
LUT
University

Software Engineering Models and Modeling

From Requirements to Models

Antti Knutas

Overview of the Process

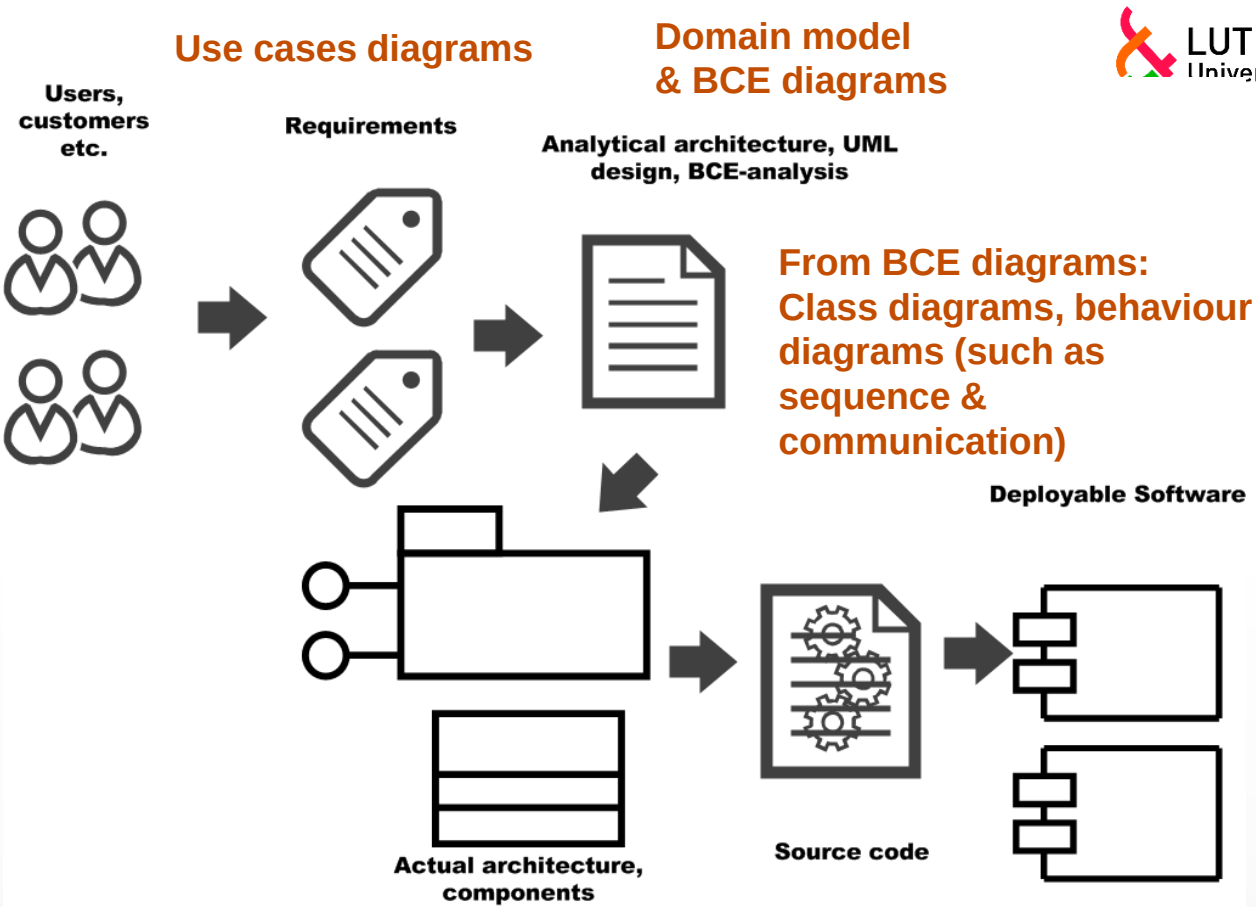
How to get from requirements, such as FURPS & user stories into models?

- We start converting user stories (use cases) into use case diagrams
- From use case diagrams, we create BCE models through robustness analysis
- From the analysis classes (boundaries, controllers, entities) we can describe technological objects
- At the same time we can first create a rudimentary domain model and then more in-depth class diagrams as required

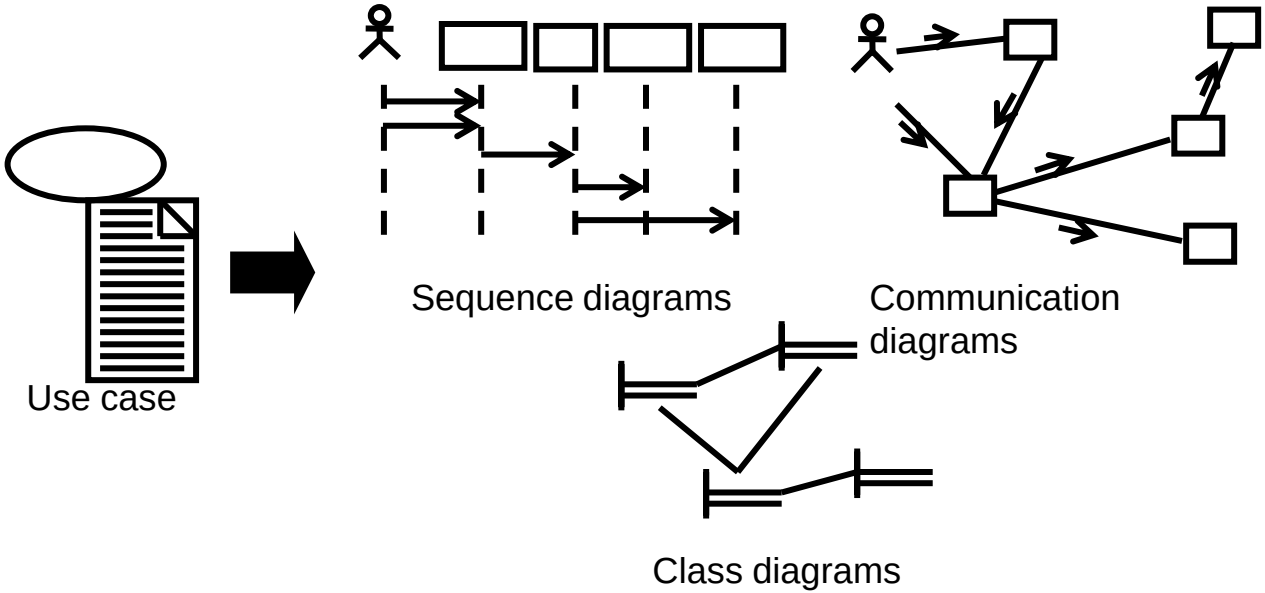
Use cases => use case diagrams => BCE model =>

Domain & class model gets built at the same time

Context & process



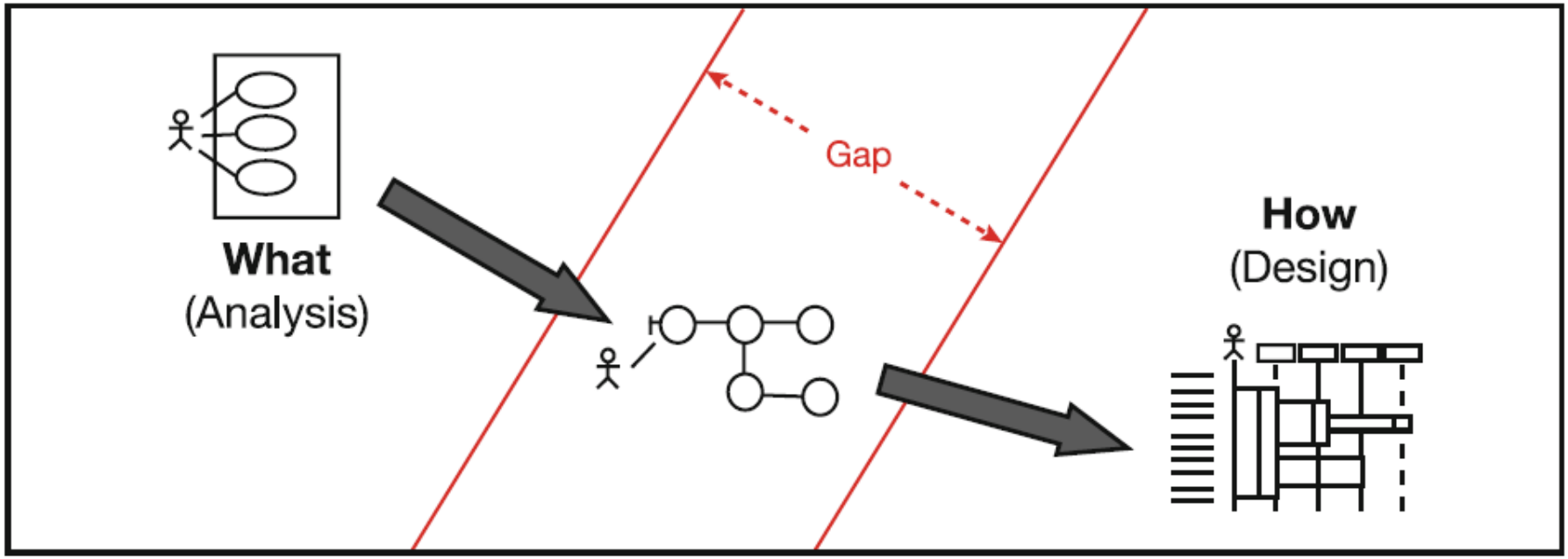
Realizing use cases (process)



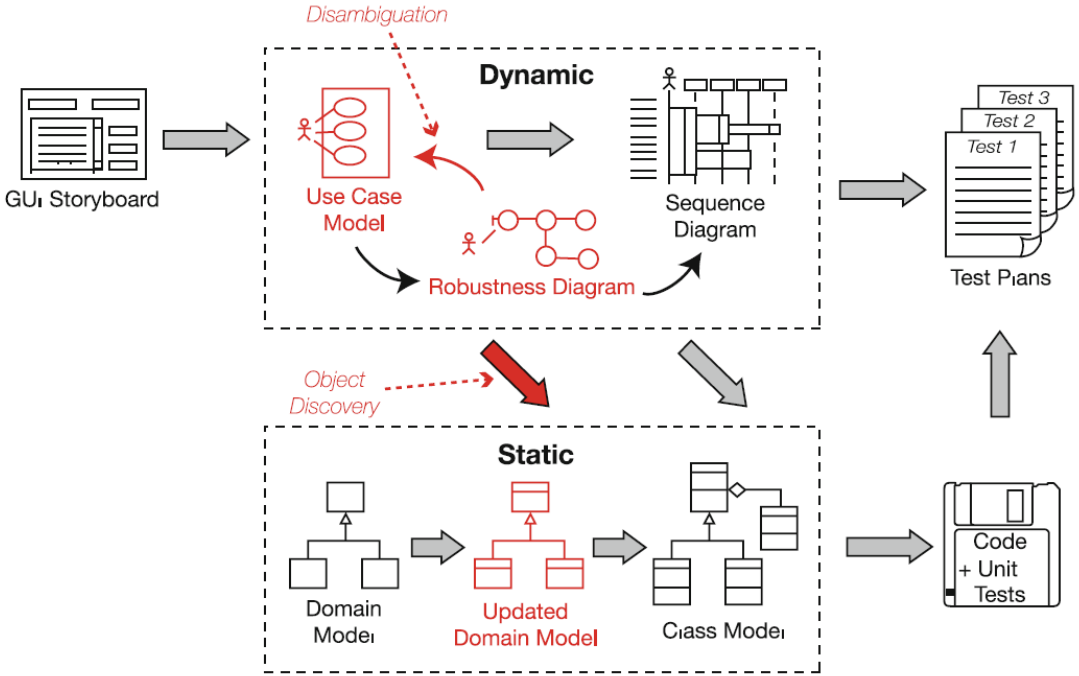
A use case is defined as a set of classes and the interaction between objects of these classes

- Interaction diagrams: sequence diagrams and communication diagrams

From What to How



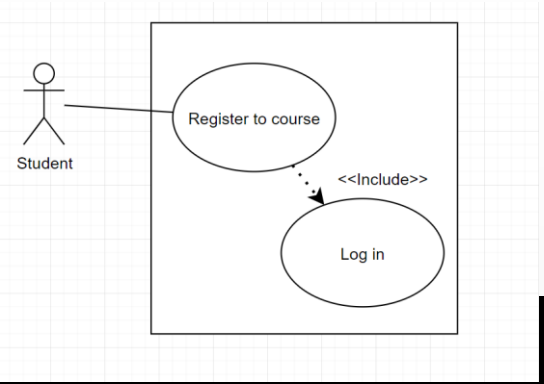
Context
& process, pt. 2



Pt. 1 Use case and domain model

Step 1: Use cases

- See the earlier lecture on requirements and use case diagrams
- Gathered through a full requirements engineering process
  - (please also see our requirements engineering course!)
  - But: Analyze the domain by observing, talking to people, reading about existing documents…
  - Then: Condense these into user stories and practical use cases
  - Finally: Create use case diagrams

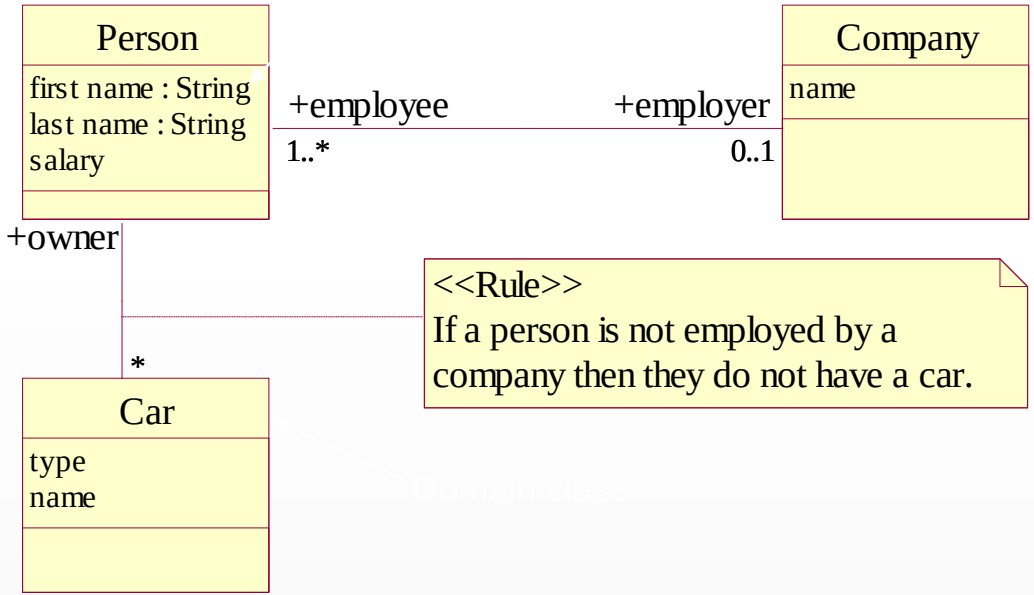


Step 2: Domain model

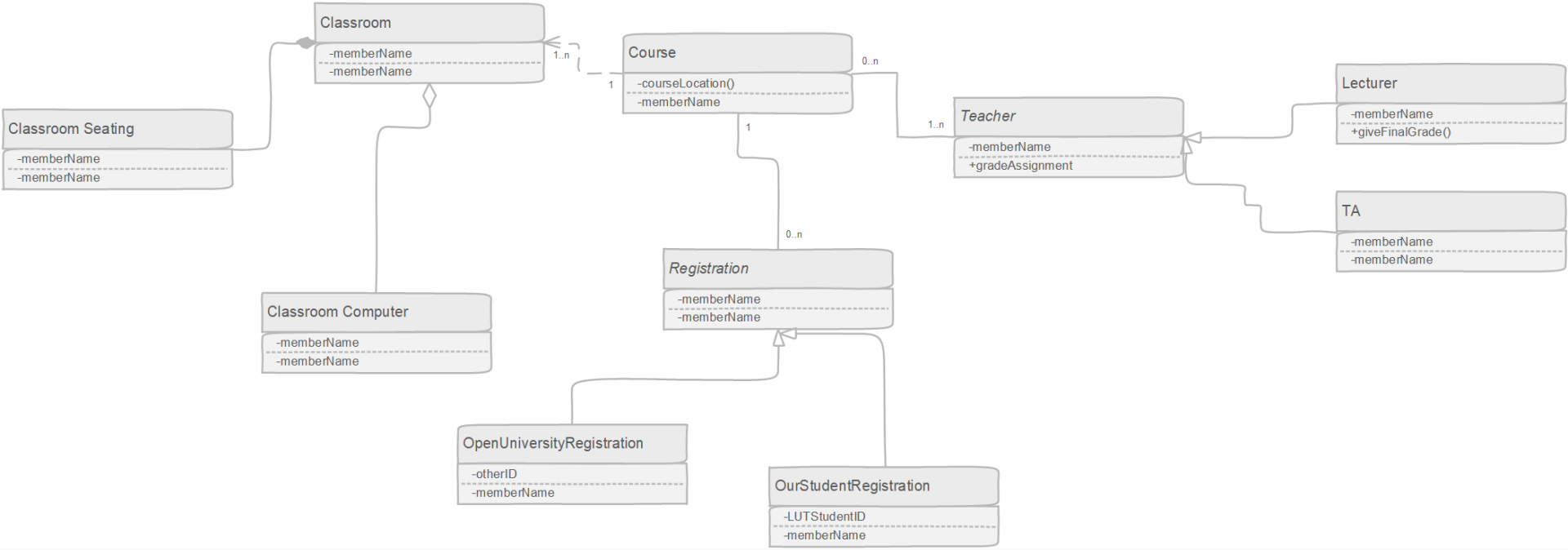
- Describes which objects and concepts exist in the system, or are related to it (in the use case / business case sense)
- Collaboration and connections between these concepts

- The following features enable us to express time invariant static business rules for a domain:
  - **Classes** – each class denotes a type of object.
  - **Attributes** – an attribute is the description of a named slot of a specified type in a domain class; each instance of the class separately holds a value.
  - **Associations** – an association is a relationship between two (or more) domain classes that describes links between their object instances. Associations can have roles, describing the multiplicity and participation of a class in the relationship.
  - **Additional rules** – complex rules that cannot be shown with symbology can be shown with attached notes.

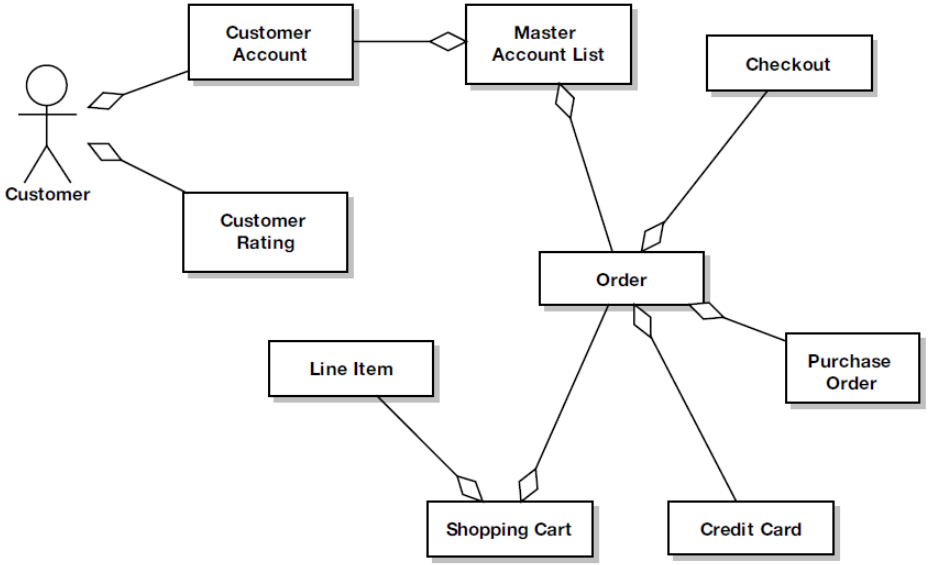
Simple domain model



Example: Domain model (UML class diagram)



Alternative example: Domain models can be even simpler



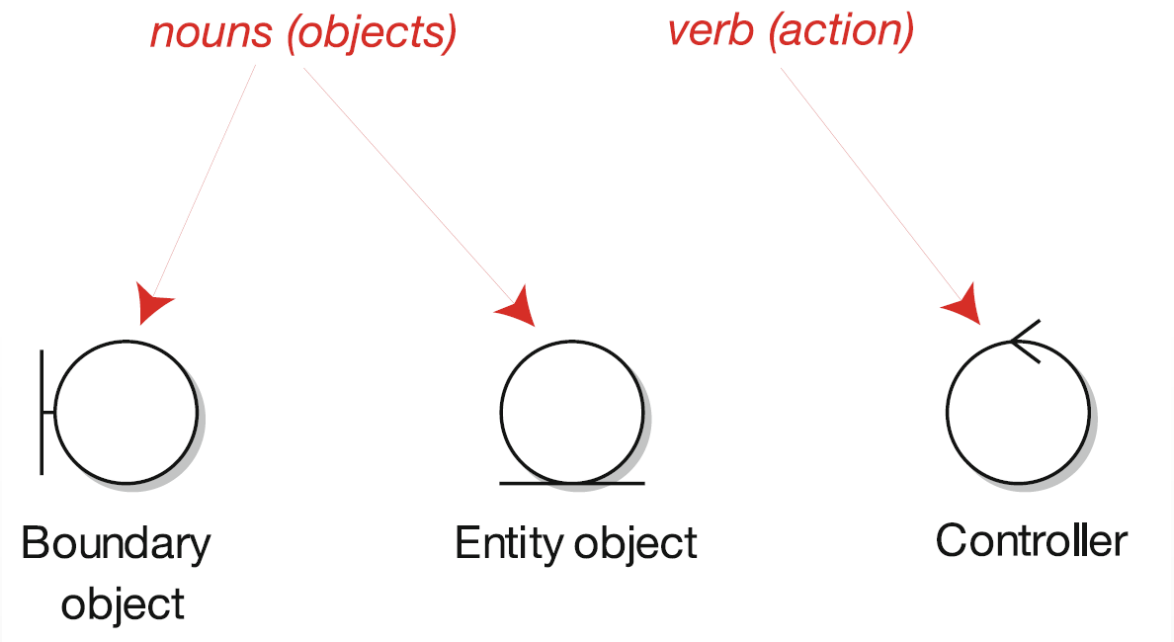
Pt. 2 from use case to BCE diagram (robustness analysis)

Step 3. Robustness analysis

- Robustness analysis: identifying a **first-guess set of objects for each use case**
- Essentially robustness diagram is an object picture of an use case
- Robustness diagram uses objects from the **domain model**
  - Update the domain model when necessary
- Review the BCE diagram structure from previous lecture if necessary

Robustness diagram

Just three components.



Robustness analysis rules

- Boundaries can interact with users (actors) and controllers
- Boundaries cannot connect to other UIs (boundaries) or data (entity)
- Controllers work with all, except users (actors)
- Entities can only connect to controllers

Can connect to	Entity	Boundary	Control	Actor
Entity			X	
Boundary			X	X
Control	X	X	X	
Actor		X		

Robustness analysis principles (selection from Rosenberg & Stephens)

1. Review use case text carefully (even paste it in)
2. Use entity classes from the domain model, update domain model if necessary
3. Rewrite use cases (clarify) if necessary
4. Make a boundary object for each user interface and name them clearly
5. Remember that controllers do not always control real world objects – they are often software logic
6. Don’t worry about the direction of arrows too much
7. Robustness diagram is an initial conceptual design, not a literal design
8. Boundary and entity classes often will become object instances in a sequence diagram and controllers will become messages
9. Robustness picture builds a picture of what technological objects are present in an use case (virtual software objects, data entities and interfaces)

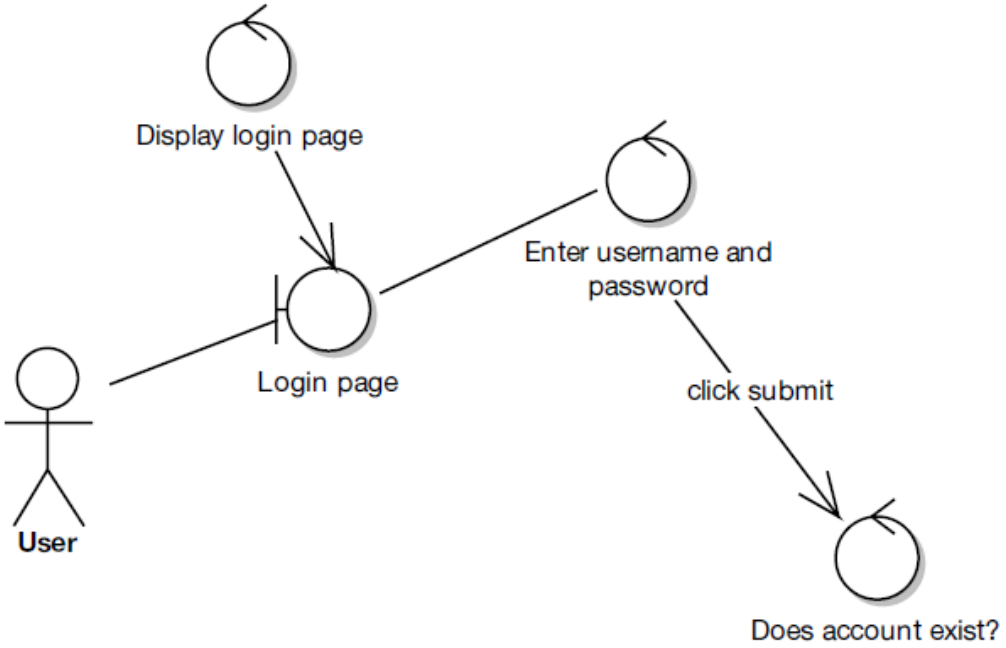
Four steps for creating the analysis (Visual Paradigm)

1. You perform robustness analysis for a use case by walking through the use case text.
2. One sentence at a time, and drawing the actors, the appropriate boundary, entity objects and controllers, and the connections among the various elements of the diagram.
3. You should be able to fit the basic course and all of the alternate courses on one diagram.
4. Anyone who reviews a robustness diagram should be able to read a course of action in the use case text, trace their finger along with the associations on the diagram, and see a clear match between text and picture.

Robustness analysis example, login to course registration system

BASIC COURSE:
The user clicks the login link from any of a number of pages; the system displays the login page. The user enters their username and password and clicks Submit. The system checks the master account list to see if the user account exists. If it exists, the system then checks the password. The system retrieves the account information, starts an authenticated session, and redisplays the previous page with a welcome message.

ALTERNATE COURSES:
User forgot the password: The user clicks the What's my Password? link. The system



Pt. 3 From BCE diagrams to Behaviour

Step 4. Describing behaviour with sequence diagrams

- Previous parts were about object discovery
- This step is about behaviour discovery

Three primary goals

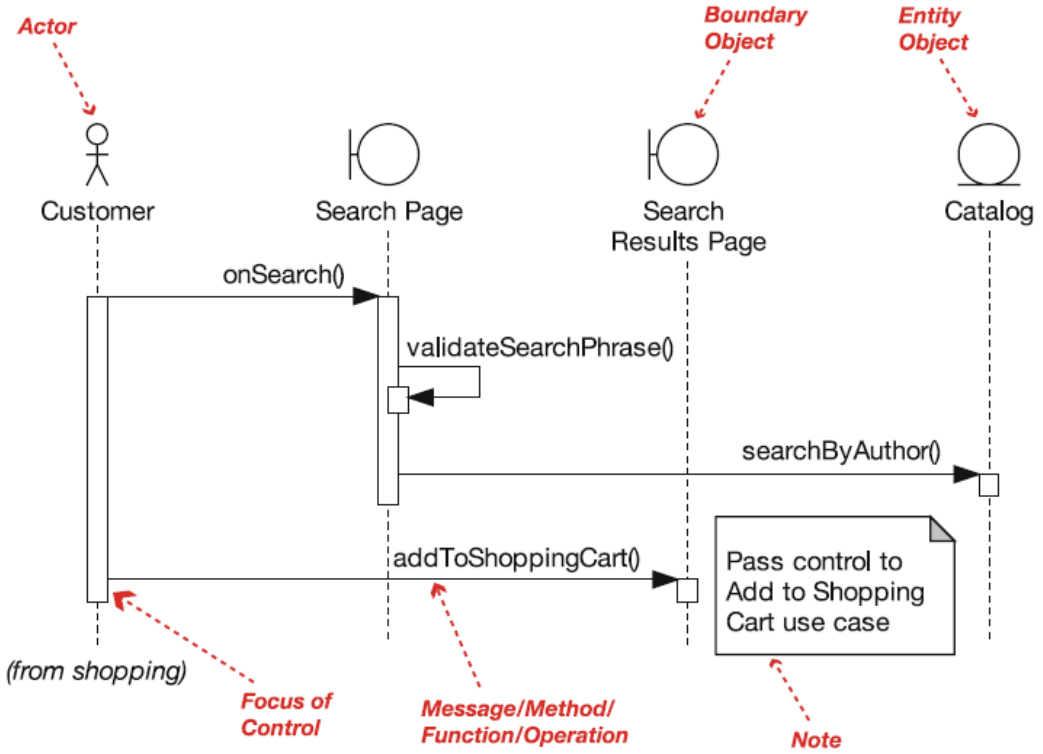
1. Allocate behaviour to classes
2. Show in detail how the classes interact over the lifetime of the use case
3. Finalize the distribution of operations among classes

Elements of Sequence Diagram

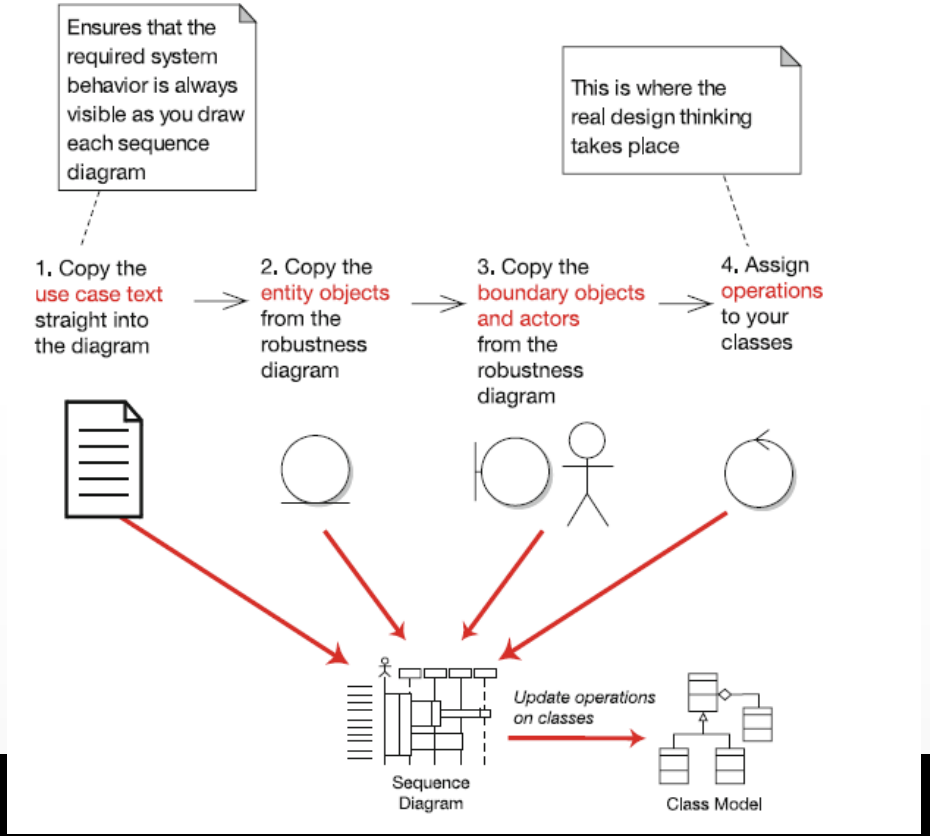
Entities are objects representing system data: Customer, Product, etc.

Boundaries are objects that interface with actors: UserInterface, DataBaseGateway, etc.

Controls are messages, mediating contact



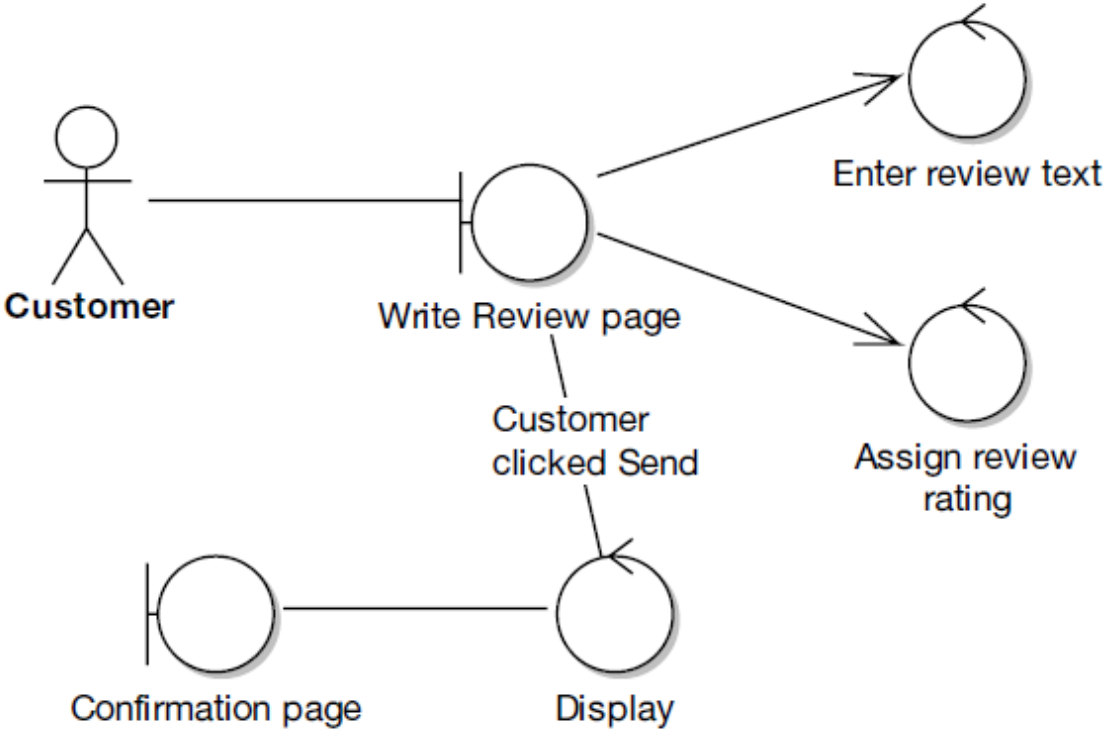
Step 4. Steps for building a sequence diagram



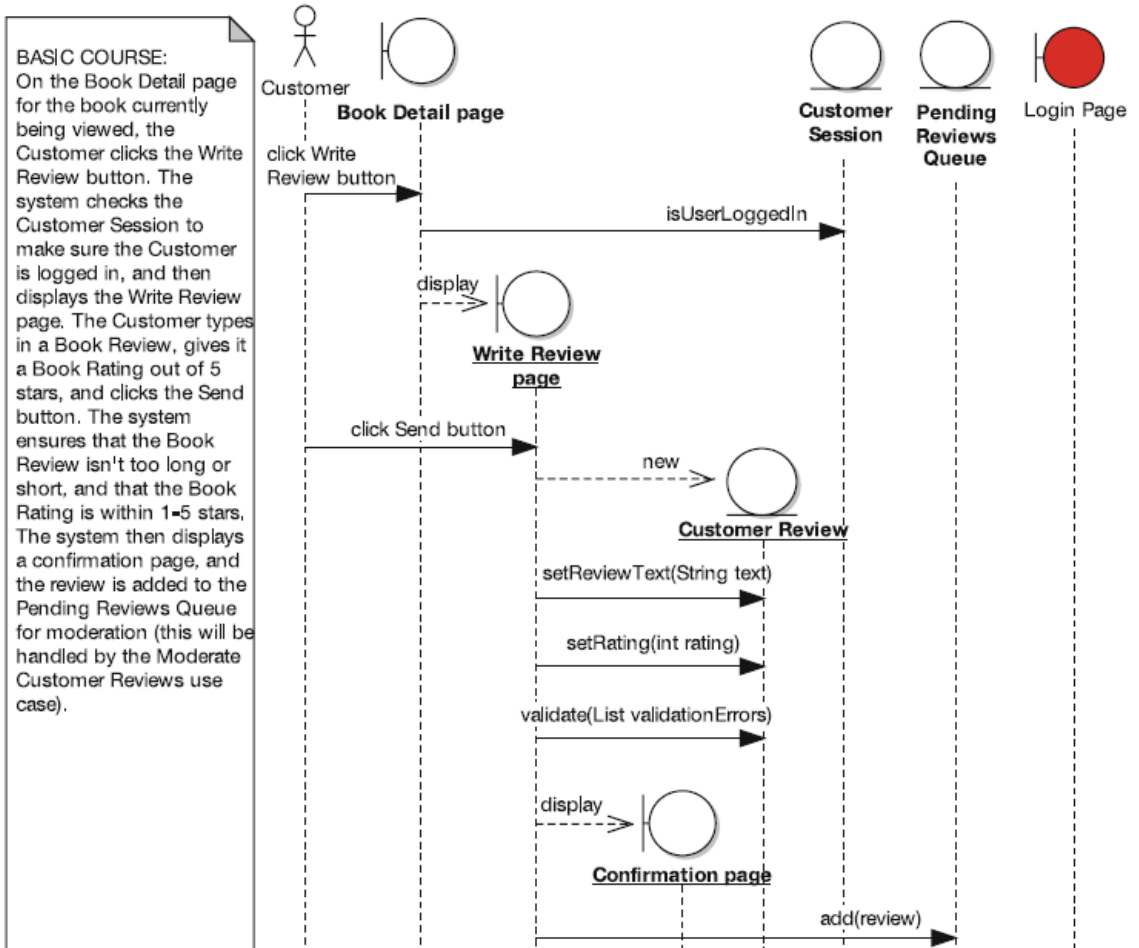
Sequence diagramming guidelines (selection from Rosenberg & Stephens)

1. Understand **why** you are sequence diagramming
2. Draw a sequence diagramming for each use case
3. Start your sequence diagram from boundary classes, entity classes, actors, and use case text that was refined in robustness analysis
4. Use the sequence diagram to show the behaviour of the use case
5. Make sure the use case text maps to the messages being passed
6. Don’t spend too much time worrying about specifics of control
7. Review your class diagram frequently while sequence diagramming

Example BCE diagram => sequence diagram (the BCE diagram)



Example BCE diagram => sequence diagram: Sequence Diagram



Recap, all in one

Finally: The point of this process

Systematic process for translating use cases and use case text into both

- Involved objects (logical view: domain model & class diagram)
- Behaviour related to use cases (process view: sequence & communications diagrams)

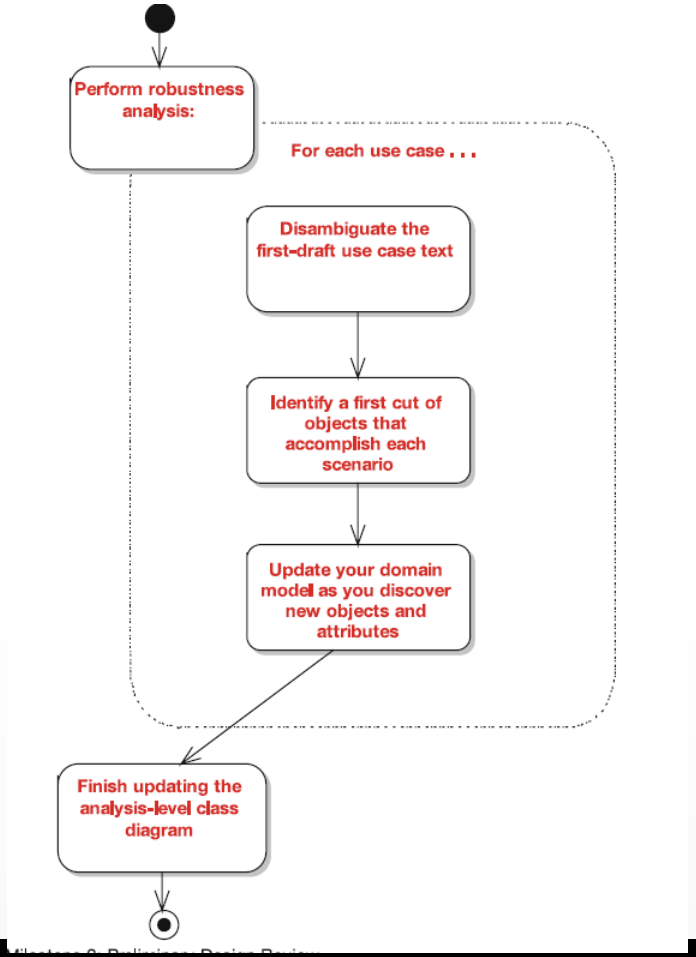
Three step process

Zero: Define use cases and use them & related data sources (documentation, interviews, observation) as the basis for modeling

1. Create domain model
2. Create BCE models through use cases
3. Start elaborating use cases with behaviour diagrams, such as sequence diagrams, where necessary

Constantly: Update domain models & use cases and detail into class diagram where necessary

Visually


Perform robustness analysis:
For each use case . . .
Disambiguate the first-draft use case text
Identify a first cut of objects that accomplish each scenario
Update your domain model as you discover new objects and attributes
Finish updating the analysis-level class diagram