Object-Oriented Analysis & Design

Object-Oriented Programming

Author: Eng. Carlos Andrés Sierra, M.Sc.
cavirguezs@udistrital.edu.co

Lecturer
Computer Engineering
Universidad Distrital Francisco José de Caldas

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Outline

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Object-Oriented

- **Object-oriented** is a way of thinking about problems. It is not just a way of programming.
- **Object-oriented thinking** involves analyzing a problem, breaking it down into *component parts* (i.e., objects) and the interactions between them.
- From **object-oriented thinking** we can design and implement a software solution, a straightforward way to represent `real-world elements`.
- The **main idea** is simple: anything in the real world can be represented as an object by simply defining its `details` and `behaviors or responsibilities`.
- **Tip:** A good exercise is to look around you and try to identify `objects and their interactions`.

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Software Implications

- Using **object-oriented thinking**, we can model a software system as a collection of objects that interact with each other. This approach applies a form of divide and conquer strategy.
- Using **objects** to represent code entities helps improve software quality metrics such as reusability, maintainability, scalability, and flexibility.
- **Objects** also help keep the code organized, easy to understand, and make it easier to fix errors.
- As **objects** increase the modularity of the code, it becomes easier to test and debug the software. Moreover, changes can be applied without affecting the entire system.
- Using **objects** enables code reuse, reducing the overall amount of code and keeping the project simple. In addition, you can create your own libraries for reuse in other projects.

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What is abstraction?

- **Abstraction** is the process of filtering out the `characteristics` of an object that we are interested in, and ignoring the rest.
- **Abstraction** is a way to simplify the complexity of the real world by focusing on the `relevant` parts.
- **Abstraction** is a way to represent the `essential` features of an object, hiding the `unnecessary` details.
- **Abstraction** is a way to model the `real world` in a simple and understandable way.

Abstraction Schemas

There are two types of **abstraction schemas**:

- **Data Abstraction:** This type of abstraction focuses on the `data` that an object contains. It is a way to hide the `implementation details` of an object and expose only the `relevant data`.
- **Behavior Abstraction:** This type of abstraction focuses on the `behavior` of an object. It is a way to hide the `implementation details` of an object and expose only the `relevant behavior`.

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Software Design

- **Software Design** is the process of transforming a set of `requirements` into a software solution. It is an iterative process.
- Based on the **requirements**, it is possible to create the conceptual design, starting with `mockups`.
- The **conceptual design** is then transformed into a detailed design, which includes the `architecture` and `components`; this is generally called **technical design** and is based on diagrams.
- Many projects fail because of **poor design**. A good design is essential for the **success** of a project. If you start coding without a good design, there will be a lack of understanding of the `requirements`.

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Requirements

Definition

Requirements are conditions or capabilities that must be implemented in a `software product`.

It is important to think like a software architect: consider both the structure and the behavior of the software.

- **Requirements** form the foundation of a software project. They define what the software should do and what the clients want (i.e., the `scope`).
- **Elicit Requirements** is the process of gathering (i.e., asking the right questions) and documenting the `needs` of the clients.
- **Functional Requirements** are the features that the software should have. They define what the software should do.
- **Non-Functional Requirements** are the qualities that the software should exhibit. They define how the software should operate.

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Conceptual Design

- Once the initial set of requirements are defined, the next step is to create a **conceptual design** of the software.
- **Conceptual Design** is a high-level design that defines the `structure` and `behavior` of the software. It is achieved by the recogniition of the appropiates components, connections, and responsabilities.
- Conceptual Design is a visual representation of the software that helps communicate the `design` (`layout`, `structure`, and `flow`) to the `stakeholders` through `mockups`.

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Mockup Example: *Cell-Phone On-Line Store*

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User Stories

- **User stories** are short, simple descriptions of a feature or function of a system.
- They are written from the perspective of the user and describe what the user wants to achieve.
- They are used to capture the requirements of a system in a simple and understandable way.

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User Stories: Format Example

User Story

Title:	Priority:	Estimate:
User Story: As a [description of user], I want [functionality] so that [benefit].		
Acceptance Criteria: Given [how things begin] When [action taken] Then [outcome of taking action]		

ProductPlan

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Use Cases

- **Use cases** are descriptions of how a system will be used by its users.
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Technical Design

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- In the **technical design**, the major components, connections and responsabilities are `identified`.
- The **technical design** is not finished until each component has been refined, designed and documented.
- The **technical designs** begin by splitting components into smaller and smaller components until they are simple enough to be designed in detail, using **technical diagrams**.

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Compromise in Requirements and Design

- **Requirements** and **Design** are interrelated. **Requirements** are the foundation of the **design**.
- **Constant communication** and **feedback** is key to creating the right solution that satisfies the **client needs**.
- **Designs** will need to be `reworked` if components, connections, and the responsibilities of the **conceptual design** prove impossible to achieve in the **technical design**, or if they **fail to meet requirements**.
- **Larger systems** generally require more time to design, more time to implement, and more time to test.
- **Components** at this stage may be *refined enough* to become collections of `functions`, `classes`, or `other components`. These pieces become a more manageable problem that **developers** can individually **implement**.

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Trade-Offs

- **Trade-offs** are inevitable in **software design**. **Quality attributes** are often competing and contradictory.
- **Trade-offs** are necessary to balance the **competing quality attributes** of a **system**.
- **Trade-offs** are made by **weighing** the **importance** of each **quality attribute** and **deciding** which **attributes** are **most important**.
- **Trade-offs** are made by **compromising** on **less important quality attributes** in order to **improve** the **more important attributes**.
- **Trade-offs** are necessary to **create** a **system** that **satisfies** the **needs** of the **users** and **stakeholders**.

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Context and Consequences

- **Context** is the environment in which a **system** will be **used**. It includes the **users**, the **stakeholders**, and the **constraints** of the **system**.
- **Context** provides important information when deciding on the balance of `qualities in design`.
- **Consequences** are the results of the **decisions** that are made during the **design** of a **system**. They include the **trade-offs** that are made and the **impact** that they have on the **system**.
- A **good practice** is to seek other perspectives on technical designs. This can be done by *asking* other developers for their opinion, or by having a design review session.
- Another **good practice** is to perform prototyping and simulation to `test the design` before implementing it.

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Satisfiying Qualities

- **Quality attributes** are the characteristics of a **system** that determine its **quality**. They are the **features** that define how well a **system** satisfies the **needs** of its **users**.
- **Quality attributes** are important because they determine how well a **system** will **satisfy** the **needs** of its **users**.
- **Quality attributes** have a strong relationship with the **non-functional requirements** to satisfy aspects as performance, resource usage and efficiency.
- Other **qualities** that software often satisfies in non-functional requirements include **reusability**, **flexibility**, and **maintainability**. This helps inform *how well* the code of software can evolve and allow for future changes.

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- **Quality attributes** are the characteristics of a **system** that determine its **quality**. They are the **features** that define how well a **system** satisfies the **needs** of its **users**.
- **Quality attributes** are important because they determine how well a **system** will **satisfy** the **needs** of its **users**.
- **Quality attributes** have a strong relationship with the **non-functional requirements** to satisfy aspects as performance, resource usage and efficiency.
- Other **qualities** that software often satisfies in non-functional requirements include **reusability**, **flexibility**, and **maintainability**. This helps inform *how well* the code of software can evolve and allow for future changes.

Outline

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Basics of Object-O riented Design I

- **Object-oriented** has become one of the most traditional and popular **paradigms** in software development.
- It is based on the concept of **objects**, which can contain data, in the form of **fields** (often known as attributes or properties), and code, in the form of **procedures** (often known as methods).

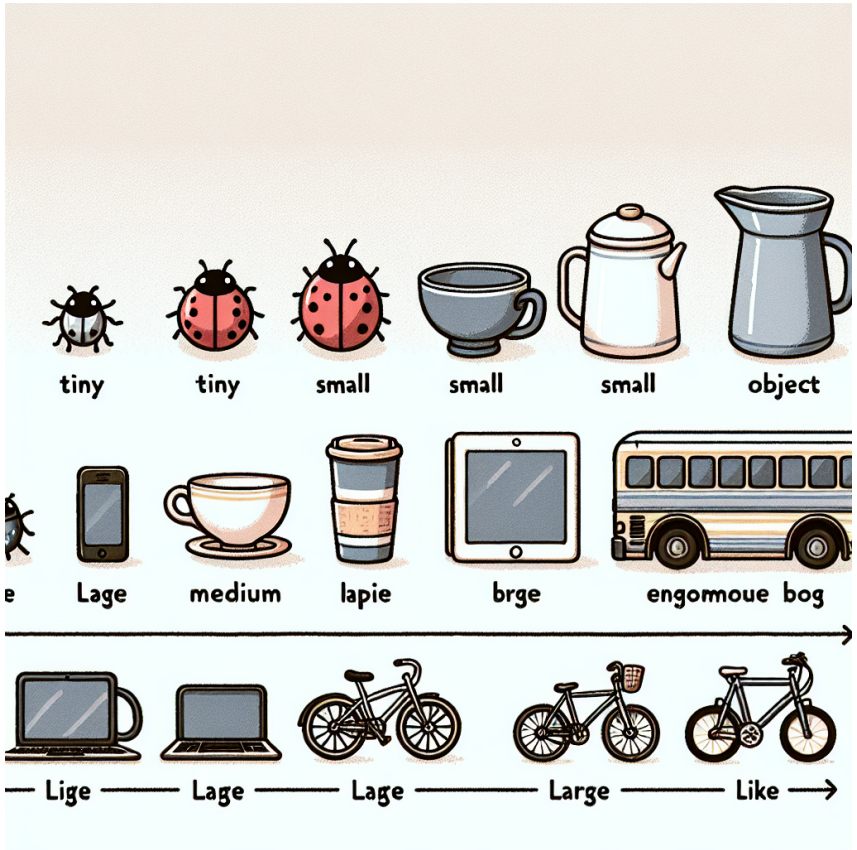

Figure: Prompt: Draw several objects sorted by size.

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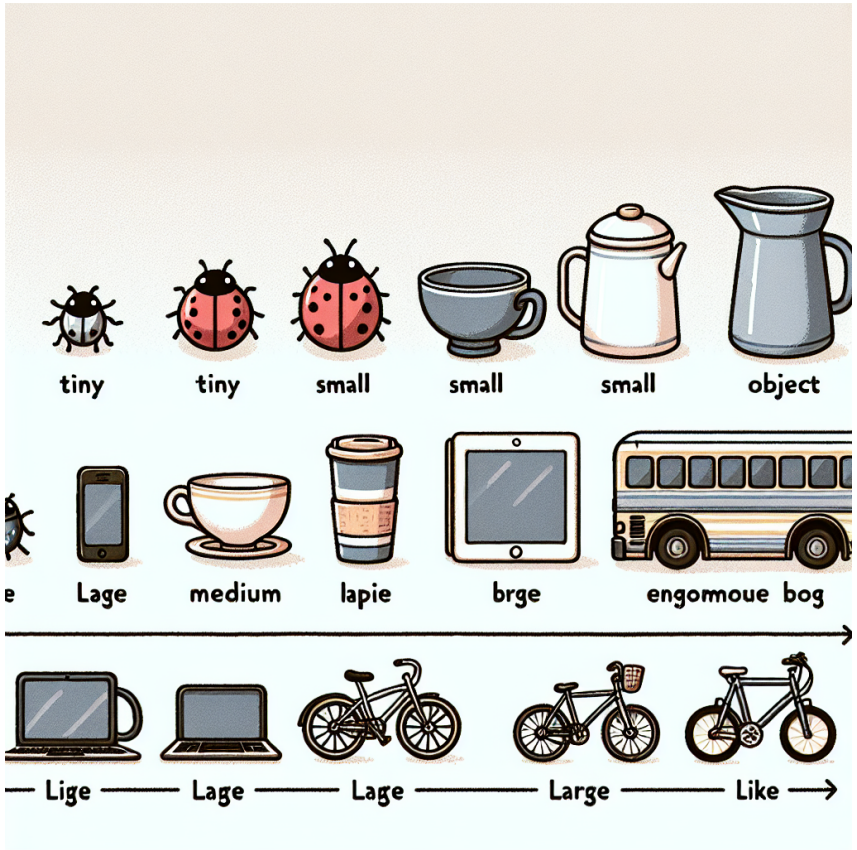


Figure: Prompt: Draw several objects sorted by size.

Basics of Object-Oriented Design II

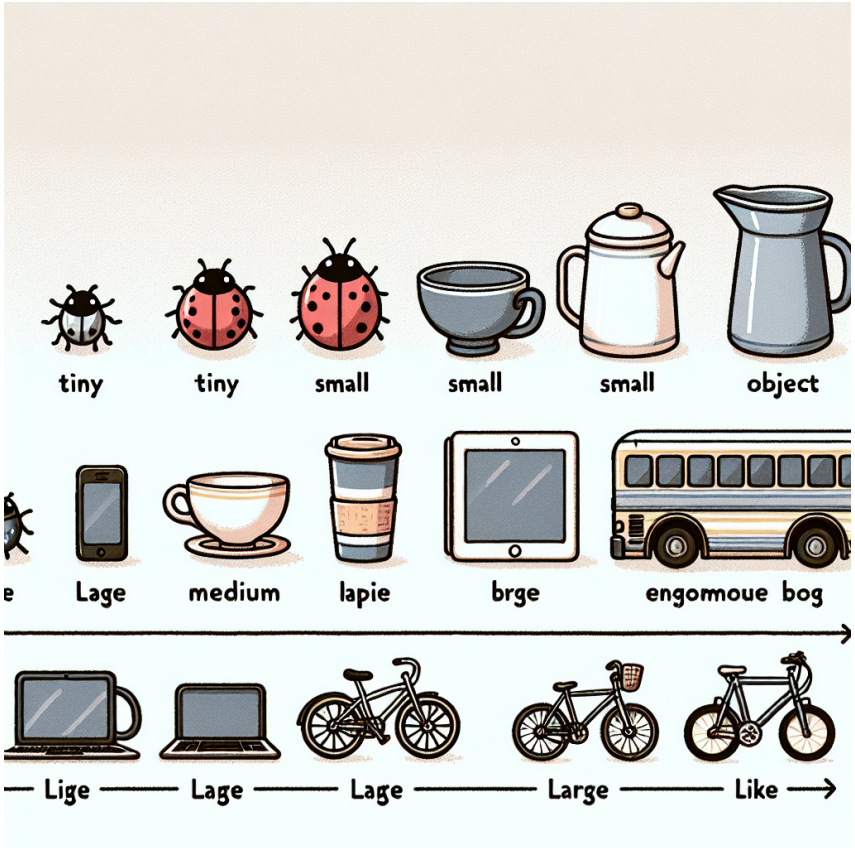
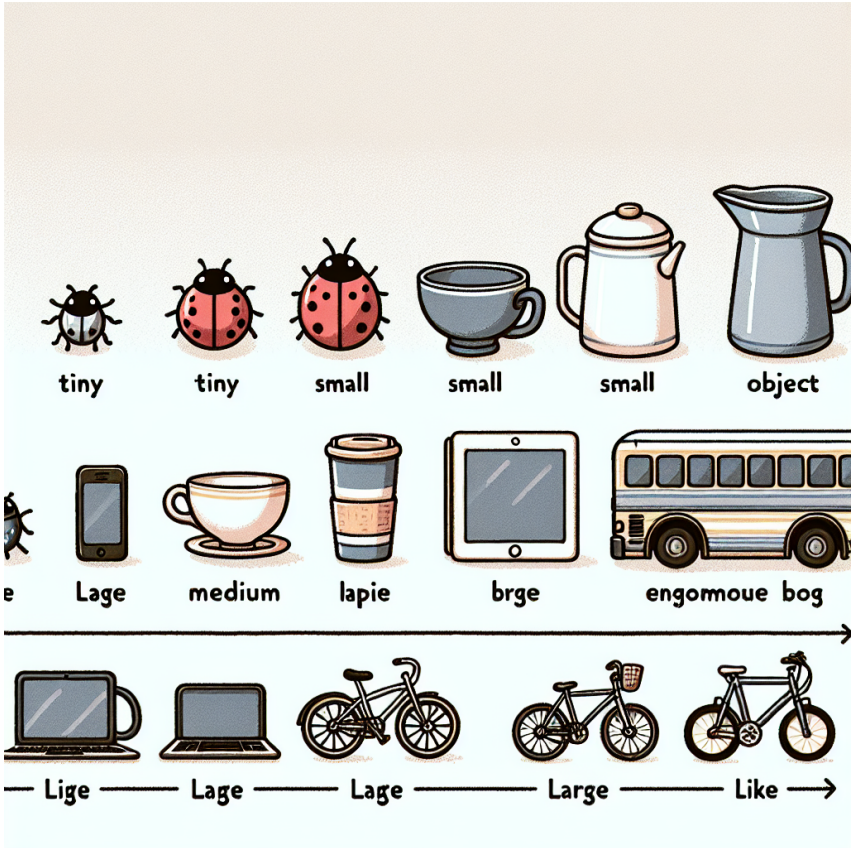


Figure: Prompt: Draw several objects sorted by size.

- The idea is to design a **system modularly**, and to make it easier to maintain, and to understand. Also the idea is emphasize the reuse of code.
- The main principles of OOD are:
  - Abstraction
  - Encapsulation
  - Inheritance
  - Polymorphism

Basics of Object-Oriented Design II



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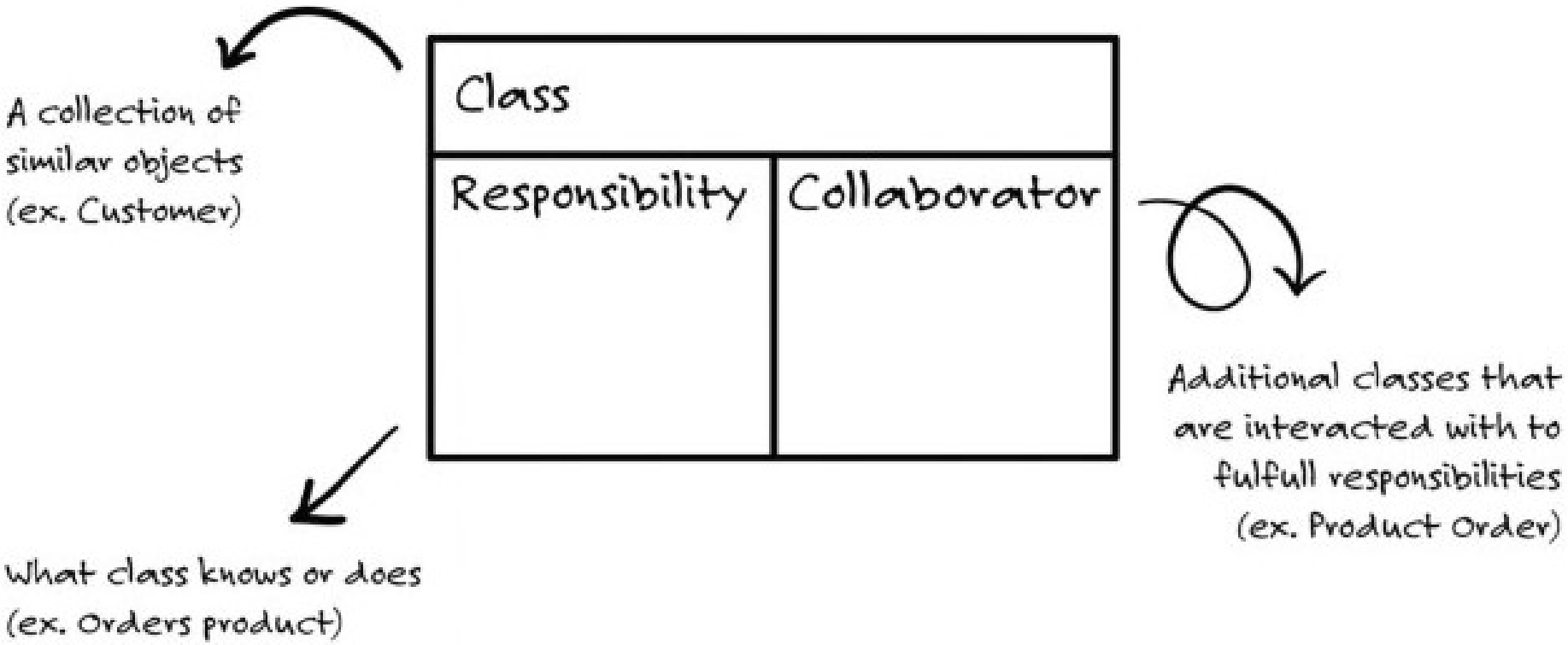
CRC Cards


A collection of similar objects (ex. Customer)
Class
Responsibility
Collaborator
Additional classes that are interacted with to fulfull responsibilities (ex. Product Order)
What class knows or does (ex. Orders product)

Prototyping and Simulation

- **CRC cards** are useful tools, but they are most powerful when used for prototyping and simulation for `conceptual design`.
- **CRC cards** are excellent tools to bring to software development team meetings. All the cards can be placed on the table, and `facilitate a discussion` or a `simulation` with the team of *how these classes work together* with other classes to achieve their responsibilities.

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Outline

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Thanks!

Questions?

Repo: *https://github.com/EngAndres/ud-public/tree/main/courses/object-oriented-programming*

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