Comp-303 : Programming Techniques
Lecture 4

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Announcements

- Requirement.&Spec. Document due in 2 weeks (in class).
- Assignment 1 will be handed out next class.

Last lecture . . .

- Variables, Objects and Primitives
- Object variables are called references
- Objects can be mutable or immutable
- Java is strongly typed and type-safe
- Java provides automatic garbage collection
- All objects are subtypes of Object and understand toString() equals()
- Primitive types are converted to other types
- All types can be cast to other types (no conversion)
- Packages provide encapsulation and naming scope
- java.util provides Vector
- Executions starts at main() method
- Tool of the day: CVS

What is UML?

- UML is a visual language used to create models of programs or modules.

Why learn UML?

- To communicate with others.
- To give a graphical representations to your ideas.
- To avoid confusion in design/communication
- Because you might need it for the project
- Because it looks really cool in your C.V.

Why use UML?

- UML has guidelines for drawing several types of diagrams:
  - Use Case Diagrams
  - Activity Diagrams
  - Interaction Diagrams
  - Sequence Diagrams
  - Class Diagrams
  - State Diagrams
  - Deployment Diagrams
- Don't worry, we won't need all of these.
- We will mostly work with *Class Diagrams*, State Diagrams and Sequence Diagrams.

Good references on UML

- Fundamentals of Object-Oriented Design in UML; Meilir Page-Jones; Addison-Wesley; 2000

Drawing UML with Dia

- Dia is a gtk+ based diagram creation program released under the GPL license.

  `http://www.lysator.liu.se/~alla/dia/`

- Dia is a free program that allows you to draw your UML diagrams.
- All the UML diagrams in these notes were created with Dia.
- Dia is available on Linux and Windows.
- Dia2code allows you to generate code from your UML class diagrams.

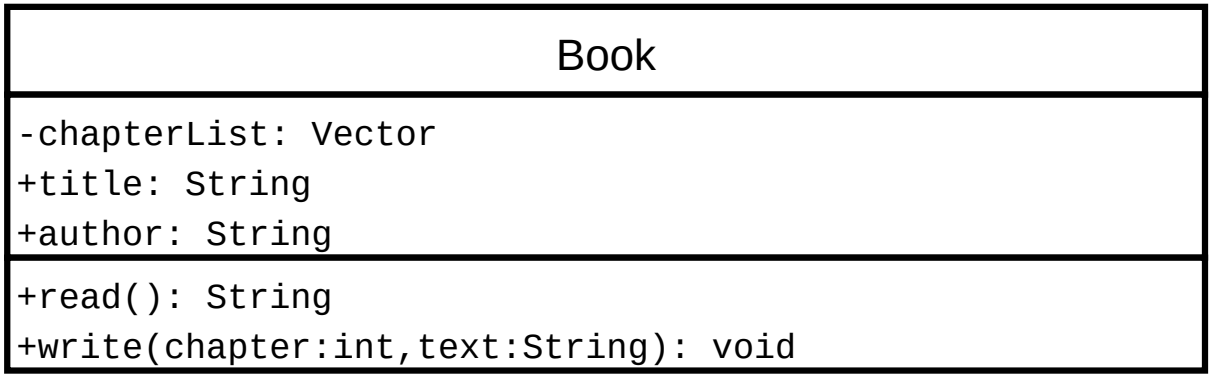
Class Diagrams

- This is the type of diagram we will use most often in class.
- It allows you illustrate both the structure and the relationships of your classes.
- There are 3 kinds of relationships between classes:
  - Hierarchy
  - Contains
  - Uses

Classes in a class diagram

Three elements can be represented in a class box:

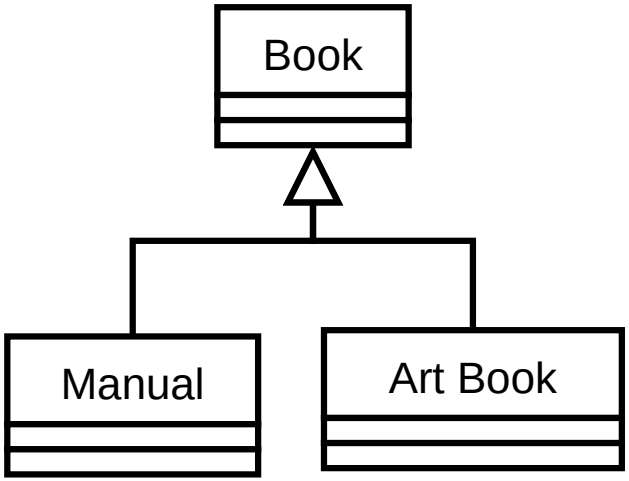
- name
- members / properties
- methods / functions



- The "+" symbol indicates a public member
- The "-" symbol indicates a private member
- If the "#" symbol was used, it would indicate a protected member

Hierarchy Relation

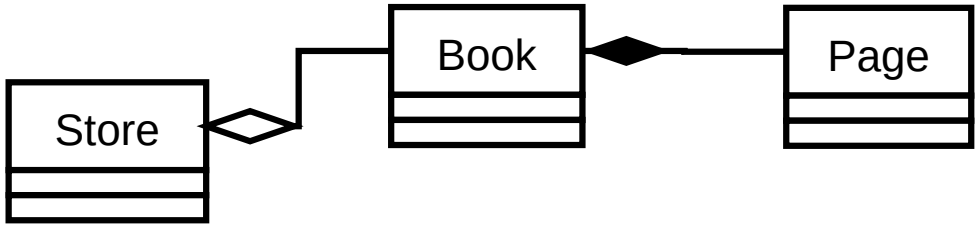
- The first type of relationship is *hierarchy*, also known as inheritance.



- An arrow is used to illustrate the inheritance relationship.
- In this diagram, Manual and Art Book are a subtype of Book.
- If the name of the class Book were written in italic, this would indicate the class is abstract.

Contains Relation

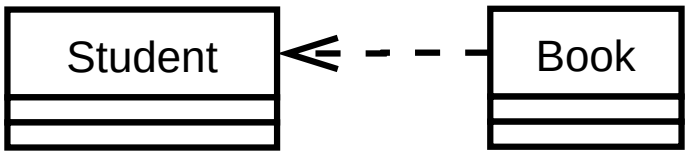
- The second type of relationship is *contains*, also known as composition or aggregation.



- A full diamond indicates a composition relation. This means Class book cannot exist without class Page.
- An empty (white) diamond indicates an aggregation relation. This means class Book can be contained in class Store. However, class Store does not need class Book to exist.

Uses Relation

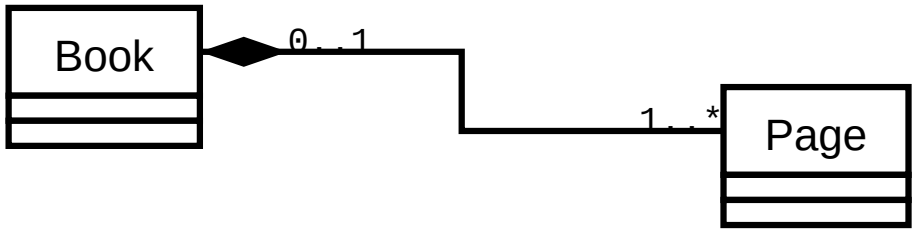
- The last type of relationship is *uses*.



- This diagram shows that the class Student uses the class Book.
- The class Student does not define itself with the class Book, it just uses it.
- Notice that the arrow seems to be doing in the wrong direction.

Cardinality of a Relation

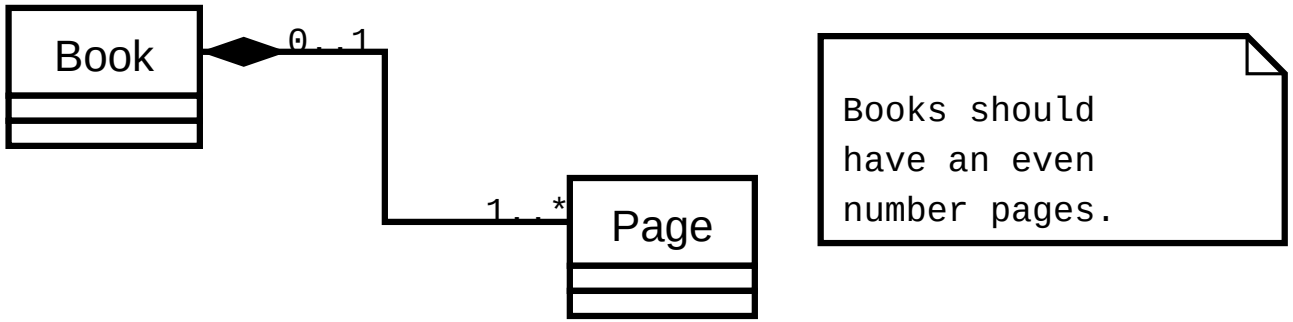
- Sometimes, it becomes important to define the cardinality of a relation.
- In other words, we want to count the number of object that can be found on each side of the relation.



- In this example, we can have either no book or one book (*0..1*).
- We also define that our scenario requires at least one page (*1..**) .
- We can't define a scenario with zero pages because that would violate the composition rule with class Book.

Adding Notes

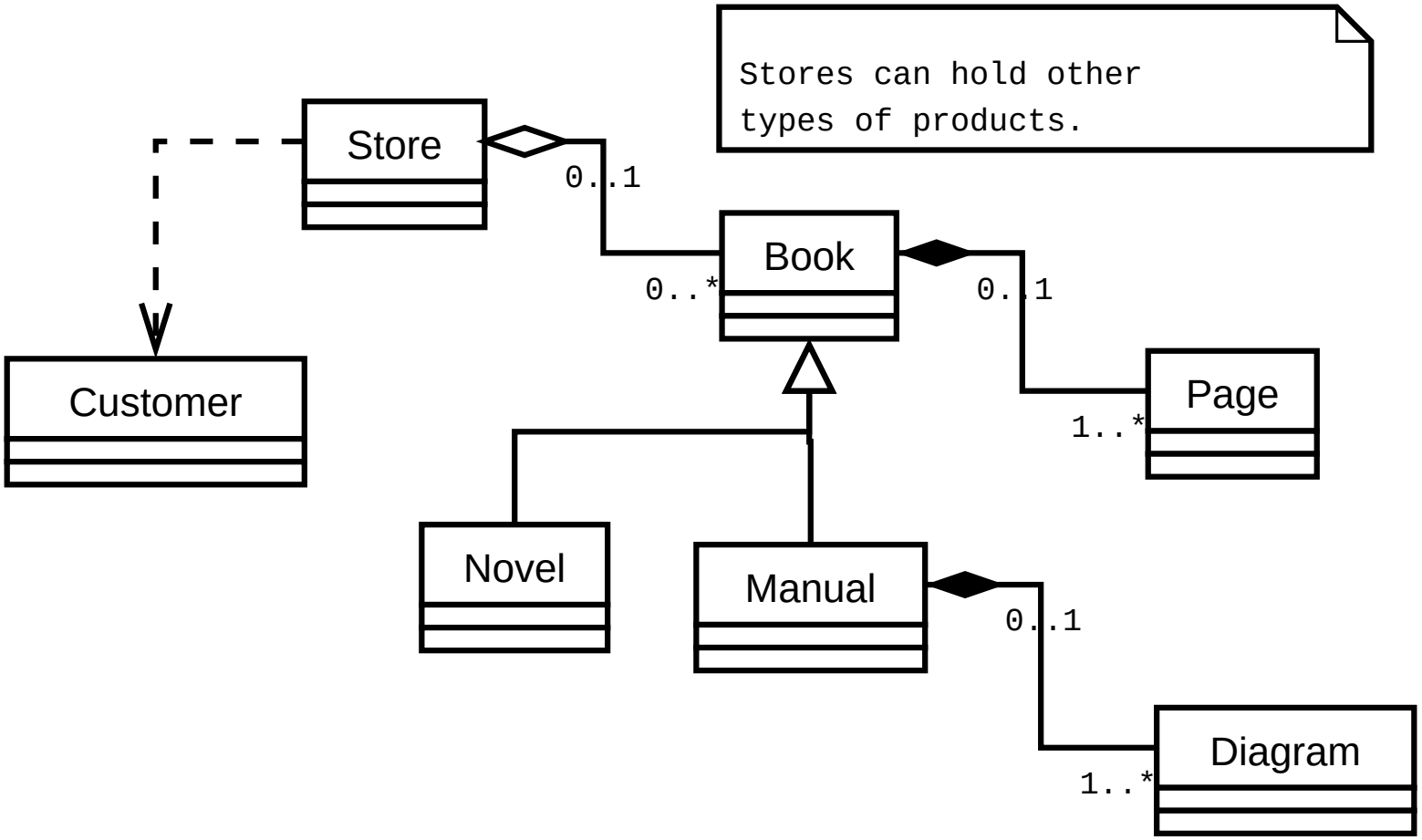
- UML is not flexible enough to describe all scenarios.
- To describe complicated scenarios, designers can use notes to annotate their designs.



- In this example, the design must add a constraint forcing the number of pages to be even.
- UML provides no primitive or easy solution.
- However, the designer can simply add the constraint as a note in the diagram.

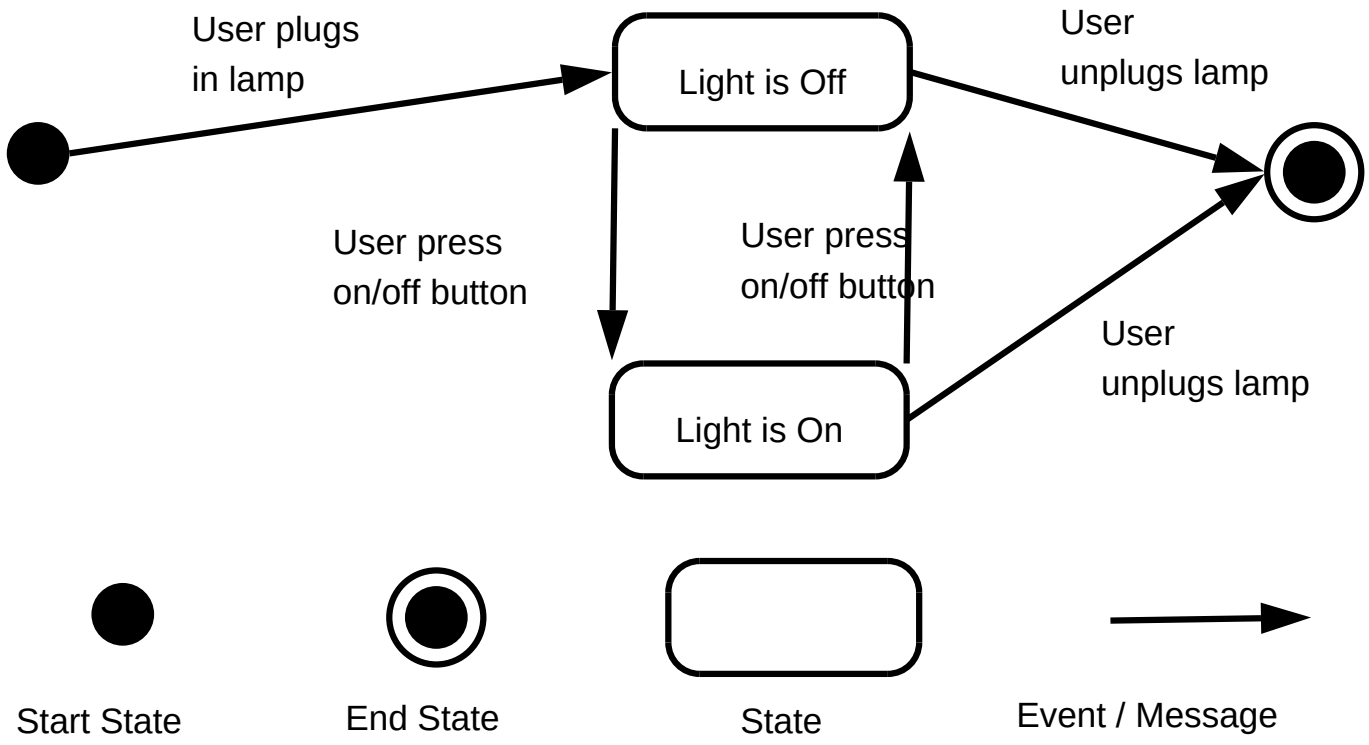
Combining all the previous elements

- We can combine all the previous elements to produce complete UML diagrams.



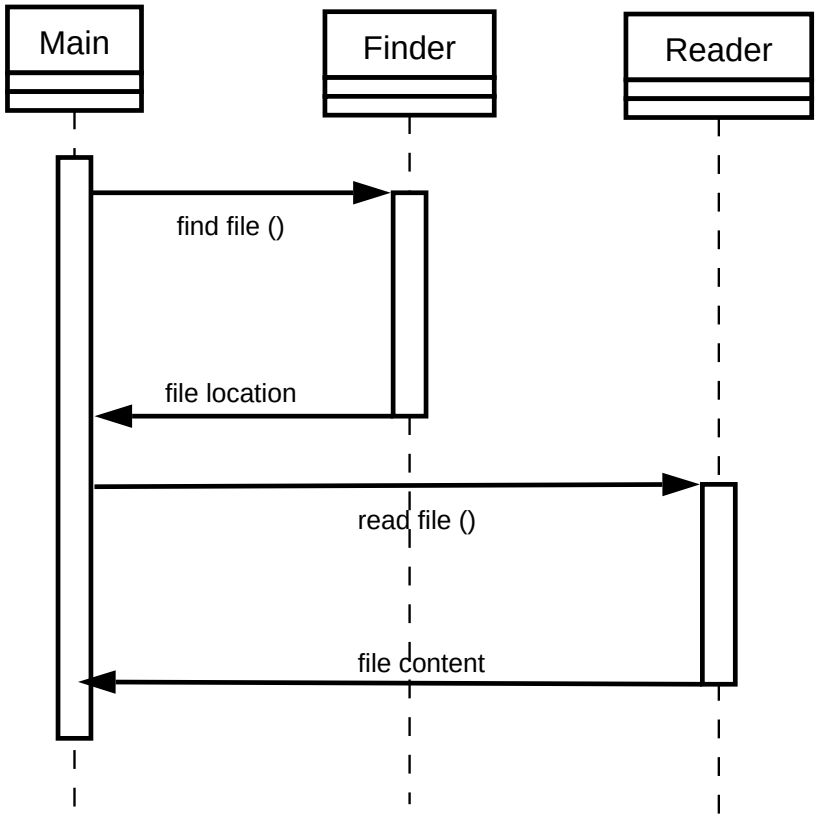
State Diagram

- State diagrams are used to describe the various state a program can reach.
- This diagram shows the various states for a typical lamp.



Sequence Diagram

- Sequence Diagrams are used to show the order in which objects are instantiated and used (object's life).
- This examples shows a program finding a file and opening it.



Hints for the project

- You should have a team by now. If you don't come and see me after class.
- Choose a project leader (not a dictator).
- You're team should be talking *at least* a hour each week.
- Have some technique to control your sources (CVS ?).
- Assign modules/packages depending on people's skill.
- Start early. There is not penalty for finishing a project early.

Requirements & Specifications

- Before attempting any large scale project, it is imperative to spend some time writing out the Requirements & Specifications.
- Requirements can be described a requests for a particular piece of software.
- Specifications can be described as the proposed solutions for the requirements.
- Validating the Requirements & Specifications with the client before starting a project is always a smart idea.
- Requirement Analysis and Specifications are covered latter in the class, so I'll be very brief on this topic.

Requirements

- As mentioned before, requirements are *the requests* for a particular piece of software.
- For the project, the main requirements are defined by the professor (programming language, size of project, etc).
- However, the main requirements are too loss to properly define your project.
- Once you have chosen your project, it is up to your team to define your requirements / goals for this project.

Specifications

- Specifications are proposed solutions to clearly stated and approved requirements.
- For the projects, your initial specifications should be a general overview of how your project will work and how you will design your module.
- Your specifications should (at a minimum) explain the four following concepts:
  - Concept : What does it do?
  - Appearance : What does it look like?
  - Controls : How can I use it?
  - Behavior : How does it work?

Specifications (cont.)

- Your specification should include a few class diagrams (doesn't need to have properties and method).
- Specifications are not binding:
  - It is normal to sometime deviate from the initial specifications.
  - However, when deviating from the initial specifications, it is important to document the changes.
  - Too many deviations from the initial specifications is a clear indication of a design flaw in the specification.
  - In a business context, variation on the initial specification is subject to client approval.

Example of Requirement.&Spec. Document

This example show how you could format your document.

- Front page
- Table of content
- Requirements
- Specifications
  - Concept
  - Appearance
  - Control
  - Behavior
    - Package A (class diag?)
    - Package B (class diag?)
    - Package C (class diag?)

More hints for the project

- Each student is expected to produce his/her package.
- Try to find a project idea that you can easily split into 3 or 4 packages.
- Simplify your project using modularity.
  - Your team only needs to agree on the public members of your package.
  - Everything private to your package is only your concern.

Summary

- What is UML and why learn it?
- References and Tools for UML
- Class diagrams
  - Elements of a class
  - Relations (Hierarchy, Contains, Uses)
  - Cardinality
  - Notes
  - Putting it all together
- State diagrams
- Sequence diagrams
- Requirements & Specifications

Tool of the day: Labyrinth

- Java reproduction of the Labyrinth game.
- Has the following features:
  - Client/Server model
  - Gui Interface
  - Multiplayer over Internet
  - Computer playing with 8 A.I. personality
- Too complex for 1 student to complete.
- Ideal for a group of 4 students.