Software Design and UML

Plan for today

- Building a software system
  - Software Development Cycle
  - Documenting your design using UML

Software Development Cycle

- Process for software development
  - People management
  - Work management
  - Team management
- Caveat: These processes are merely guidelines
  - Your actual mileage may vary!

Software Development Cycle

- Gather Requirements
  - Find out what the user needs
- System Analysis
  - Express these needs formally in system terms
- Design
  - Design a high level solution
- Implementation
  - Turn solution into code
- Testing
  - Verify that the solution works
- Maintenance
  - Iterate the cycle

Software Development Cycle

- Problem Domain
  - Gather Requirements / System Analysis
- Solution domain
  - Design / Implementation
  - Note: no code until implementation!

Software Development Cycle

- Testing
  - Unit testing
  - Integration testing
  - System testing
  - Reviews
    - Requirements / Design / Code

Software Development Cycle

- Maintainance
  - Modifications – iterate over complete cycle
- Note: This is just one methodology for software developments, there are others (e.g. eXtreme Programming).
- Questions?

Unified Modeling Language

- From the UML FAQ:
  - "The Unified Modeling Language is a third-generation method for specifying, visualizing, and documenting the artifacts of an object-oriented system under development."
  - Booch, Jacobson, Rumbaugh (the Three Amigos)
    - All three now work at Rational Software

Unified Modeling Language

- UML is a language for describing models.
  - Describes what a system is supposed to do but not how it should be implement.
  - Analysis and Design NOT Implementation.
  - CASE tools can generate code from well specified designs.

Unified Modeling Language

- Major Components
  - Entities
    - things in your model
  - Relationships
    - associations between things in the model
  - Diagrams
    - Graphical representation of elements and relationships that present different views of the system.
    - Often presented as a graph (shapes connected by arrows).

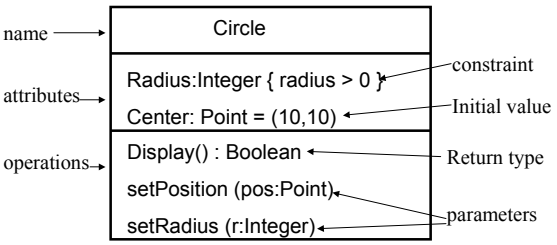
Unified Modeling Language

- UML defines numerous types of diagrams
- In this class we will focus on the following:
  - Class diagrams
    - Illustrates classes/objects and relationships
  - Use Case diagrams
    - Illustrates user interaction (scenerios) with system
  - Sequence Diagrams
    - Illustrates objects interaction over time in realizing a use case.

Class Diagrams

- Classes and Objects
  - All objects have the following:
    - Name – how an object is identified
    - Attributes – defines an object's state
    - Operations – defines an object's behavior
  - Classes
    - Categories of objects with the same set of attributes and behavior
    - Objects are instantiations of classes

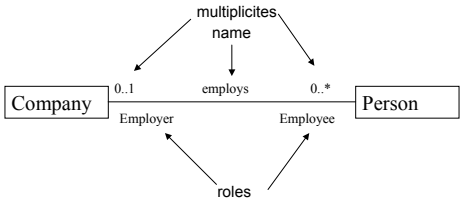
Class Diagrams – Classes



Class Diagrams -- Relationships

- Associations
  - Relationship between different objects of different classes
  - Associations can have the following:
    - Name – identifies the association type
    - Multiplicity – indicates how many objects can participate in the association
    - Roles – Meaning of classes involved
  - Represented by lines connecting associated classes

Class Diagrams -- Associations

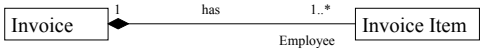


Class Diagrams -- Relationships

- Aggregation
  - Specifies a "whole"/"part" relationship"
  - has-a relationship
    - Indicated by a line with an unfilled diamond at the end
  - Composition – strong aggregation where the part generally does not exist without the whole.
    - Indicated by a line with a filled diamond at the end

Class Diagrams -- Aggregation

Aggregation

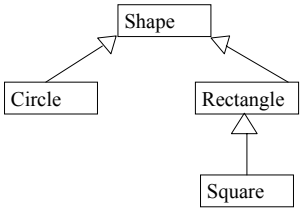


Composition

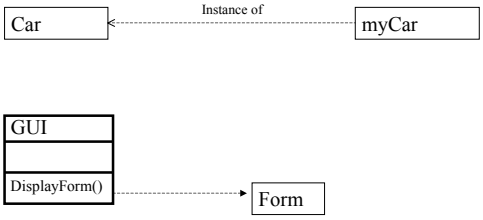
Class Diagrams -- Relationships

- Generalization
  - is-A relationship
  - Indicates inheritance
    - Indicated by a line with an open triangle.
- Dependency
  - Relationship where a change in one element requires a change in the other
    - Instantiation Relationships
    - Temporary associations (operation arguments)
    - Creator / Createe relationship
    - Indicated by a dotted line

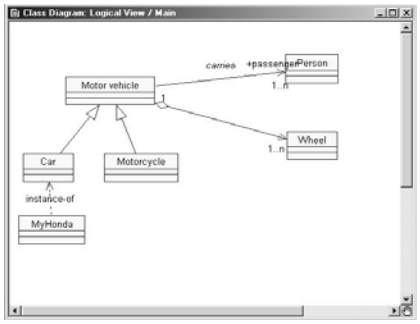
Class Diagrams -- Generalization



Class Diagrams -- Dependency



Class Diagram – Summary



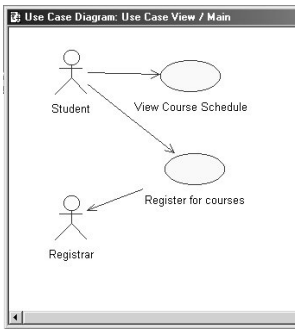
Class Diagrams -- Summary

- Classes / Objects – represented as boxes
  - Name / Attributes / Operations
- Relationships – lines connecting boxes
  - Associations
  - Aggregations / Composition
  - Generalization
  - Dependency
- Questions?

Use Case Diagram

- Use case – Scenario about system use from a external ***user perspective***.
  - Extremely useful tool for requirements gathering and analysis.
  - Use cases are indicated by an oval
  - Actor – Entity located outside of a system that is involved in the interaction with the system in a use case.
  - Actors are indicated by a stick person.

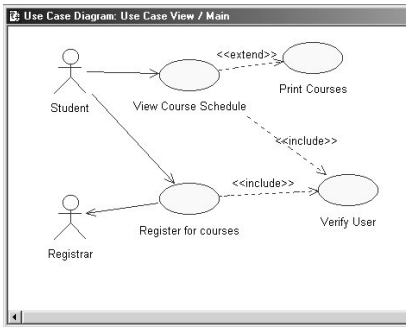
Use Case Diagram



Use Case – Relationships

- Use Cases can have relationships with other use cases
  - Include –use case that is performed during the course of another use case.
  - Extend – Adding extra steps to an already existing use case.

Use Case – Relationships



Use Case -- Documentation

- To be documented with a use case:
  - Sequence of steps that occur in the scenario
  - Preconditions
  - Postconditions
  - Variations and alternative scenarios

Use Case – Register for courses

- Precondition:
  - Student has been assigned a valid id/password
- Postcondition:
  - Student becomes registered and can attend class.

Use Case – Register for courses

- Sequence of events
  - Student logs into system
  - System extracts student data from DB
  - Based on this data, system presents a menu of courses student can take
  - Student chooses course
  - Notification sent to registrar to add student to course.

Use Case – Register for courses

- Alternative scenarios
  - Student database unavailable
  - Courses cannot be retrieved
  - Course chosen by student is full.
  - Communication to registrar is unavailable.

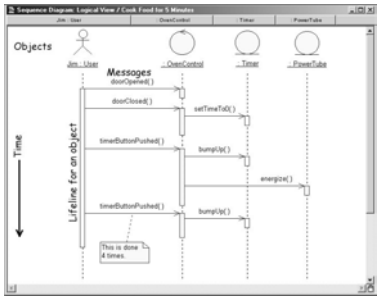
Use case diagram – Summary

- Use case – Scenario about system use from a external ***user perspective***.
  - Ovals in diagram
- Actor – Entity located outside of a system that is involved in the interaction with the system in a use case.
  - Stick person
- Relationships
  - Extend / Include
- Documentation
- Questions?

Sequence Diagram

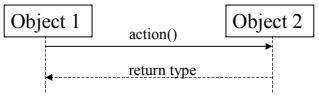
- Messages
  - A communication between objects
  - Types:
    - Call and return – Calls a method on an object and waits for it's return
    - Create action – creates a new object
    - Destroy action – destroys an existing object
    - Send – A signal is sent to an object. Asynchronous! Sending object does NOT wait for ack or return
- A Sequence Diagram illustrates time ordering of messages that go back and forth between objects in performing a given scenario

Sequence Diagram

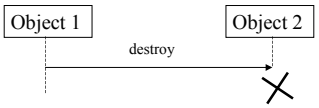


Sequence Diagram – Messages

- Return values – dotted arrow

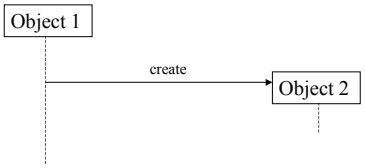


- Destroy – object Xed out



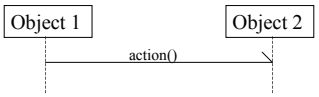
Sequence Diagram – Messages

- Create – object suddenly appears

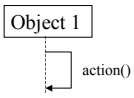


Sequence Diagram – Messages

- Send – Half arrow



- Objects / classes can talk to themselves



Sequence Diagram -- Summary

- Illustrates time ordering of messages that go back and forth between objects in performing a given scenario
  - show examples of important interactions; they are not graphical representations of method code
- Questions

Summary

- Software Design and Life Cycle
  - Requirements / Analysis / Design / Implementation / Test / Maintenance
- UML
  - Class Diagrams
  - Use Case Diagrams
  - Sequence Diagrams

The Microwave Example

- There is a single control button available for the user of the oven.
  - If the oven door is closed and you push the button, the oven will cook (energize the power tube) for 1 minute.
  - If you push the button at any time when the oven is cooking, you get an additional minute of cooking time.
  - Pushing the button when the door is open has no effect.
  - Opening the door stops the cooking and clears the timer to 0.

The Microwave Example

- There is a light inside the oven.
  - Anytime the oven is cooking, the light must be turned on.
  - Any time the door is open, the light must be on.
  - If you close the door, the light goes out.
  - If the oven times out, it turns off both the power tube and the light. It then emits a warning beep to tell you that it is finished.

Next Time

- Example / demo of building UML diagrams using Rational Rose.