

Analiza și Modelarea Sistemelor Software - Lecture 2: UML Class Diagrams

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Agenda

1. Quick recap
2. What are class diagrams?
3. Core elements of class diagrams
4. Associations, multiplicity & composition
5. Advanced concepts (generalization, interfaces, dependencies)
6. **Interactive exercise 1:** Identify model elements
7. Design heuristics and good practices
8. **Interactive exercise 2:** Build a small class model
9. Wrap-up & next steps

Recap from Last Class

- ▶ Why modeling is crucial
- ▶ How abstraction helps communication
- ▶ First exposure to diagrams (morning routine exercise)

Today: move from informal to formal models.

What is a Class Diagram?

- ▶ **Purpose:** describes the *static structure* of a system
- ▶ **Main elements:** classes, attributes, operations, relationships
- ▶ **Used for:**
 - ▶ Domain modeling
 - ▶ Design-level documentation
 - ▶ Communication between stakeholders

Sample class diagram

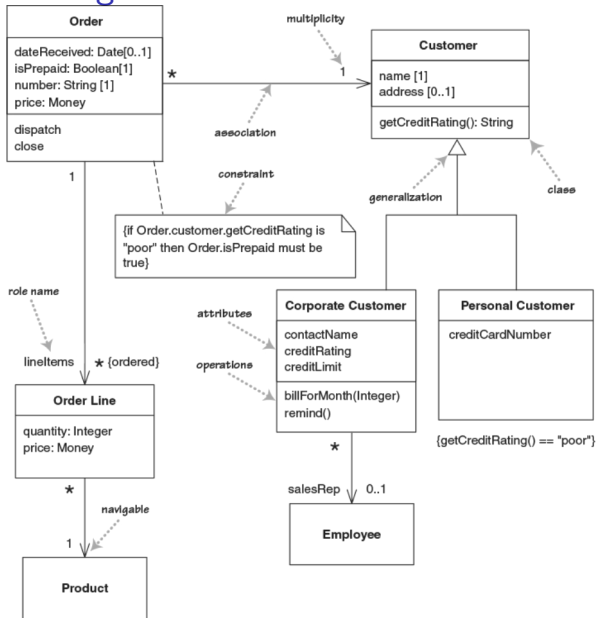


Figure 1: Order processing

Core Elements

Concept	Description	Example
Class	Blueprint for objects	Book, Student
Attribute	Property of a class	title: String, age: Integer
Operation	Behavior of a class	borrowBook(), calculateFine()
Visibility	Access modifier	+ public - private # protected ~ package

Attribute ::= visibility name: type multiplicity = default {props}

Operation ::= visibility name(parameter-list): return-type {props}

Parameter ::= direction name: type = default_value

Associations

- ▶ Represent *relationships* between classes
- ▶ Can have:
 - ▶ **Roles**: names describing relationship ends
 - ▶ **Multiplicity**: number of instances
 - ▶ **Navigability**: direction of the relationship

Properties vs Associations:

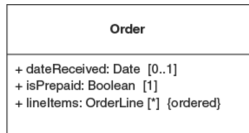


Figure 2: Properties

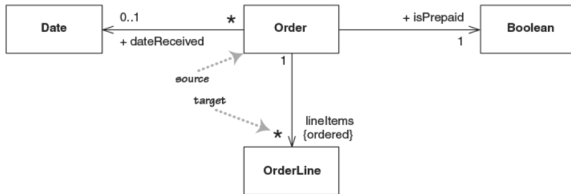


Figure 3: Associations

Bidirectional Associations

- Pair of properties which are linked together as inverses

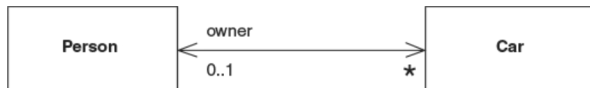


Figure 4: A bidirectional association

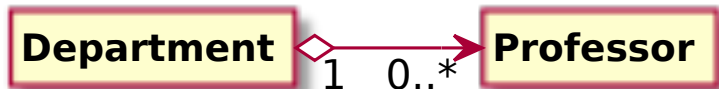
If I start with a car, take its **owner**, then take the cars property of the owner, then I should find the original car among those cars.



Figure 5: Another way to show a bidirectional association

Aggregation vs Composition

- ▶ **Aggregation** (\diamond): “has-a” relationship, but parts can exist independently

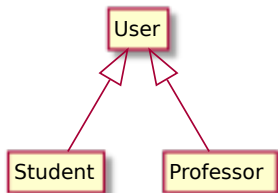


- ▶ **Composition** (\blacklozenge): “owns-a” relationship, parts die with the whole

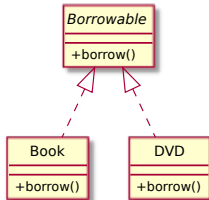


Generalization and Interfaces

- **Generalization:** inheritance between classes



- **Implementation** of an interface



Dependencies

- ▶ A dependency exists between two elements if
 - ▶ changes to the definition of one element (the supplier or target)
 - ▶ may cause changes to the other (the client or source).
- ▶ Indicated with a dashed arrow



Example – Interfaces and abstract classes in Java

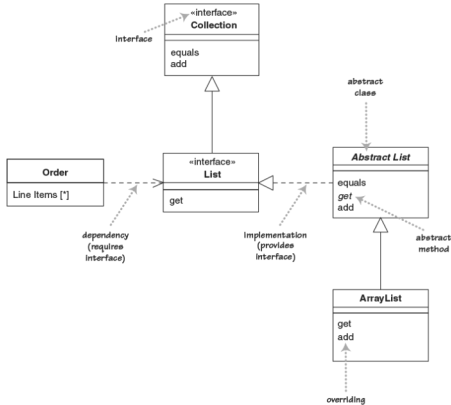


Figure 6: Interfaces and abstract classes in Java – expanded view

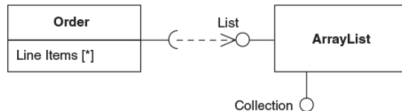


Figure 7: Interfaces and abstract classes in Java – ball-and-socket view

Interactive Exercise 1: Spot the Elements

Class: Library

- name: String
- books: List<Book>
- + addBook(b: Book)
- + findBook(title: String): Book

Class: Book

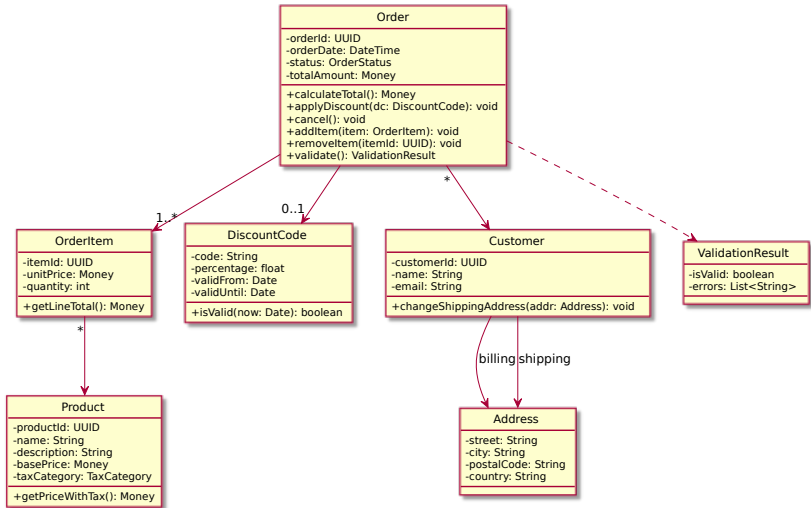
- title: String
- author: String
- + borrow()
- + return()

Task (5 minutes): Identify classes, attributes, operations, and their relationships.

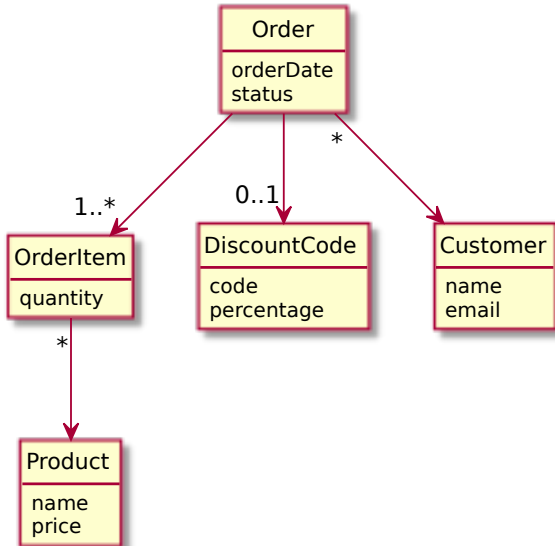
Design Heuristics & Good Practices

- ▶ Favor composition over inheritance
- ▶ Keep diagrams readable (<20 classes per diagram)
- ▶ Use consistent naming conventions
- ▶ Model only what's necessary
- ▶ Document assumptions and constraints

Example – over-complicated diagram



Example – Simplified (conceptual) diagram



Interactive Exercise 2: Build a Class Diagram

Scenario: Online food delivery system.

- ▶ Entities: Customer, Restaurant, Order, MenuItem, DeliveryDriver
- ▶ Operations: place order, assign driver, calculate total

Task (15 minutes):

- ▶ Form small groups
- ▶ Sketch a class diagram
- ▶ Show associations, multiplicities, and at least one inheritance relationship

Then: Present and discuss different design choices.

Wrap-Up

Today's takeaways:

- ▶ Class diagrams model the structure of systems
- ▶ Associations and multiplicities matter
- ▶ Composition, inheritance, and dependencies define relationships
- ▶ Modeling requires balance: detail vs. clarity

Next class: requirements analysis