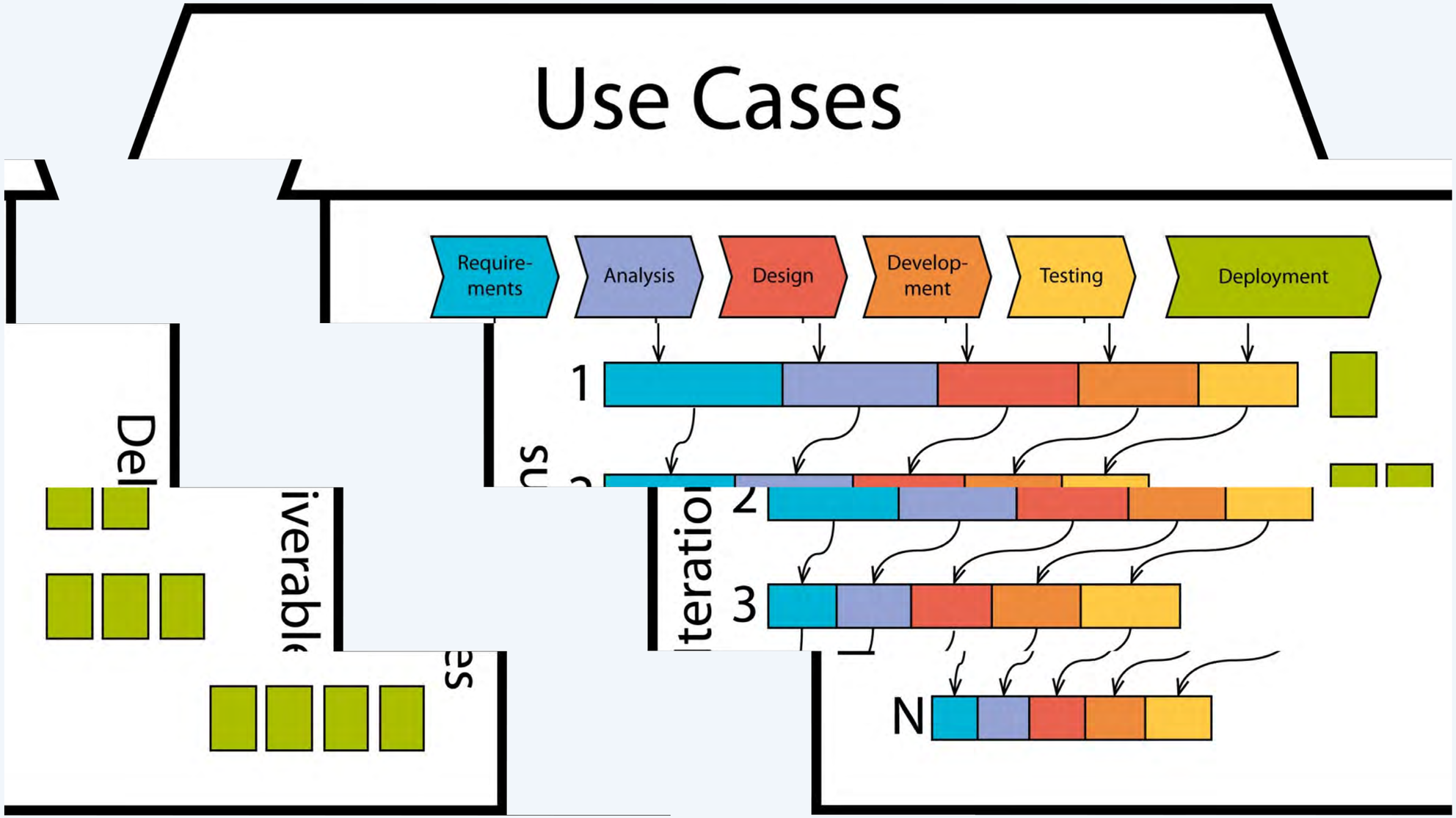
- After identifying the actors
- Search for triggers for use cases
  - Trigger = events that must occur to cause the system to produce a result.
  - The system is often called by the actor, who thus becomes the actor of the use case.
  - The following triggers are distinguished:
    - Internal
    - External
    - Temporal

Use Case Description

- Name
- Short description
- Precondition: Prerequisite for successful execution
- Postcondition: System status after successful execution
- Error situations: errors relevant to the problem area
- System state in the event of an error
- Actors who communicate with the use case
- Trigger: triggering events for the use case
- Standard process: individual steps
- Alternative processes: Deviations from the standard process

Rules for Use Case Modeling

- The most important functional requirements must be defined in the use cases.
- A use case....
  - describes a transaction for the client to pay.
  - describes a typical case of using one system and no more.
  - is like a play. The use case description contains the choreography.
  - has an introduction, a body and a conclusion.
  - should be described as simply as possible.
  - must be defined precisely.
  - is fully described when customers, users and software developers accept it.
  - provides the basis for a system test.
  - should be described on a maximum of two pages.


Use Cases
Require-
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Analysis
Design
Develop-
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Testing
Deployment
1
2
3
N

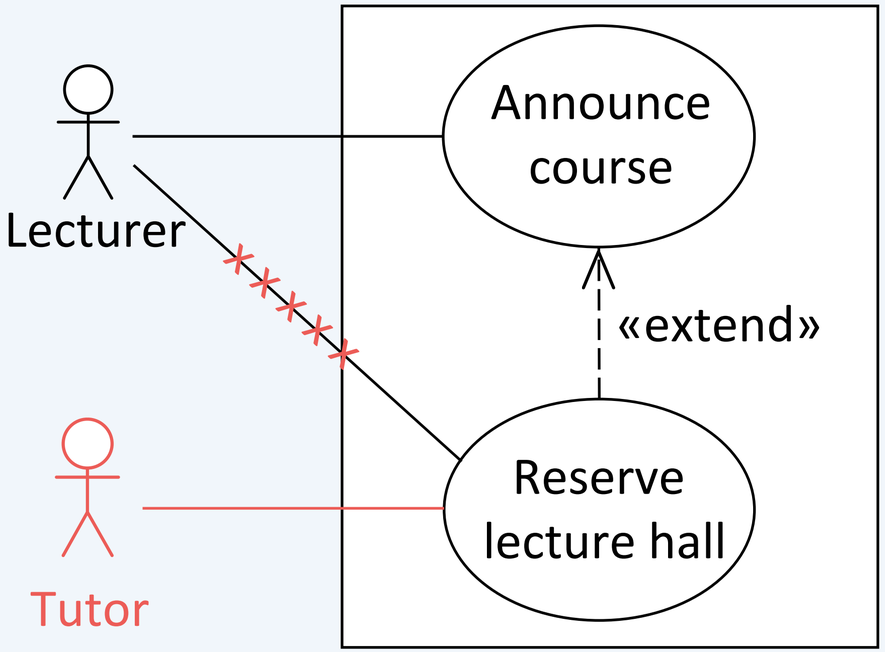
Use Case Diagram
Common Modeling Errors

Christian Huemer und Marion Scholz

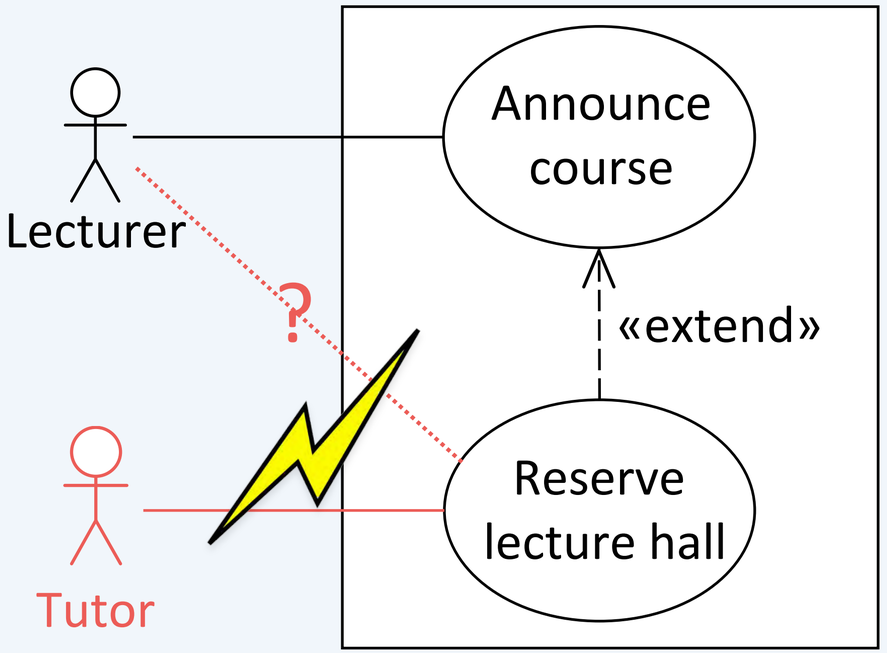
Presented by Nicholas Bzowski

«extend»

UML Standard..



..in practice often:



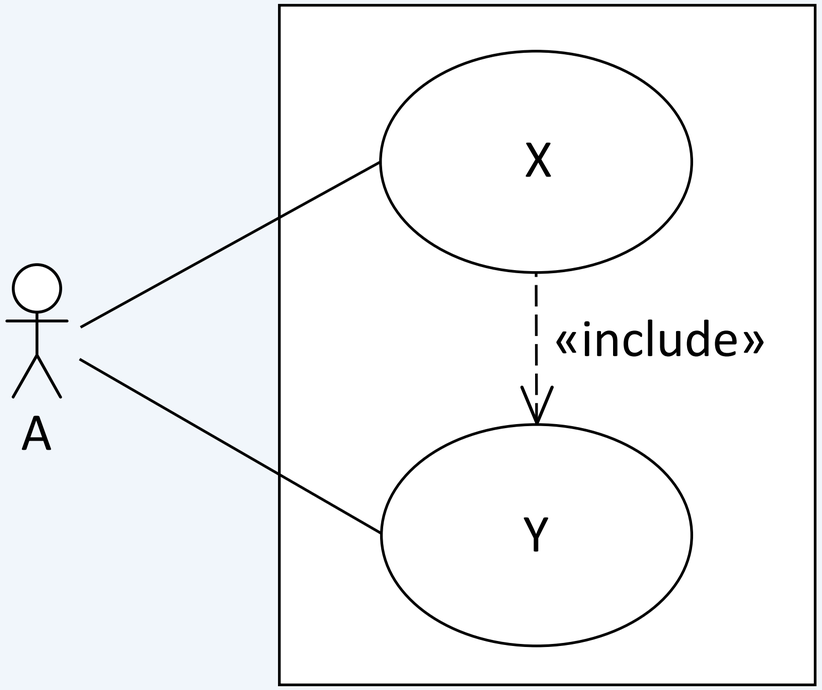
unclear who reserves the lecture hall!

How to show that someone else (alone) reserves the lecture hall?

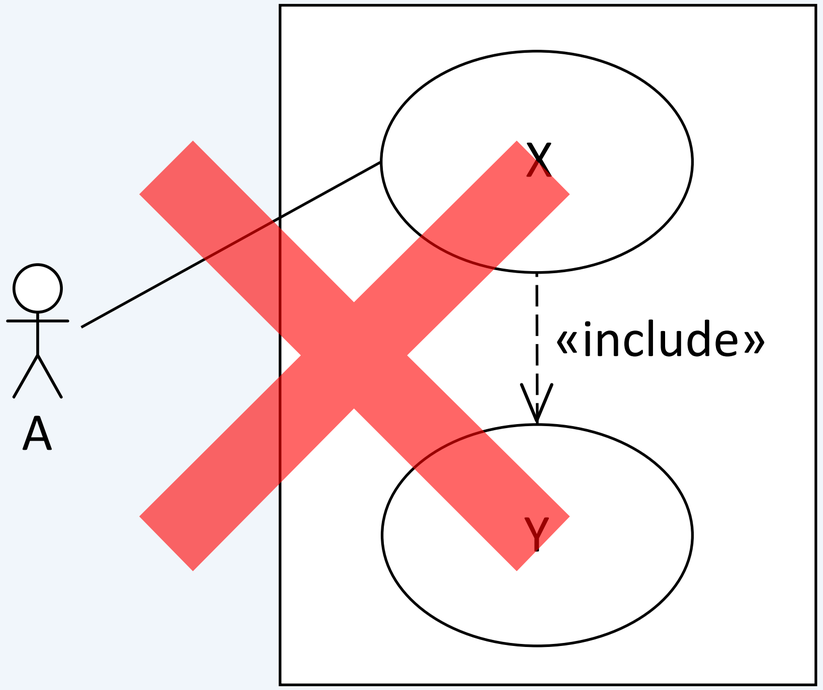
«include»

- similar to **«extend»**

UML Standard..

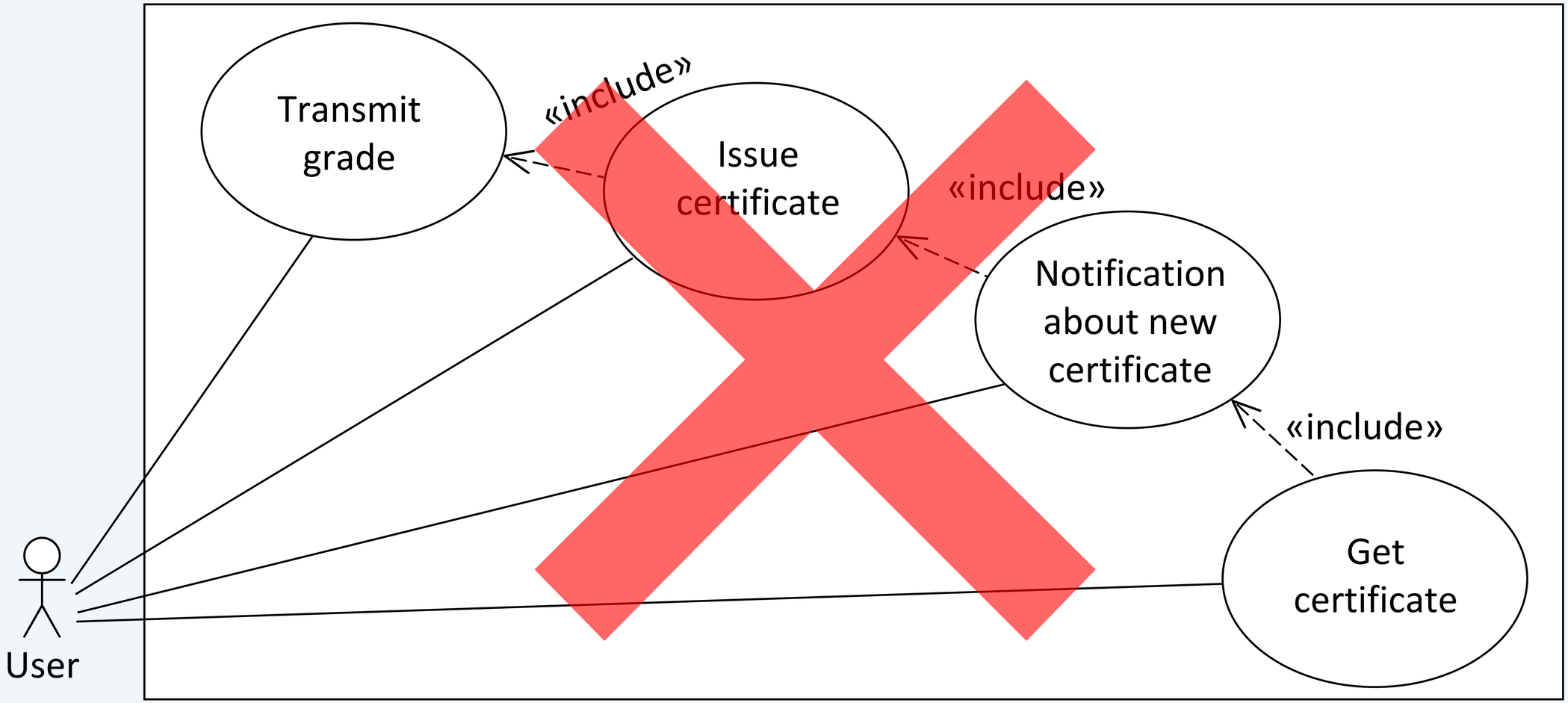


..in practice often:



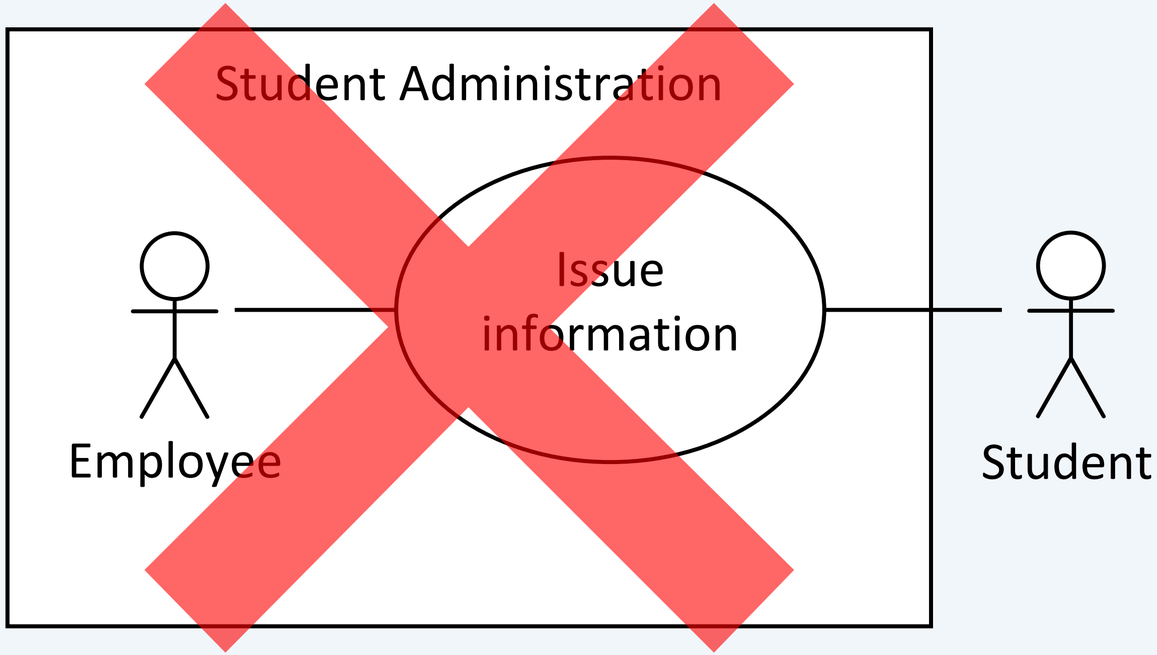
Processes

- Use case diagrams **do not model processes**!



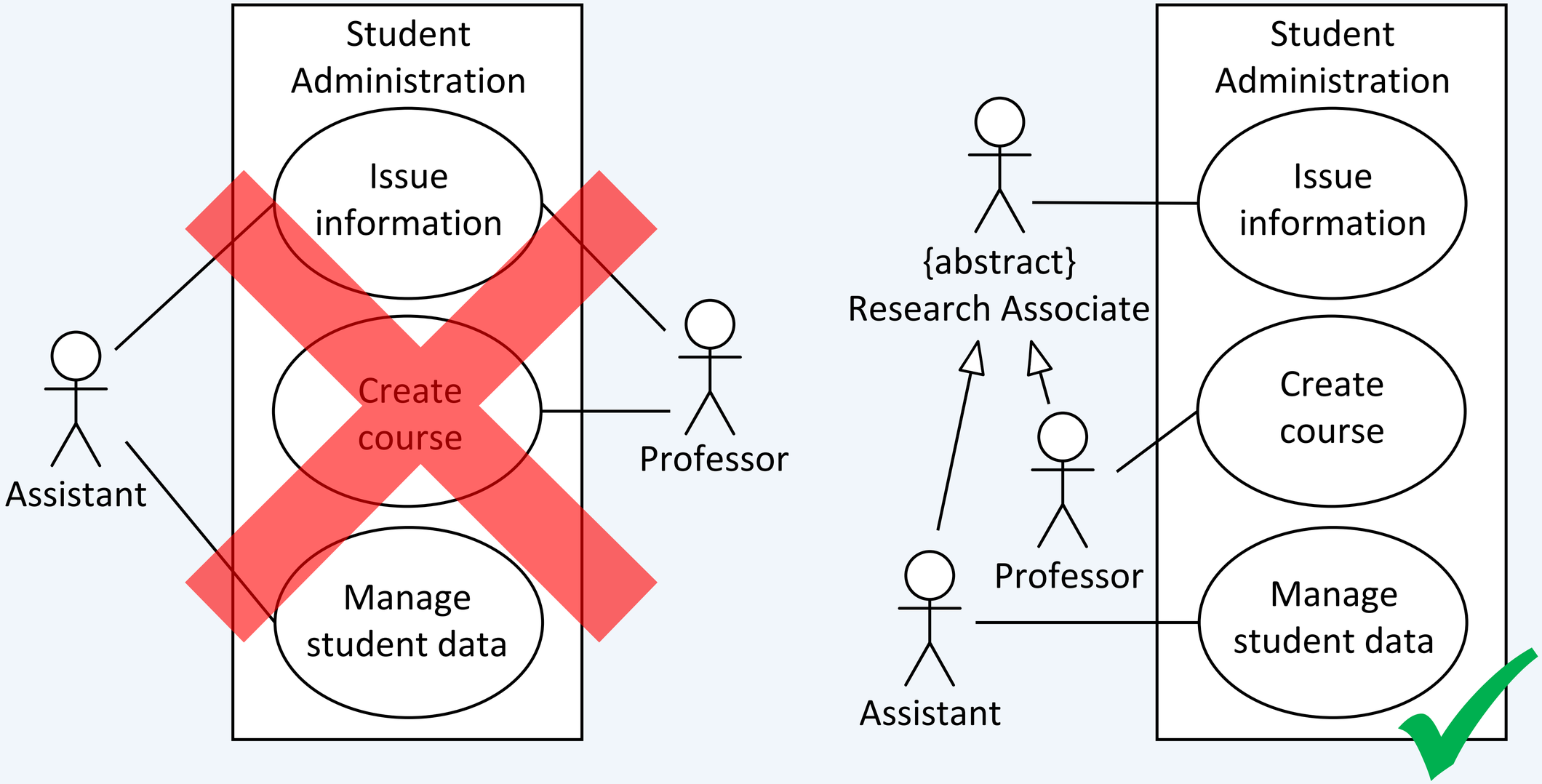
System Boundaries

- Actors are always outside the system boundaries!



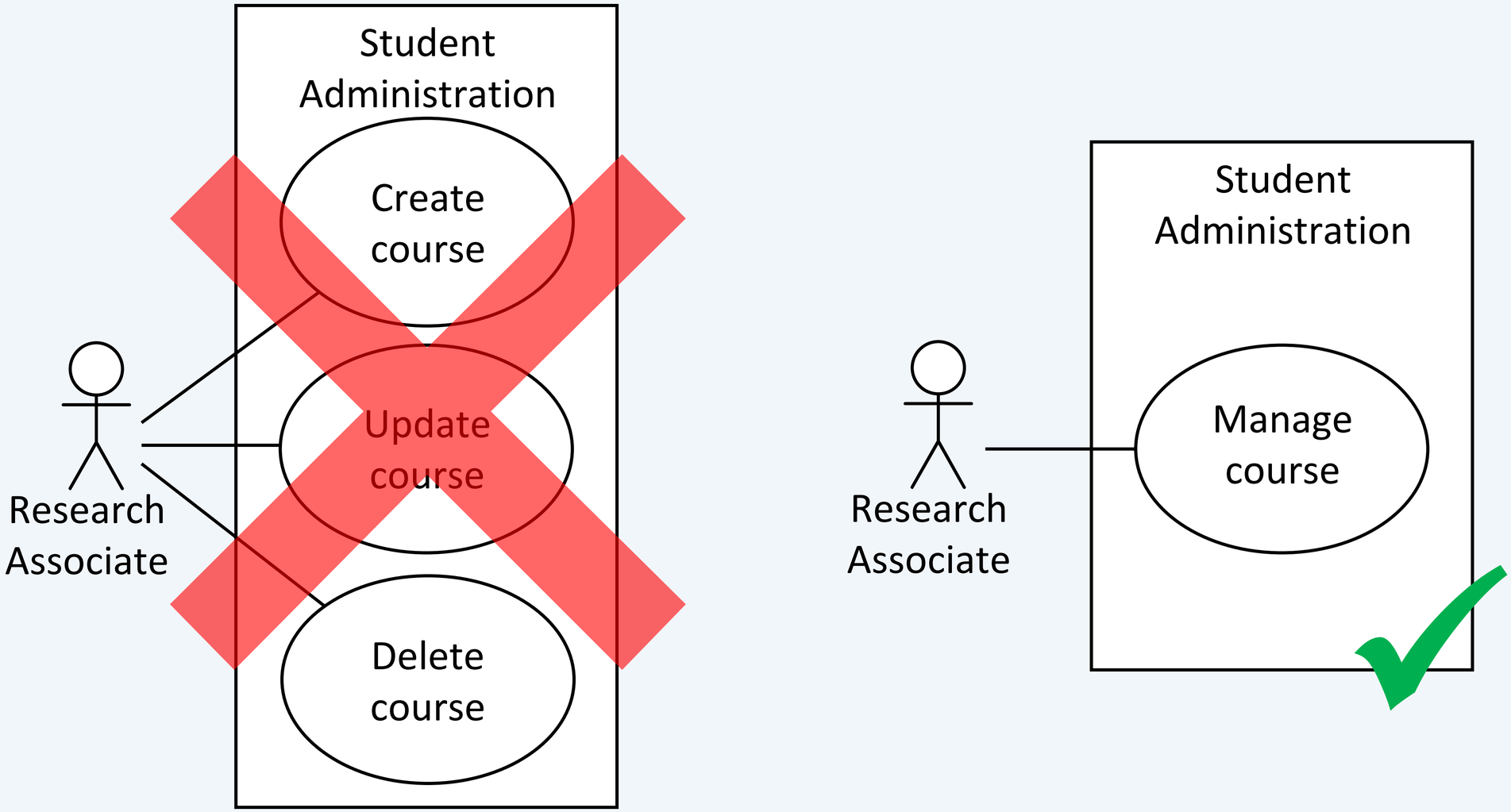
“and” or ”either or”

- Either **`Assistant`** or **`Professor`** are involved in **`Issue information`**



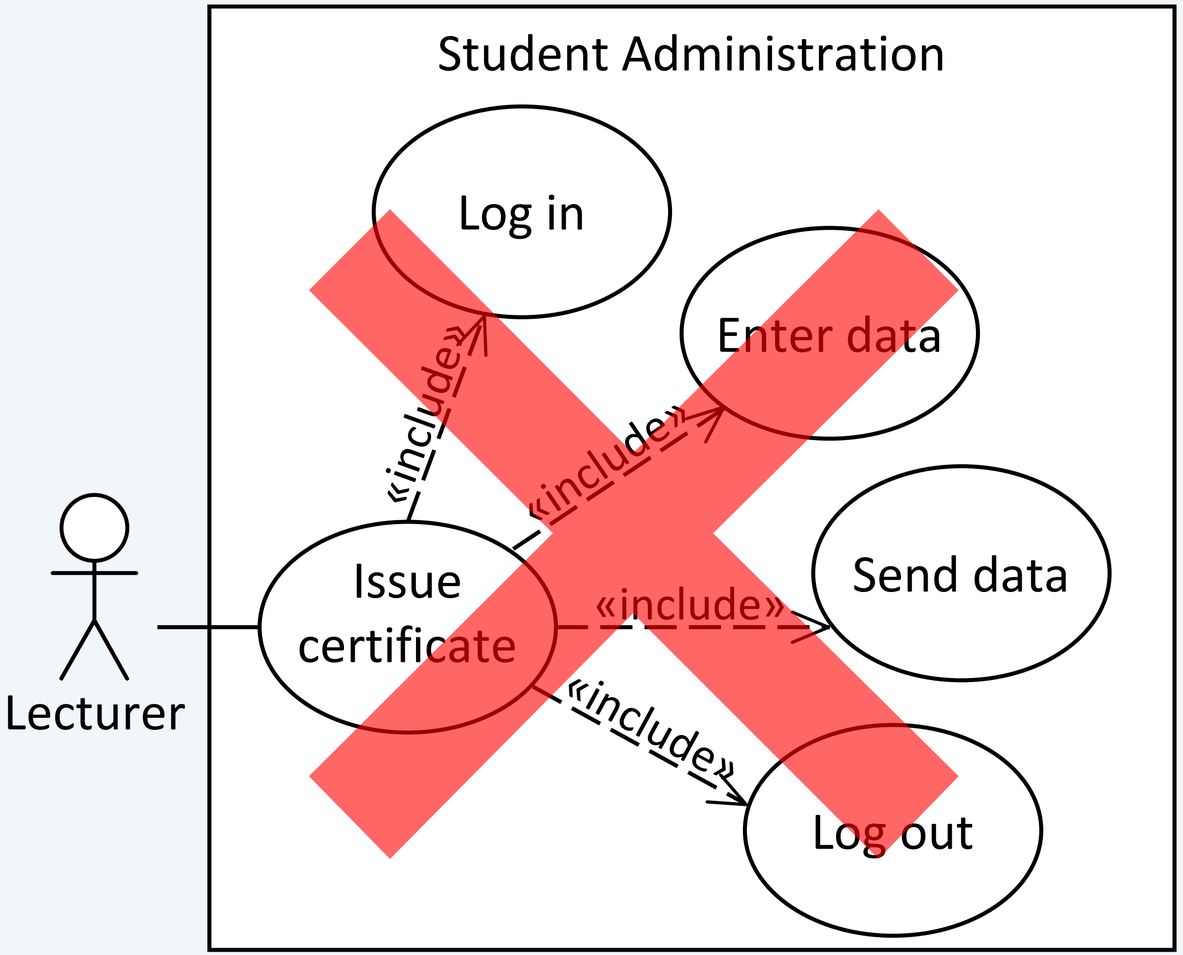
Level of Granularity

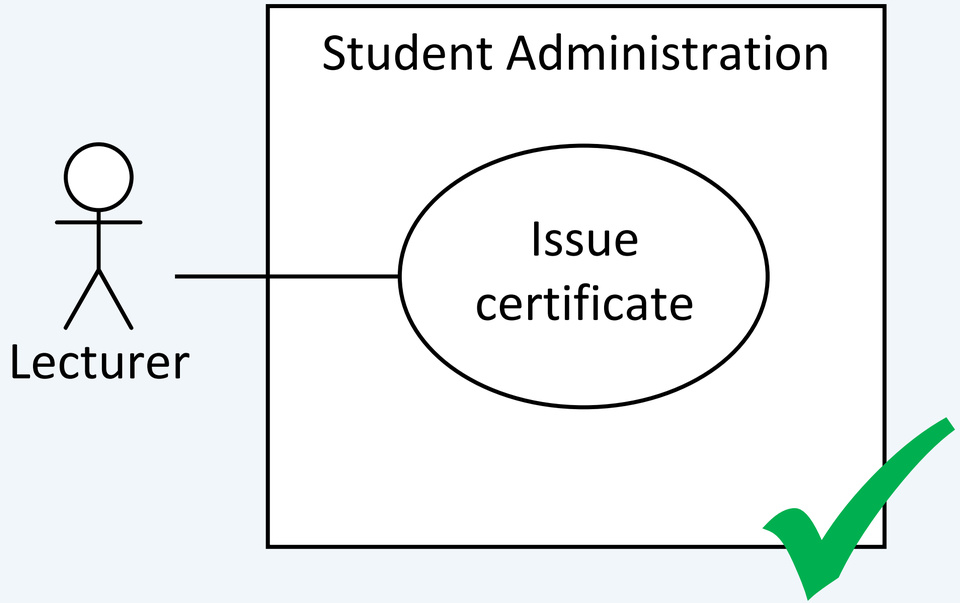
- Many small use cases are combined into one use case that contains the different possibilities



Functional Decomposition

- The individual steps are always executed together in a predefined sequence, so this is only a **single** use case ⇒ no functional decomposition





Use Case Diagram
Student Administration Example

Christian Huemer und Marion Scholz

Presented by Nicholas Bzowski

Example: Student Administration

- **Objective:** simplified representation of the “ student administration” system of a university

Verbal Description

- Many important administrative activities at a university are handled by the Student Administration Office. Students can enrol and register here, as well as withdraw from the study program.
- Students receive certificates here. Employees print out the certificates. Lecturers send certificate-relevant data to the Student Administration Office. Students are then automatically informed by the notification system.
- A distinction is made between 2 types of employees: a) those who deal exclusively with the administration of student data (**`service employee`**) and b) those who perform all other tasks (**`administration employee`**), but both groups provide information.
- **`administration employee`** issue certificates as soon as students collect them. They also create courses. When a course is created, a lecture hall can be reserved at the same time.

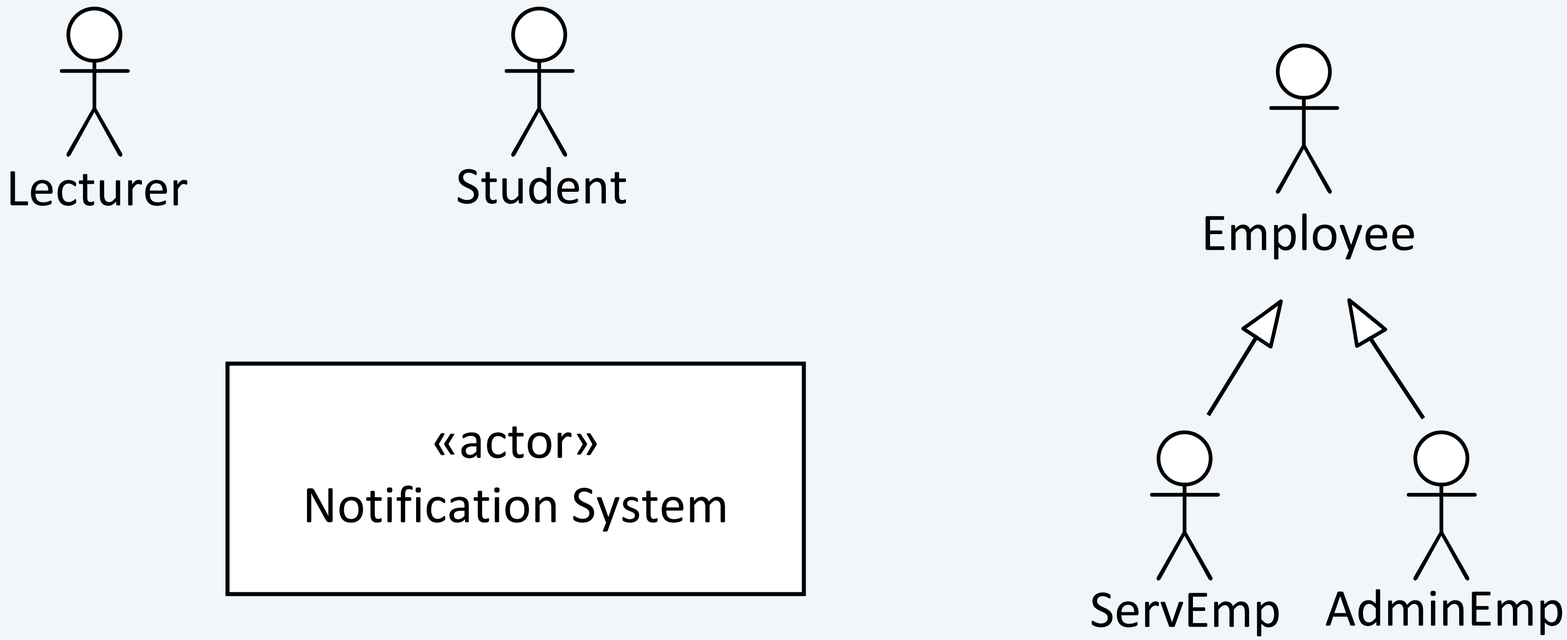
Example: Actors (1/2)

Who are the users?

- Many important administrative activities at a university are handled by the Student Administration Office. **Students** can enrol and register here, as well as withdraw from the study program.
- Students receive certificates here. Employees print out the certificates. **Lecturers** send certificate-relevant data to the Student Administration Office. Students are then automatically informed by the **notification system**.
- A distinction is made between 2 types of **employees**: a) those who deal exclusively with the administration of student data (**`service employee`**) and b) those who perform all other tasks (**`administration employee`**), but both groups provide information.
- **`administration employee`** issue certificates as soon as students collect them. They also create courses. When a course is created, a lecture hall can be reserved at the same time.

Example: Actors (2/2)

- Who are the users?



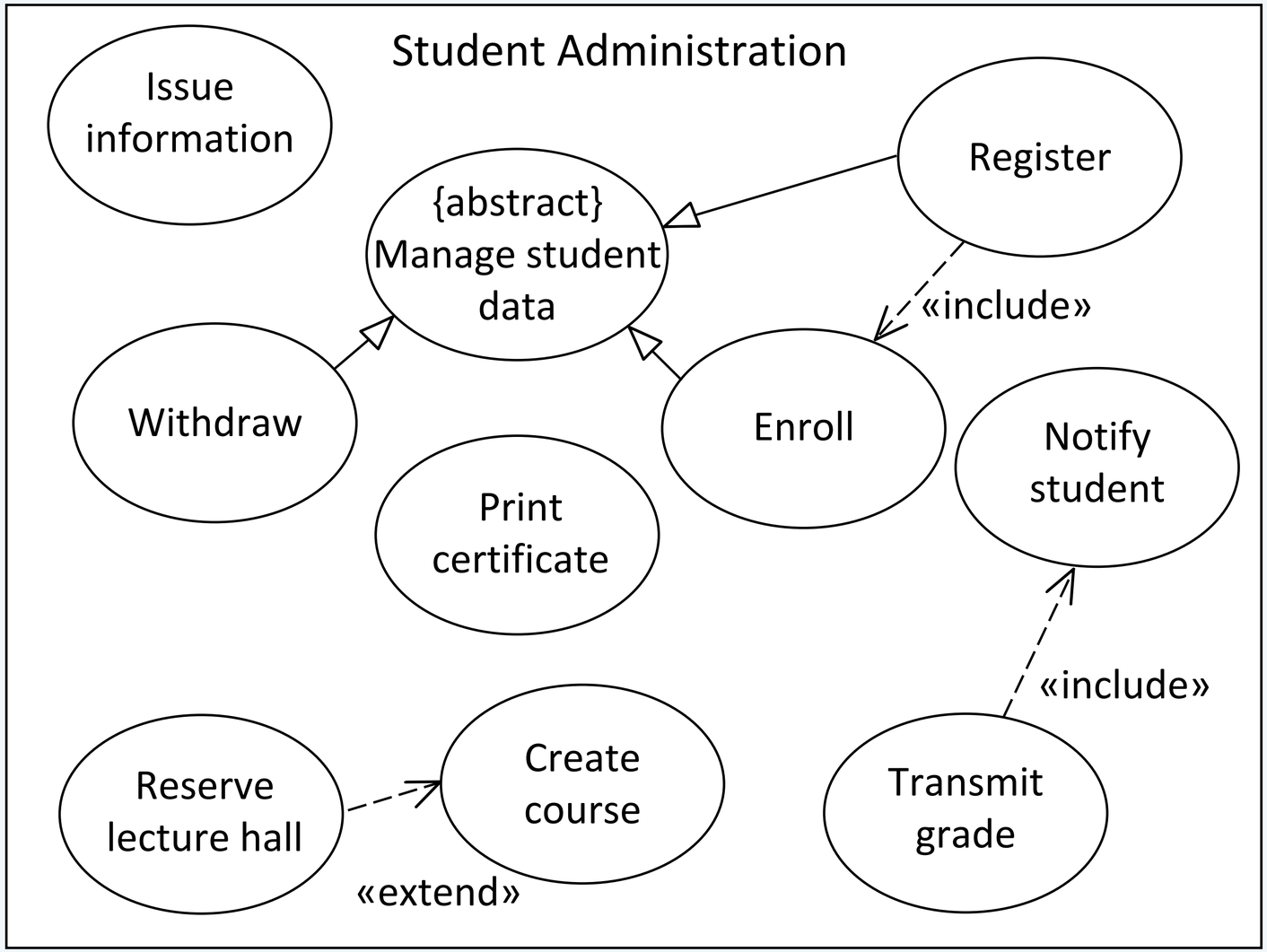
Example: Use Cases (1/2)

What services does the student administration office offer?

- Many important administrative activities at a university are handled by the Student Administration Office. Students can **enrol** and **register** here, as well as **withdraw** from the study program.
- Students receive certificates here. Employees **print out the certificates**. Lecturers **send certificate-relevant data** to the Student Administration Office. **Students** are then automatically **informed** by the notification system.
- A distinction is made between 2 types of employees: a) those who deal exclusively with the administration of student data (**`service employee`**) and b) those who perform all other tasks (**`administration employee`**), but both groups **provide information**.
- **`administration employee`** issue certificates as soon as students collect them. They also create courses. When a **course is created**, a **lecture hall can be reserved** at the same time.

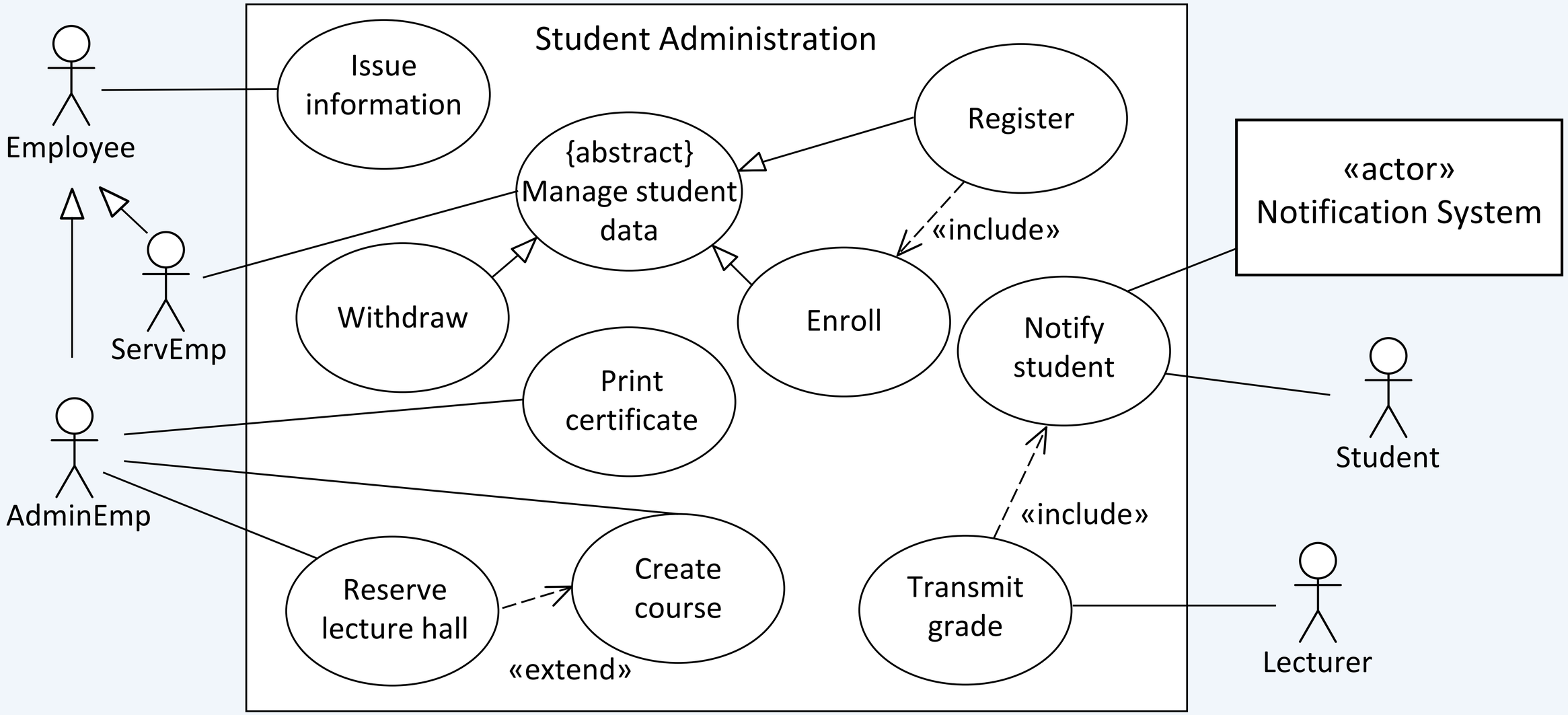
Example: Use Cases (2/2)

- What services does the student administration office offer?



Example: Associations

- Which actors use which use cases?



Example: Description (1/2)

- **Name:** Print certificate
- **Short description:** At the request of a student, an **`AdminEmp`** prints the certificate on paper.
- **Precondition:** Student has already been graded and all relevant data has already been submitted.
- **Postcondition:** Certificate is in printed form for the student
- **Error situations:** The printer does not work
- **System state in the event of an error:** Certificate was not printed
- **Actors who communicate with the use case**: **`AdminEmp`**
- **Trigger:** Student would like a printed certificate

Example: Description (2/2)

- **Standard process:**

  (1) Student goes to the study department and asks for a printed certificate.

  (2) **`AdminEmp`** enters the student number.

  (3) **`AdminEmp`** selects the certificate.

  (4) **`AdminEmp`** selects “print”.

  (5) System confirms that the certificate has been printed

  (6) Certificate is handed over to the student.

- **Alternative processes:**

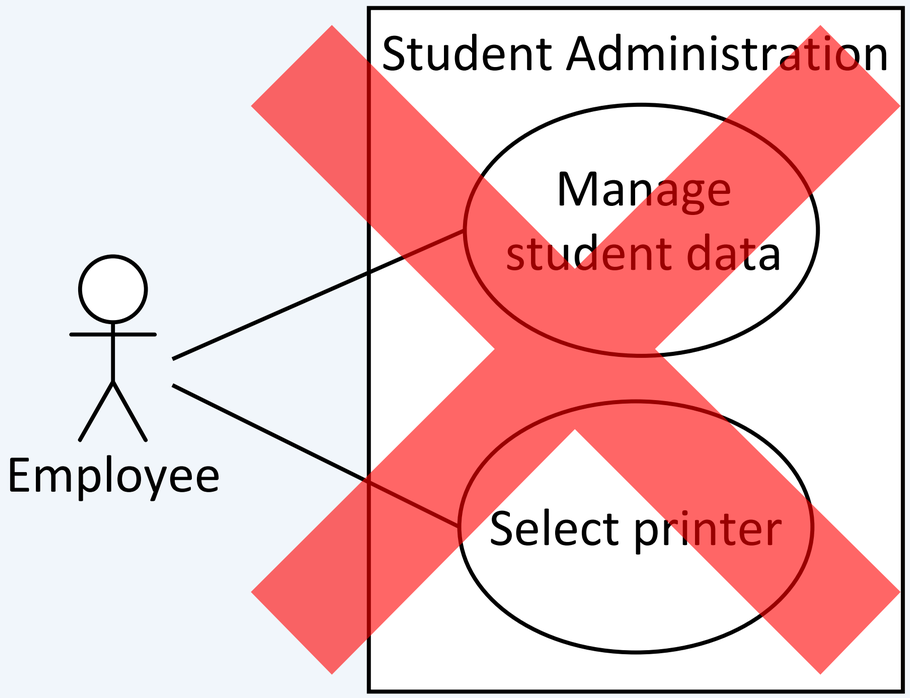
  (1') Student requests the printed certificate via email.

  (2-5) same as above

  (6') Certificate is sent by post

Example: Modeling Tips (1/2)

- The use cases should be at the same level of abstraction.



Example: Modeling Tips (2/2)

- Only use cases and actors that are relevant should be included.
- Of course, there are other people who have something to do with the student administration office, but they are negligible in this context of modeling.

- Ex.: