Modeling Interactions and Behavior

Dr. Marouane Kessentini
Department of Computer Science
Interaction Diagrams

• Interaction diagrams are used to model the dynamic aspects of a software system
  – They help you to visualize how the system runs.
  – An interaction diagram is often built from a use case and a class diagram.

• The objective is to show how a set of objects accomplish the required interactions with an actor.
Interactions and messages

– Interaction diagrams show how a set of actors and objects communicate with each other to perform:
  • The steps of a use case, or
  • The steps of some other piece of functionality.

– The set of steps, taken together, is called an interaction.

– Interaction diagrams can show several different types of communication.
  • E.g. method calls, messages send over the network
  • These are all referred to as messages.
Elements found in interaction diagrams

- Instances of classes
  - Shown as boxes with the class and object identifier underlined

- Actors
  - Use the stick-person symbol as in use case diagrams

- Messages
  - Shown as arrows from actor to object, or from object to object
Creating interaction diagrams

• You should develop a class diagram and a use case model before starting to create an interaction diagram.

  – There are two kinds of interaction diagrams:
    • Sequence diagrams
    • Communication diagrams
Sequence Diagrams

- Used during requirements analysis
  - To refine use case descriptions
  - To find additional objects (“participating objects”)

- Used during system design
  - To refine subsystem interfaces

- Used during Testing
  - To specify expected behavior and validate output

- Classes are represented by rectangles
- Lifelines are represented by dashed lines
- Messages are represented by arrows
- Activations are represented by narrow rectangles.
Sequence diagrams – an example

[Diagram showing sequence of interactions between CourseSection, Registration, and Student]

[Class diagram with relationships and methods such as Course.getPrerequisite(), CourseSection.requestToRegister(), Registration.addToSchedule(), Student.addToList()]

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Sequence diagrams – same example, more details
Sequence diagrams – an example with replicated messages

– An *iteration* over objects is indicated by an asterisk preceding the message name

![Sequence diagram with replicated messages and objects](image)
Sequence diagrams – an example with object deletion

- If an object’s life ends, this is shown with an X at the end of the lifeline
Basic Course

1: Customer

The Customer specifies an author on the Search Page and then presses the Search button.

The system validates the Customer’s search criteria.

The system searches the Catalog for books associated with the specified author.

When the search is complete, the system displays the search results on the Search Results Page.

Alternate Course

If the Customer did not enter the name of an author before pressing the Search button, the system displays an error message to that effect and prompts the Customer to enter an author name.

2: Search Page

onSearch()

validateSearchCriteria()

searchByAuthor()

create()

display()

displayErrorMessage()
State Diagrams

• A state diagram describes the behaviour of a system, some part of a system, or an individual object.
  – At any given point in time, the system or object is in a certain state.
    • Being in a state means that it is will behave in a specific way in response to any events that occur.
  – Some events will cause the system to change state.
    • In the new state, the system will behave in a different way to events.
  – A state diagram is a directed graph where the nodes are states and the arcs are transitions.
States

– At any given point in time, the system is in one state.
– It will remain in this state until an event occurs that causes it to change state.
– A state is represented by a rounded rectangle containing the name of the state.
– Special states:
  • A black circle represents the start state
  • A circle with a ring around it represents an end state
Transitions

– A transition represents a change of state in response to an event.
  • It is considered to occur instantaneously.

– The label on each transition is the event that causes the change of state.
State diagrams – an example of transitions with time-outs and conditions

(a)

(b)
Nested substates and guard conditions

• A state diagram can be nested inside a state.
  – The states of the inner diagram are called *substates*.
State diagram – an example with substates
Example
Difficulties and Risks in Modelling Interactions and Behaviour

• Dynamic modelling is a difficult skill
  – In a large system there are a very large number of possible paths a system can take.
  – It is hard to choose the classes to which to allocate each behaviour:
    • Ensure that skilled developers lead the process, and ensure that all aspects of your models are properly reviewed.
    • Work iteratively:
      – Develop initial class diagrams, use cases, responsibilities, interaction diagrams and state diagrams;
      – Then go back and verify that all of these are consistent, modifying them as necessary.
    • Drawing different diagrams that capture related, but distinct, information will often highlight problems.