

# OBJECT-ORIENTED ANALYSIS & DESIGN

## Object-Oriented Programming

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# Outline

- 1 Object-Oriented Thinking
- 2 Design in the Software Process
- 3 Design for Quality Attributes
- 4 Objects



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3 Design for Quality Attributes

4 Objects



# 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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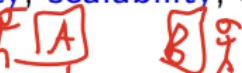
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*Team → Integration*
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Components



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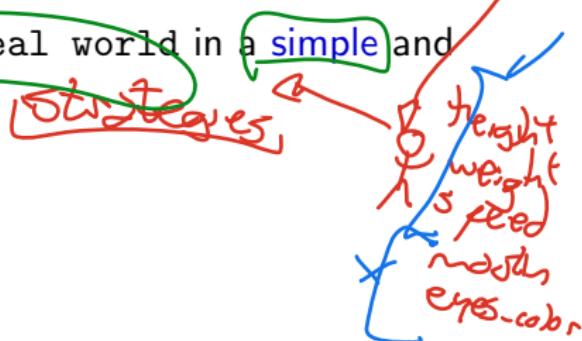
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# What is abstraction?

- **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.

*details*



# 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.
- VideoBeam** → **Retina**
- Data Information**
- HoursLife = 70
  - Frequency = 60 Hz
  - Resolution =  $2029 \times 712$
  - ID Serial



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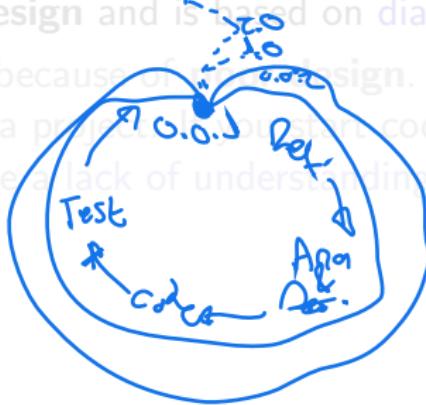
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# Software Design

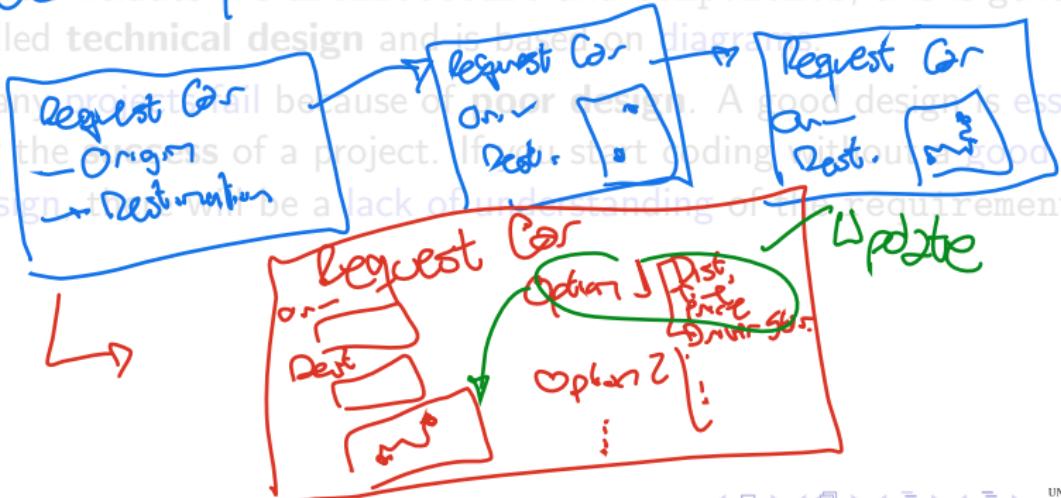
- **Software Design** is the process of transforming a set of requirements into a software solution. It is an iterative process.
  - Based on the requirements, it is possible to create the conceptual design, starting with mockups.
  - The conceptual design is then transformed into a detailed design, which includes the architecture, components, and interfaces. 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. Without coding without a good design, there will be a lack of understanding of the requirements.
- User needs → impact  
→ add value*



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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 **functional requirements**).
- 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.

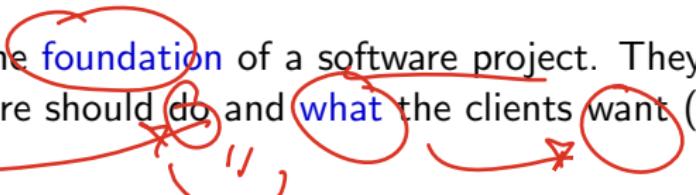


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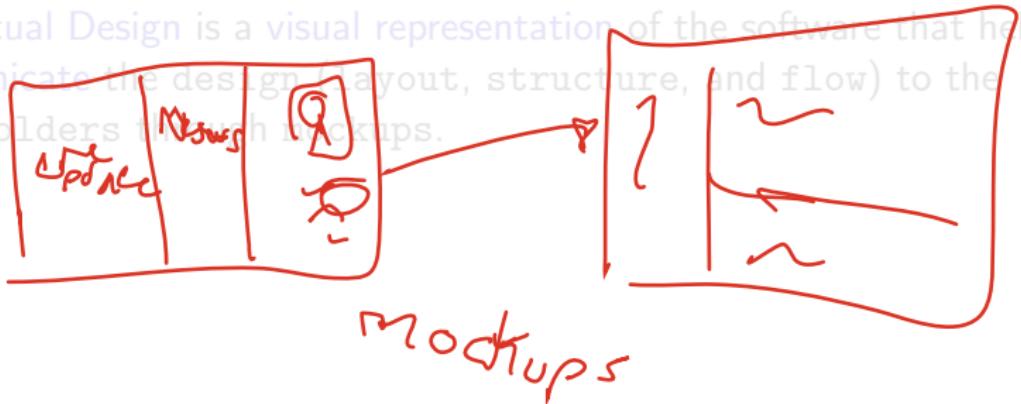
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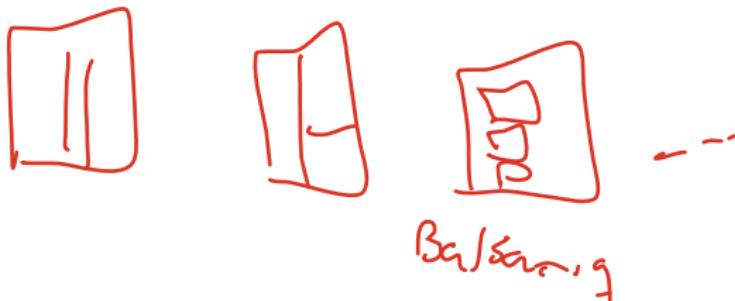
# Conceptual Design

- 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 recognition of the appropriate components, connections, and responsibilities.
- Conceptual Design is a visual representation of the software that helps communicate the design (layout, structure, and flow) to the stakeholders through mockups.

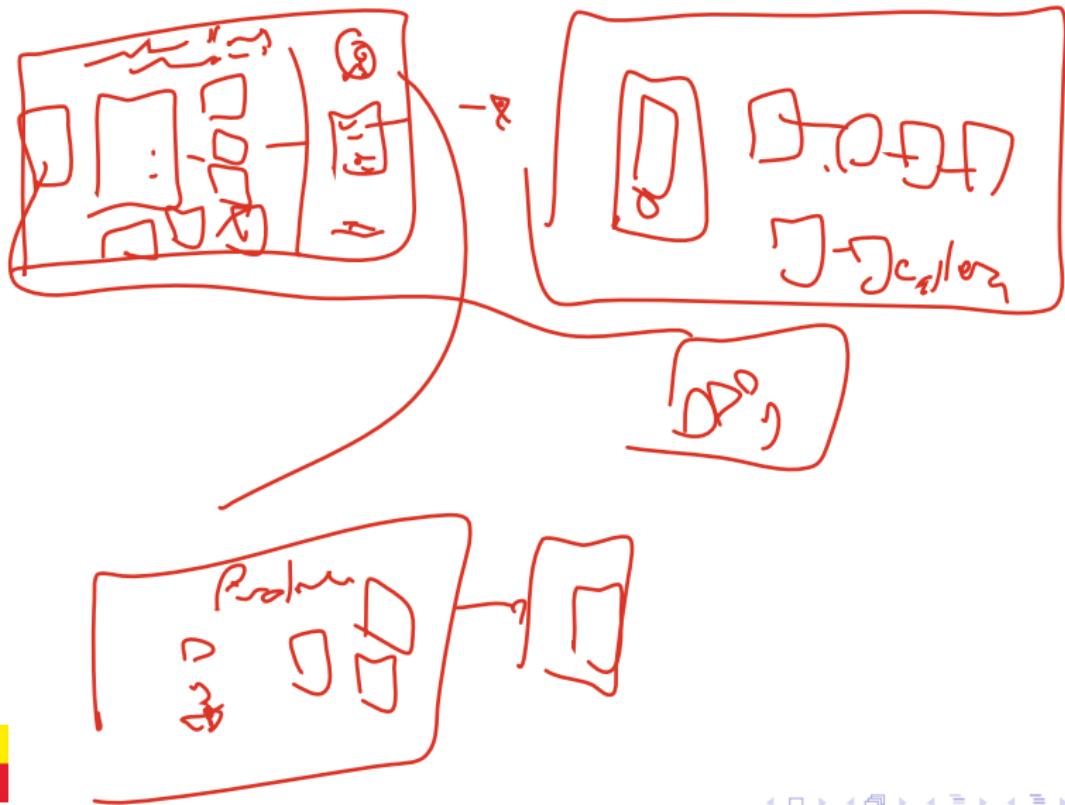


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# Mockup Example: Cell-Phone On-Line Store



# 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.

User Story → need client id words



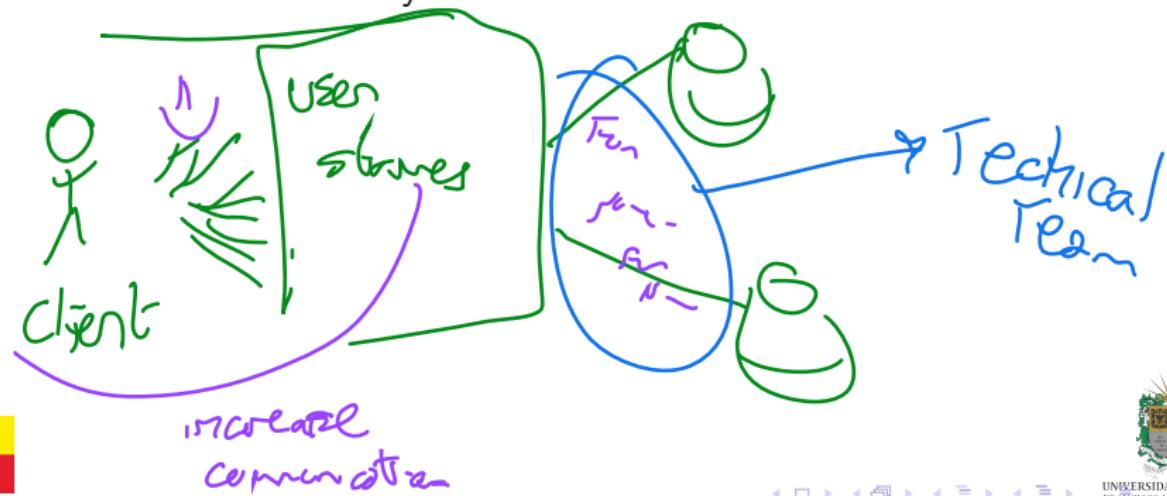
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- requirement*



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# User Stories: Format Example

Sprint / Weeks

| <b>User Story</b>                                                                                          |                       |                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------------------------------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title:                                                                                                     | Priority:             | Estimate:                                                                                                                                                                                                                                                                                               |
| Student Enrollment                                                                                         | High<br>medium<br>low | 3 weeks                                                                                                                                                                                                                                                                                                 |
| <b>User Story:</b>                                                                                         |                       |                                                                                                                                                                                                                                                                                                         |
| <p>As a [description of user],<br/>           I want [functionality]<br/>           so that [benefit].</p> |                       | <p>As a student,<br/>           I want to enroll courses online<br/>           so that I can avoid queues and save time</p>                                                                                                                                                                             |
| <b>Acceptance Criteria:</b>                                                                                |                       | <p>Given [how things begin]<br/>           When [action taken]<br/>           Then [outcome of taking action]</p> <p>Given after that<br/>           NO students<br/>           they enroll courses &amp; watch schedule<br/>           each one must see an<br/>           graphic weekly schedule</p> |

 ProductPlan


# Use Cases

- **Use cases** are descriptions of how a system will be used by its users.
- They are used to capture the functional requirements of a system in a structured and detailed way.
- They are written from the perspective of the user and describe the interaction between the user and the system.

Roles

UML

Functional  
Requirements

Unified  
Model  
Language



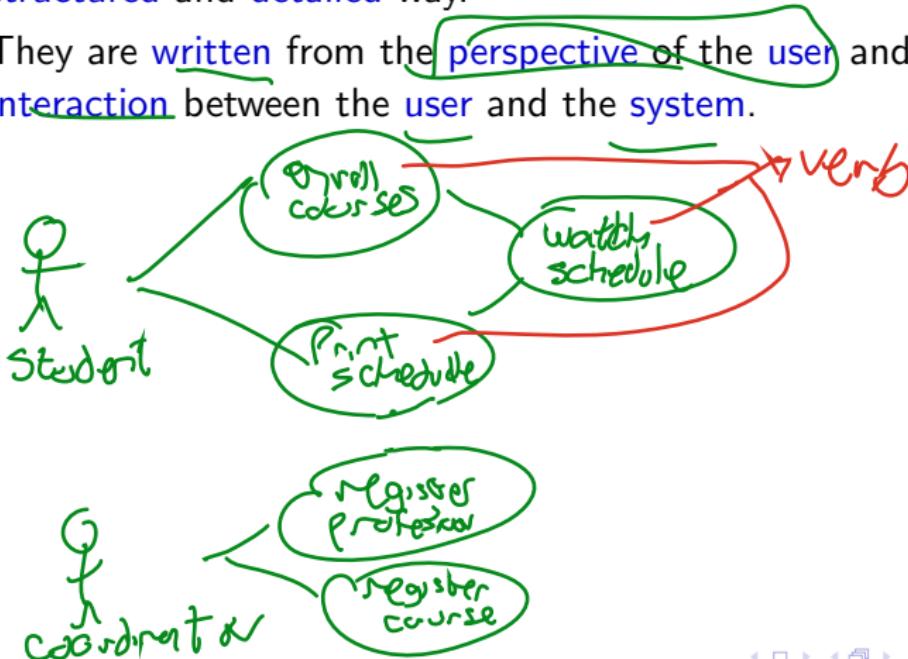
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- In the **technical design**, the major **components**, **connections** and **responsibilities** are identified.
- The **technical design** is not finished until each component has been refined, designed and documented.
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# 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** 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

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- **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**.
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# Satisfying 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.
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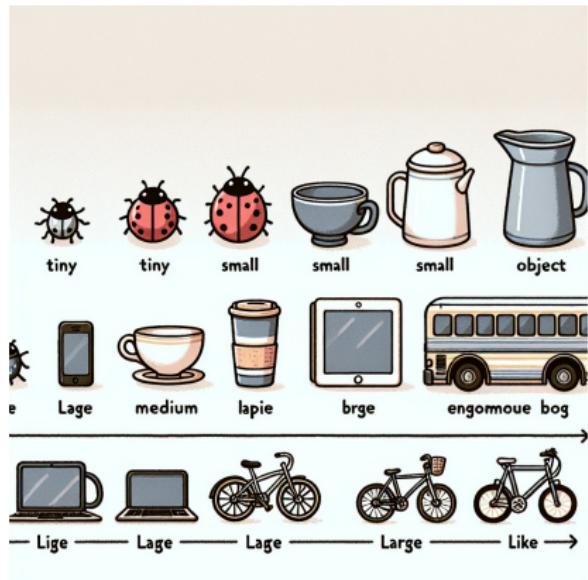
# Outline

- 1 Object-Oriented Thinking
- 2 Design in the Software Process
- 3 Design for Quality Attributes
- 4 Objects



# Basics of Object-Oriented 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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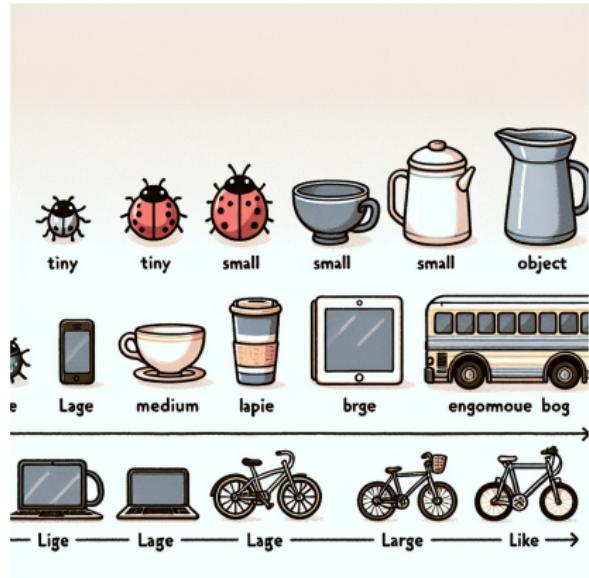


Figure: Prompt: Draw several objects sorted by size.



# Basics of Object-Oriented Design II

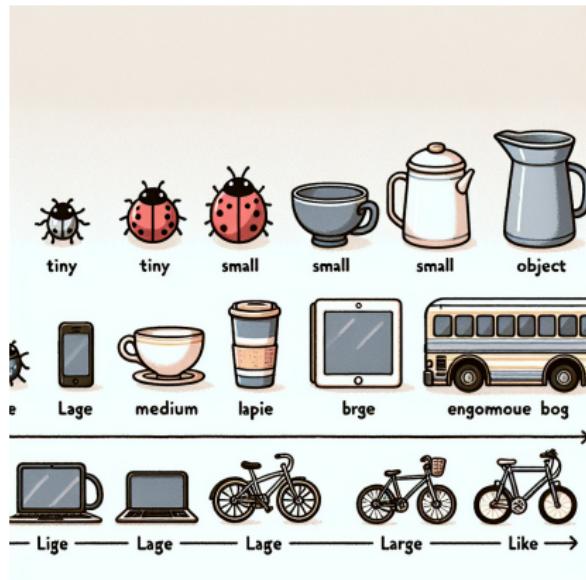


Figure: Prompt: Draw several objects sorted by size.



- 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



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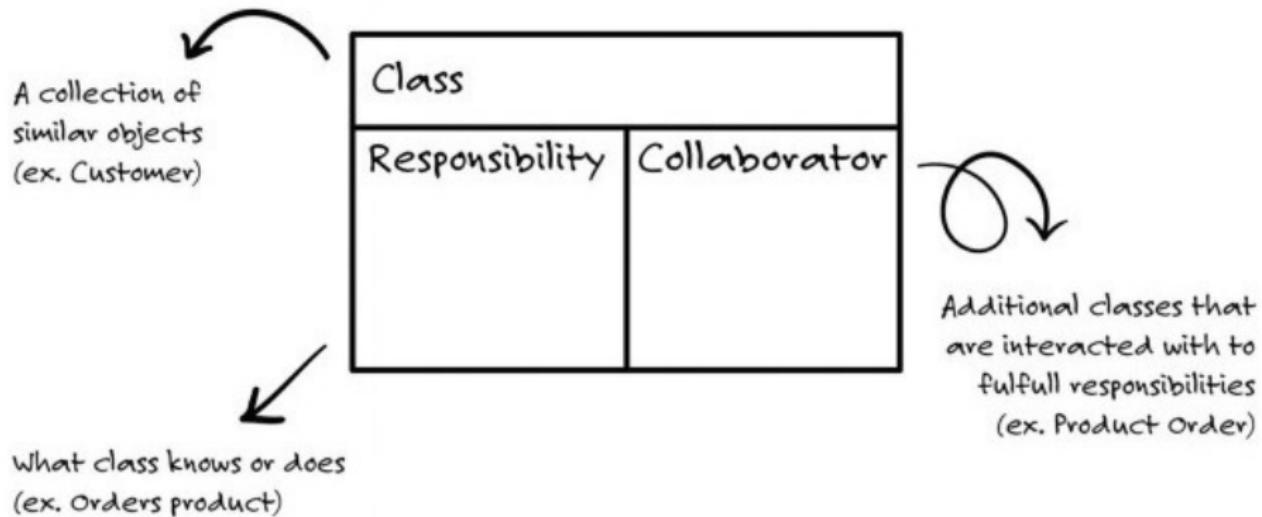
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# CRC Cards



# 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**.



# Outline

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# Thanks!

## Questions?



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

