Object-Oriented Analysis & Design

Object-Oriented Programming

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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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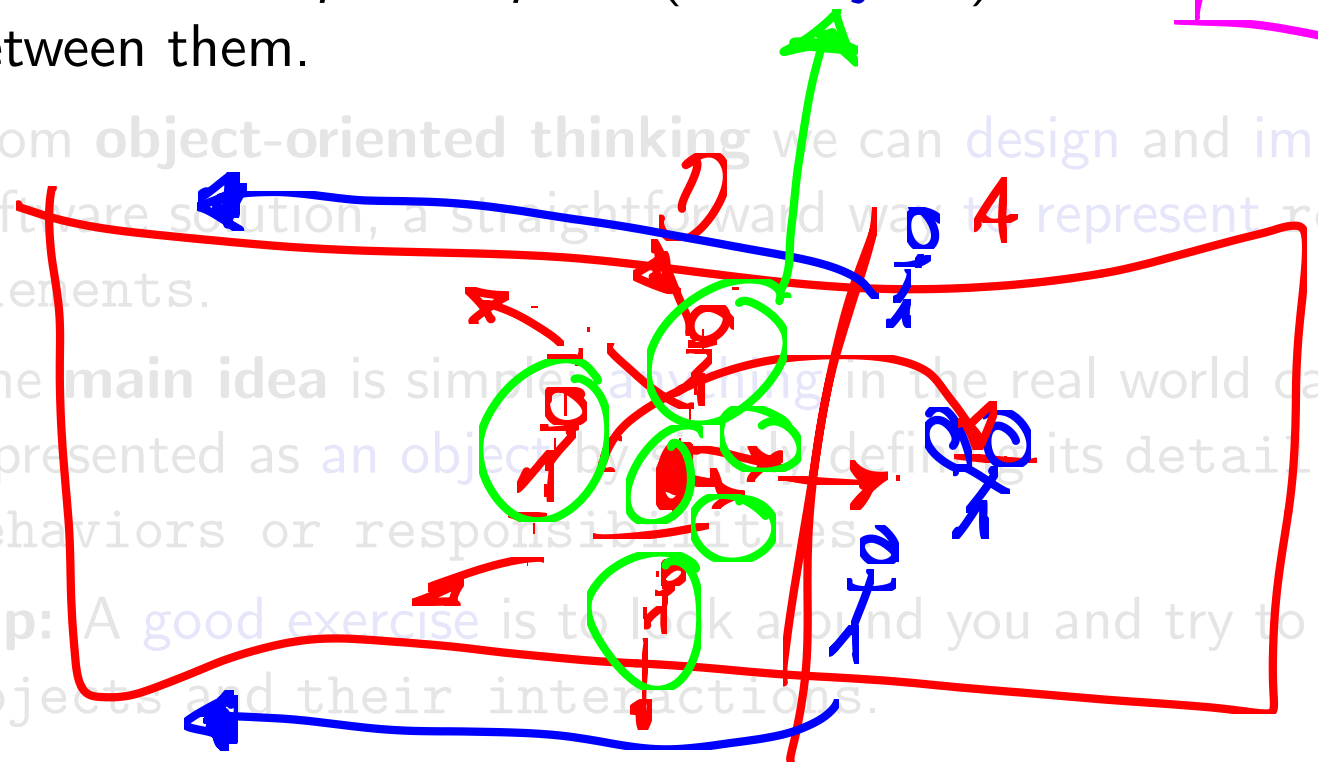

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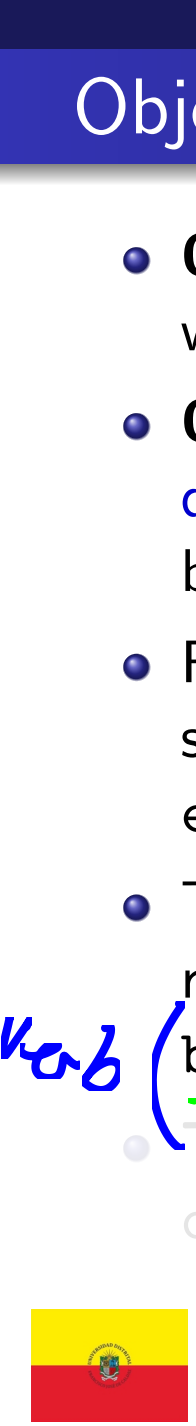

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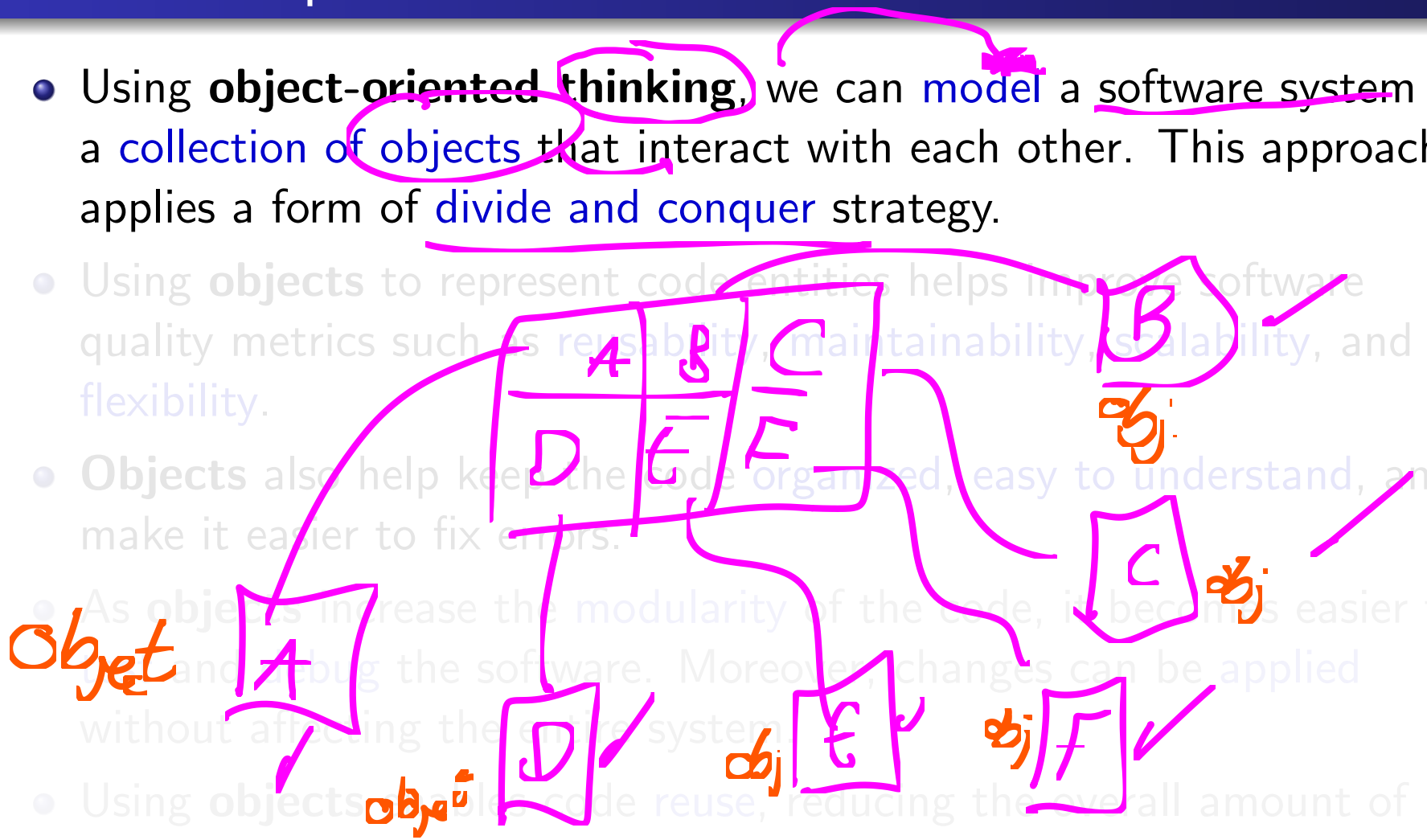
Software Implications

- 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 expand and debug the software. Moreover, changes can be applied without affecting the entire system.
- Using **objects** fosters 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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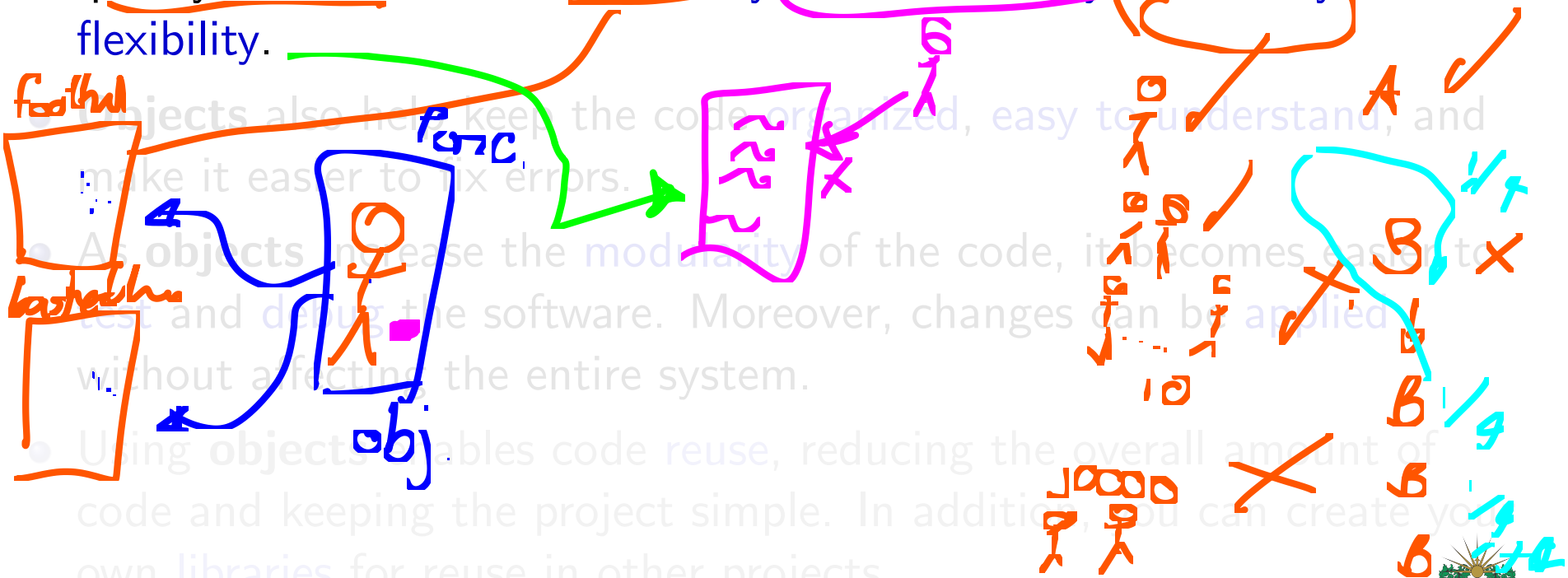

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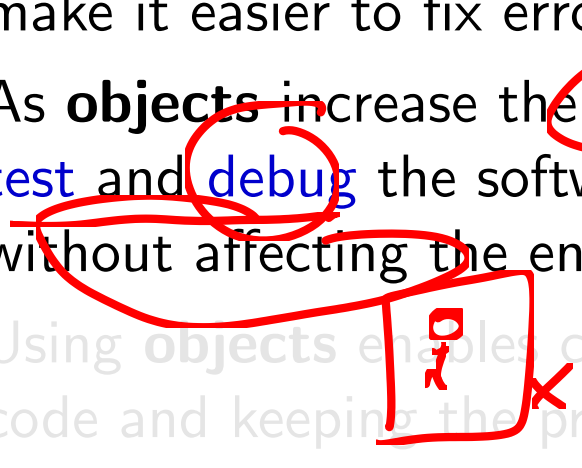

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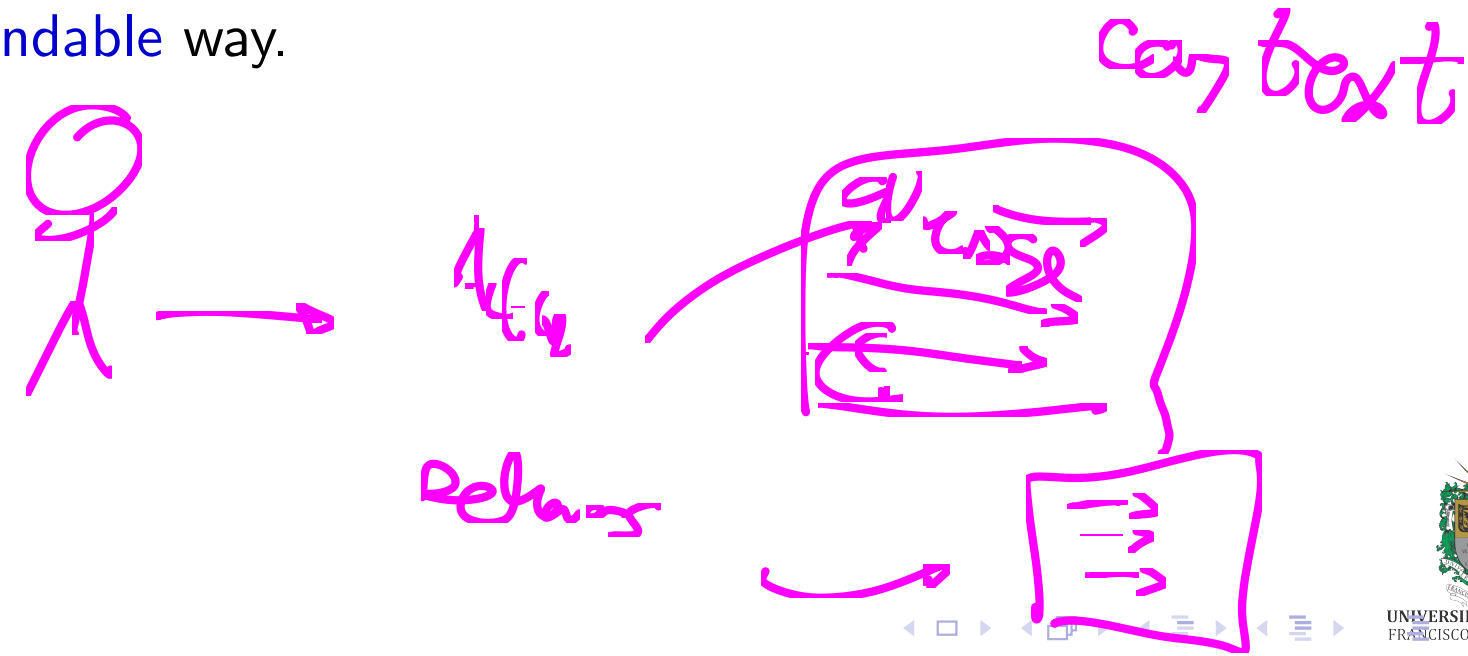
What is abstraction?

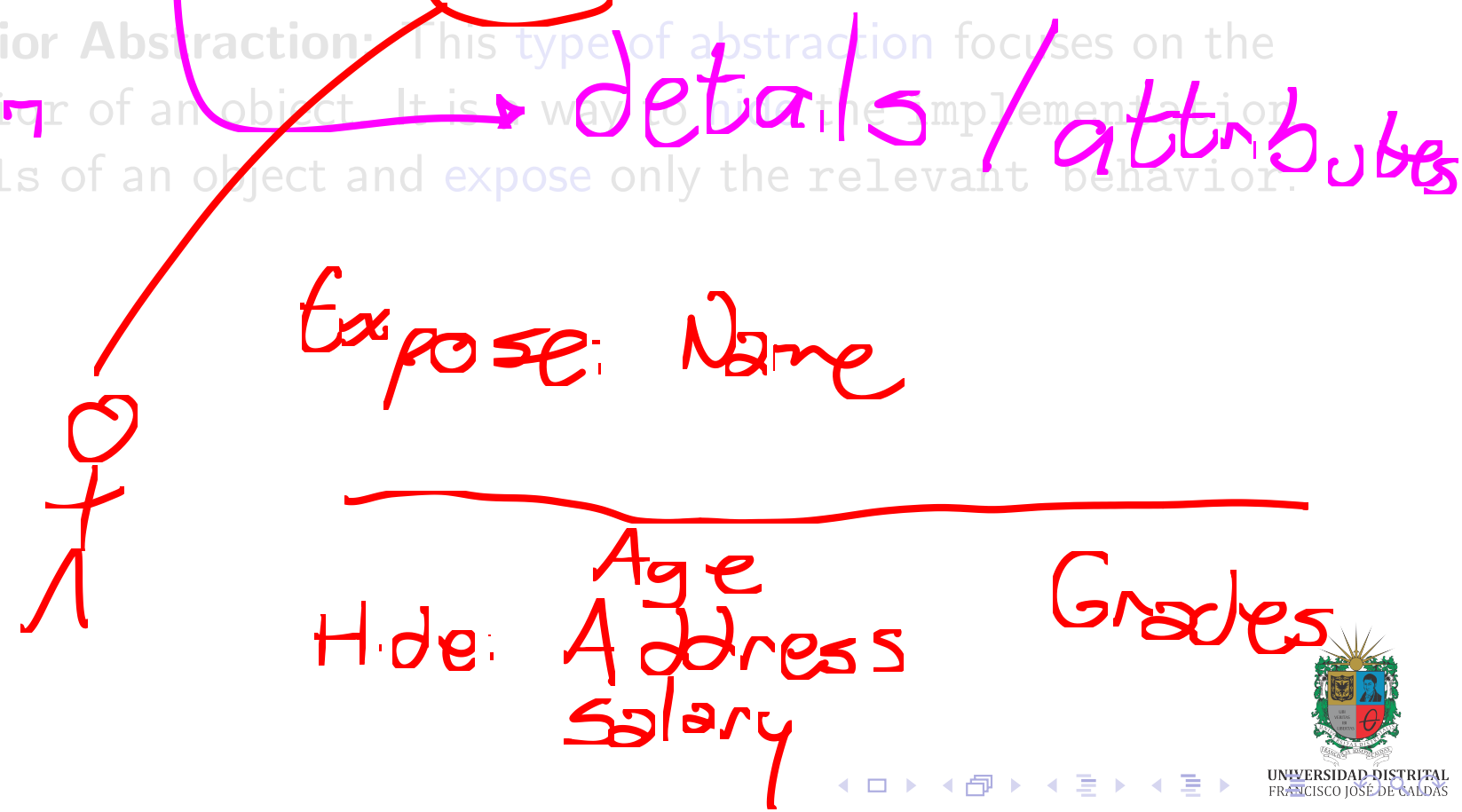
- **Abstraction** is the process of filtering out the `characteristics` of an object that we are interested in, and ignoring the rest.
- **Abstraction** is a way to simplify the complexity of the real world by focusing on the `relevant` parts.
- **Abstraction** is a way to represent the `essential` features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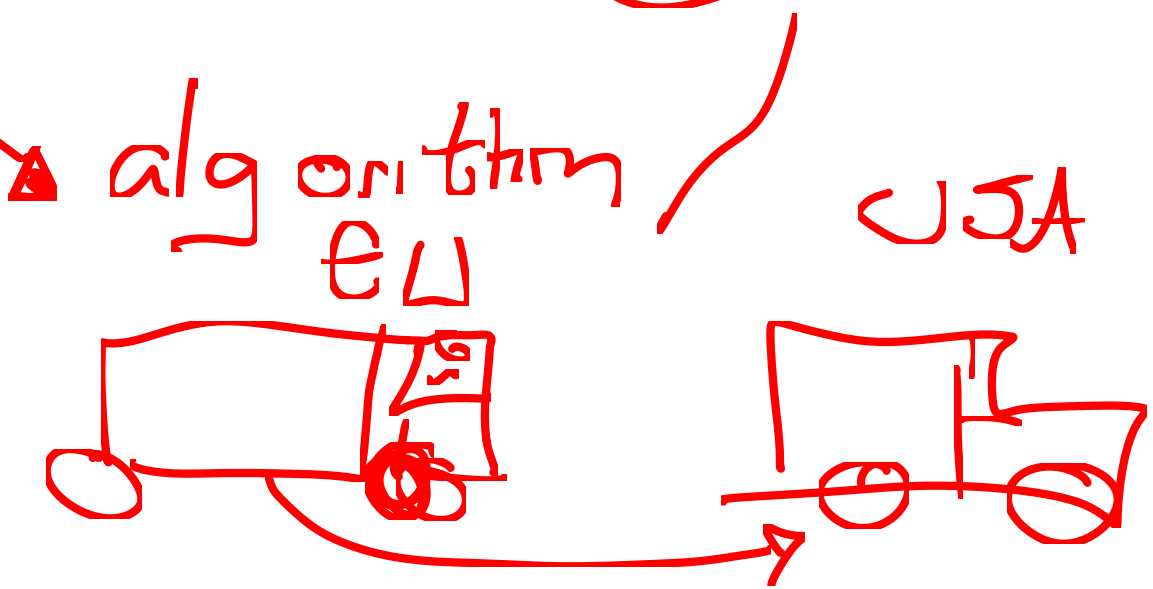

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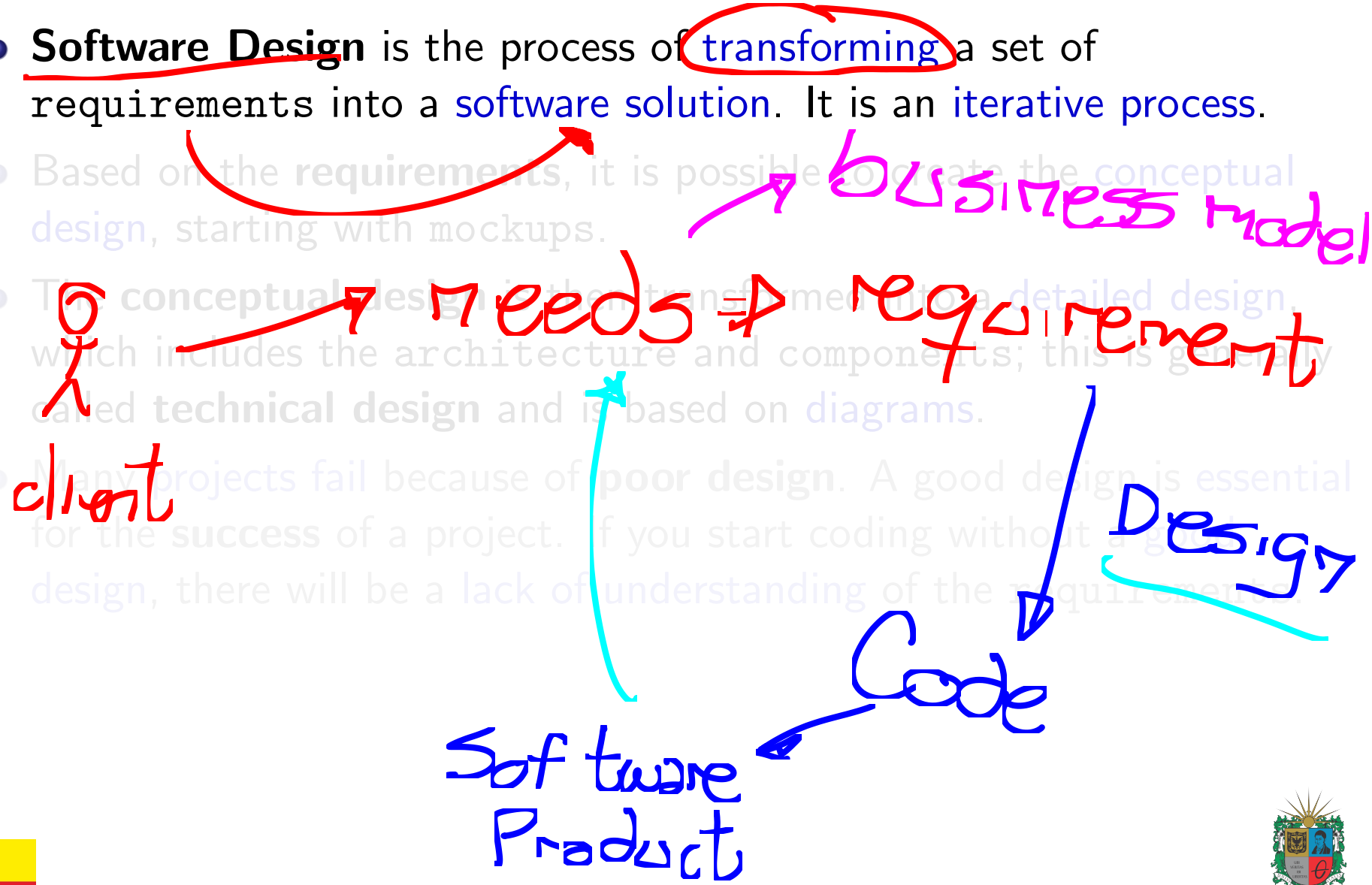
Software Design

- **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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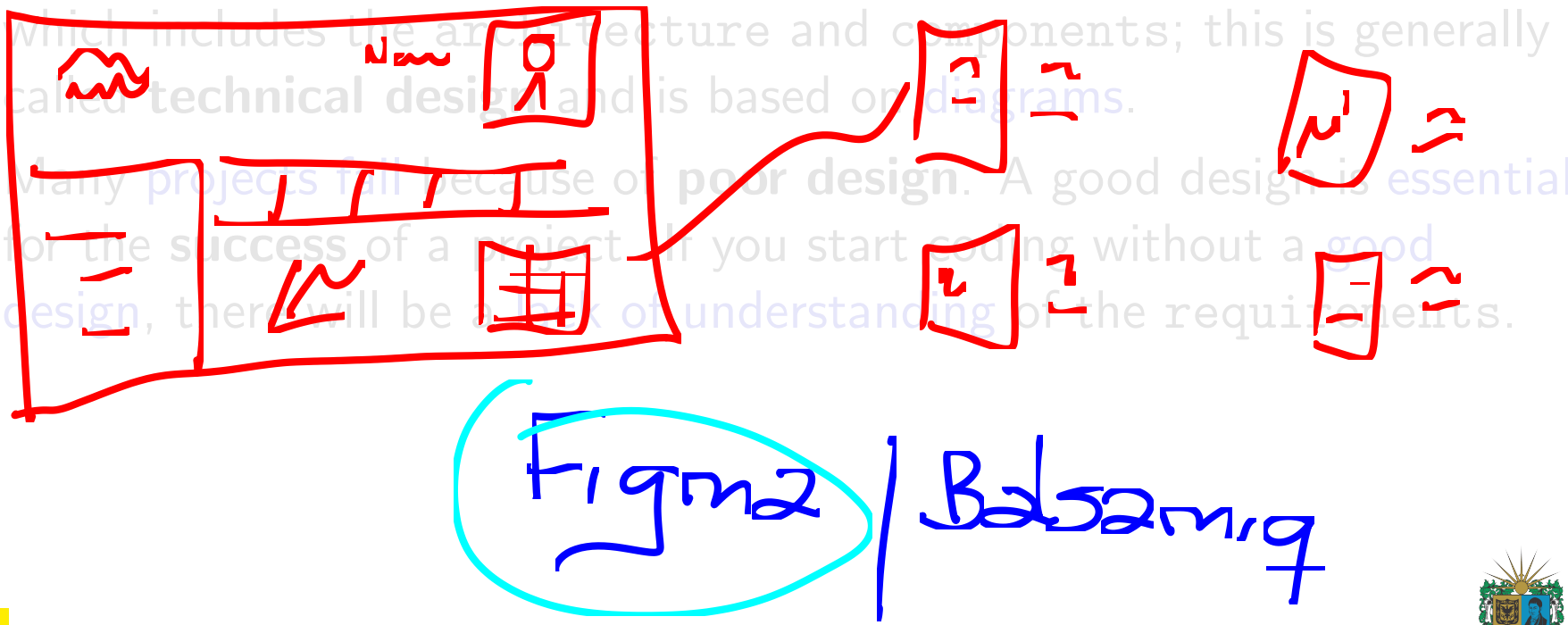

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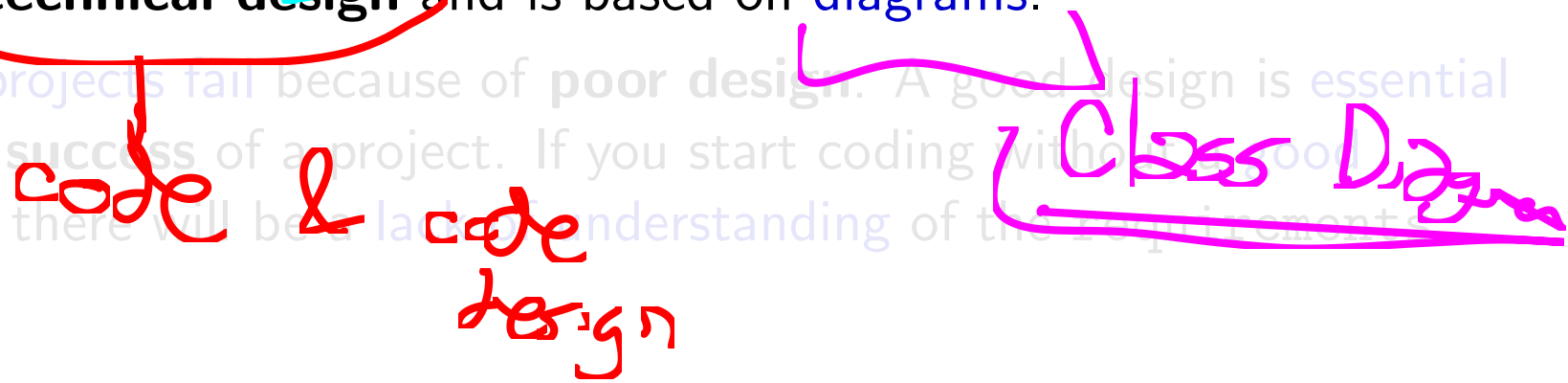

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Requirements

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.
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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 appropiate 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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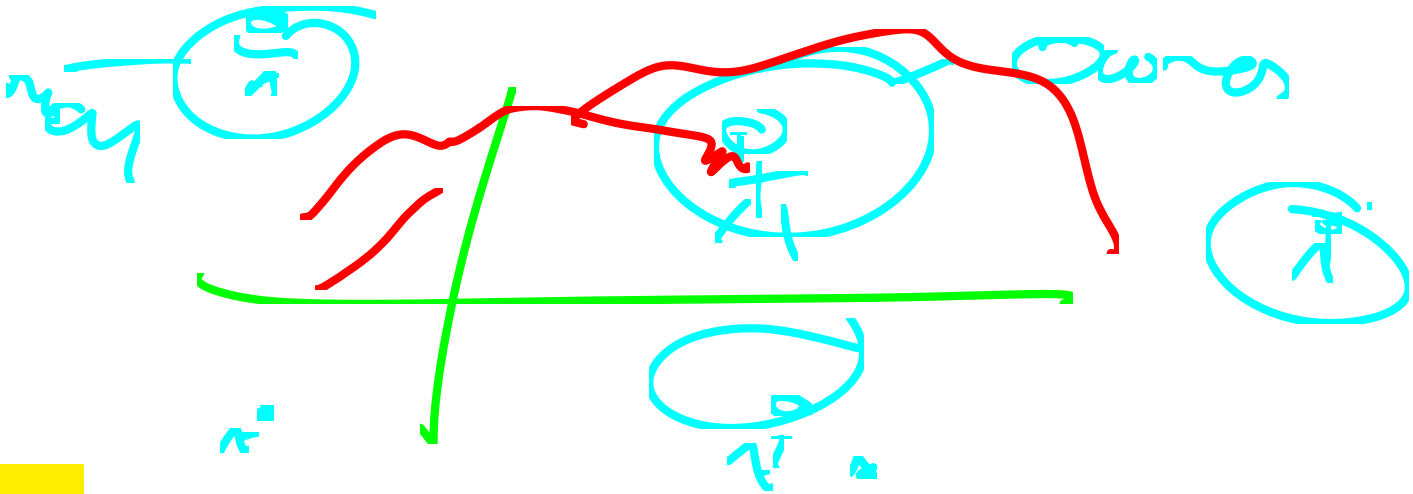
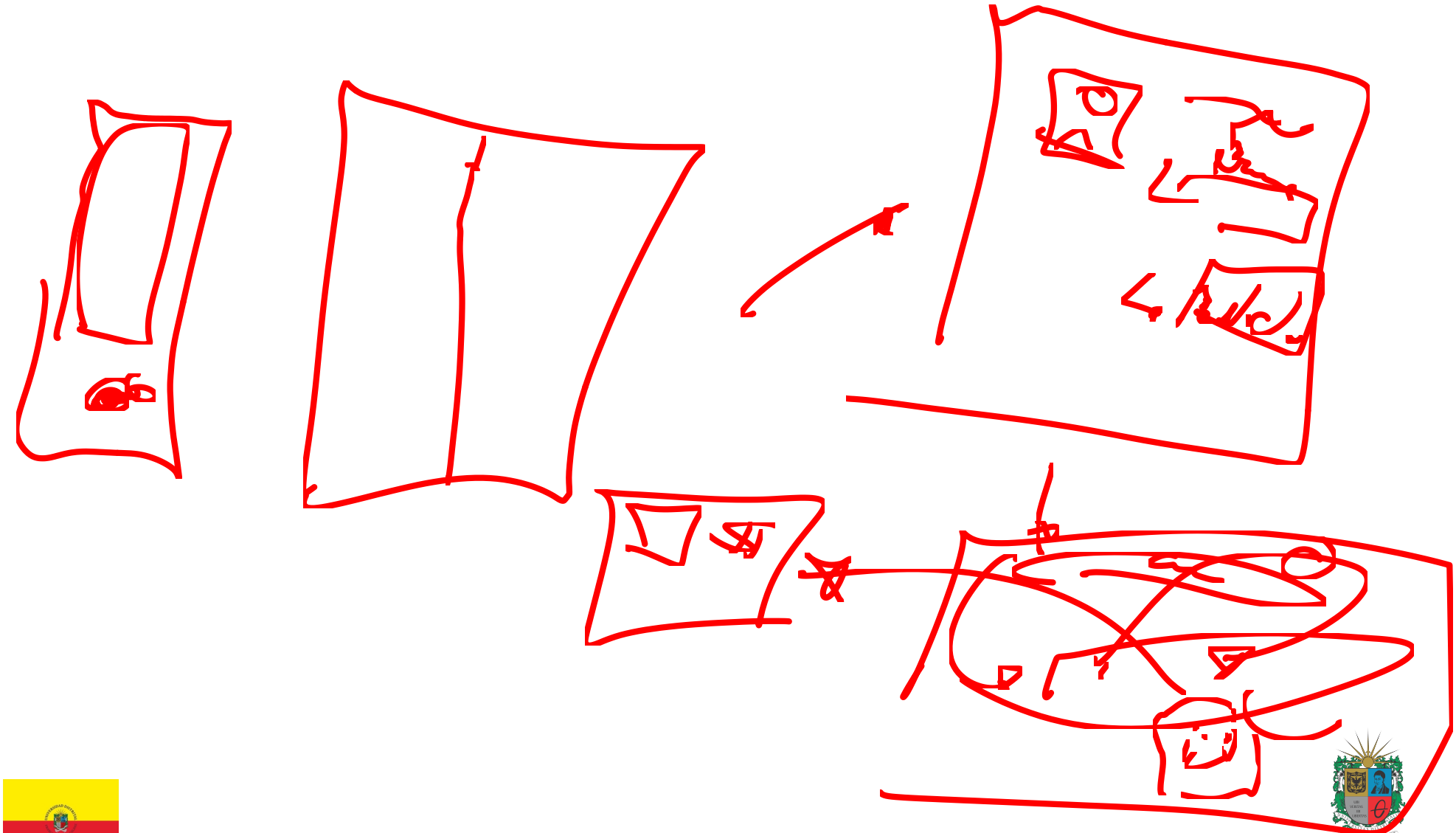


Mockup Example: *Cell-Phone On-Line Store*



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.

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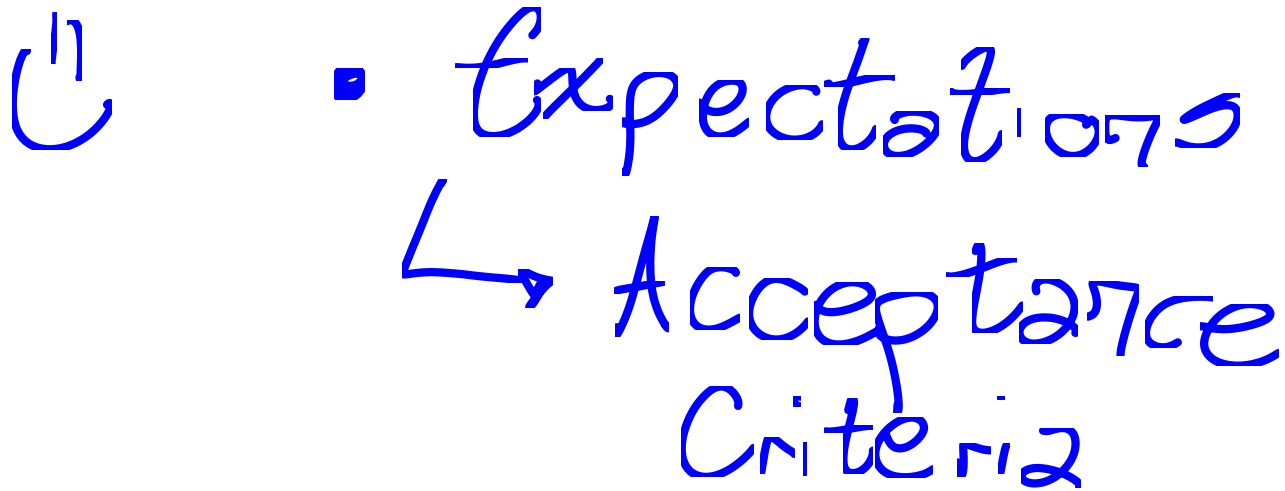

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User Stories: Format Example

User Story

Title: Watch sch. schedule	Priority:	Estimate:
User Story: As a [description of user], I want [functionality] so that [benefit].	As a student, I want watch my schedule, so that I can attend to my courses.	
Acceptance Criteria: Given [how things begin] When [action taken] Then [outcome of taking action]	Given the enrolling out dates when I do click in schedule button Then my schedule should be watching as a table	

role

action

ProductPlan

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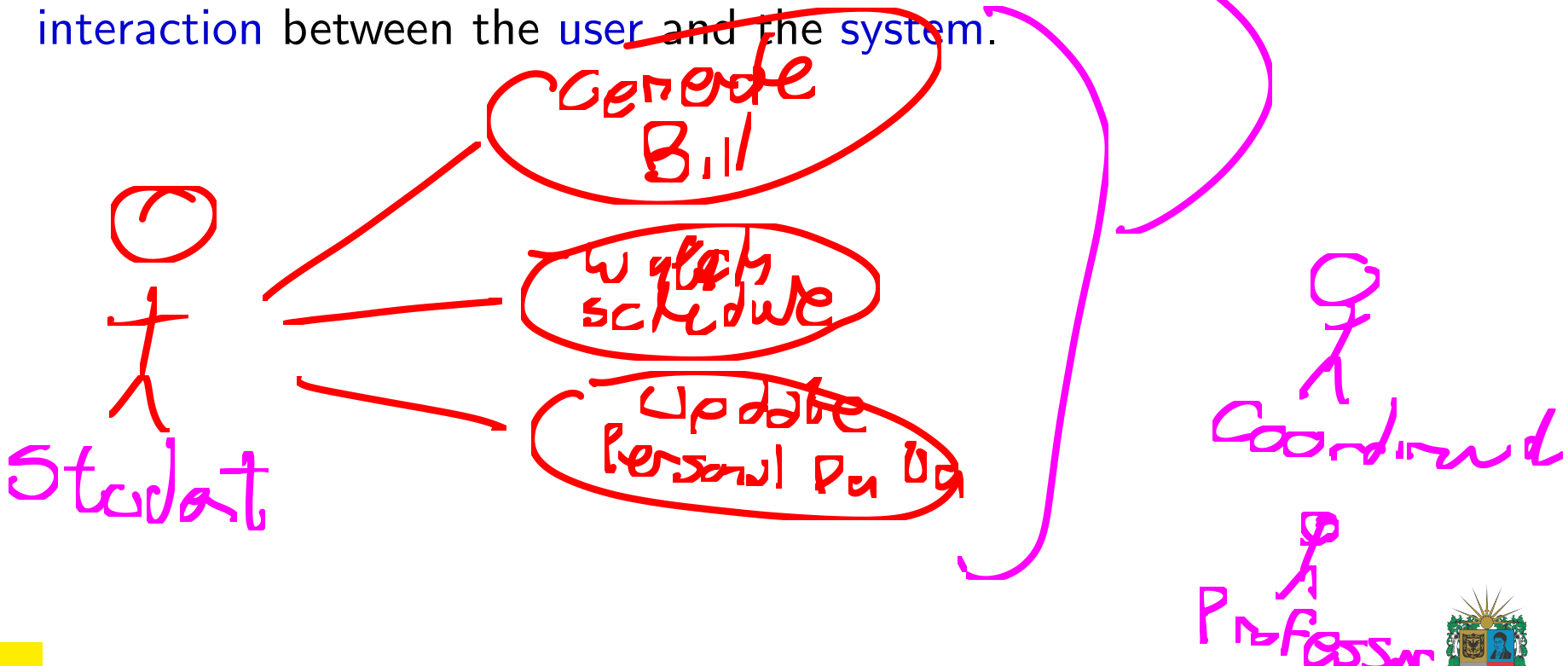
Use Cases

- **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.



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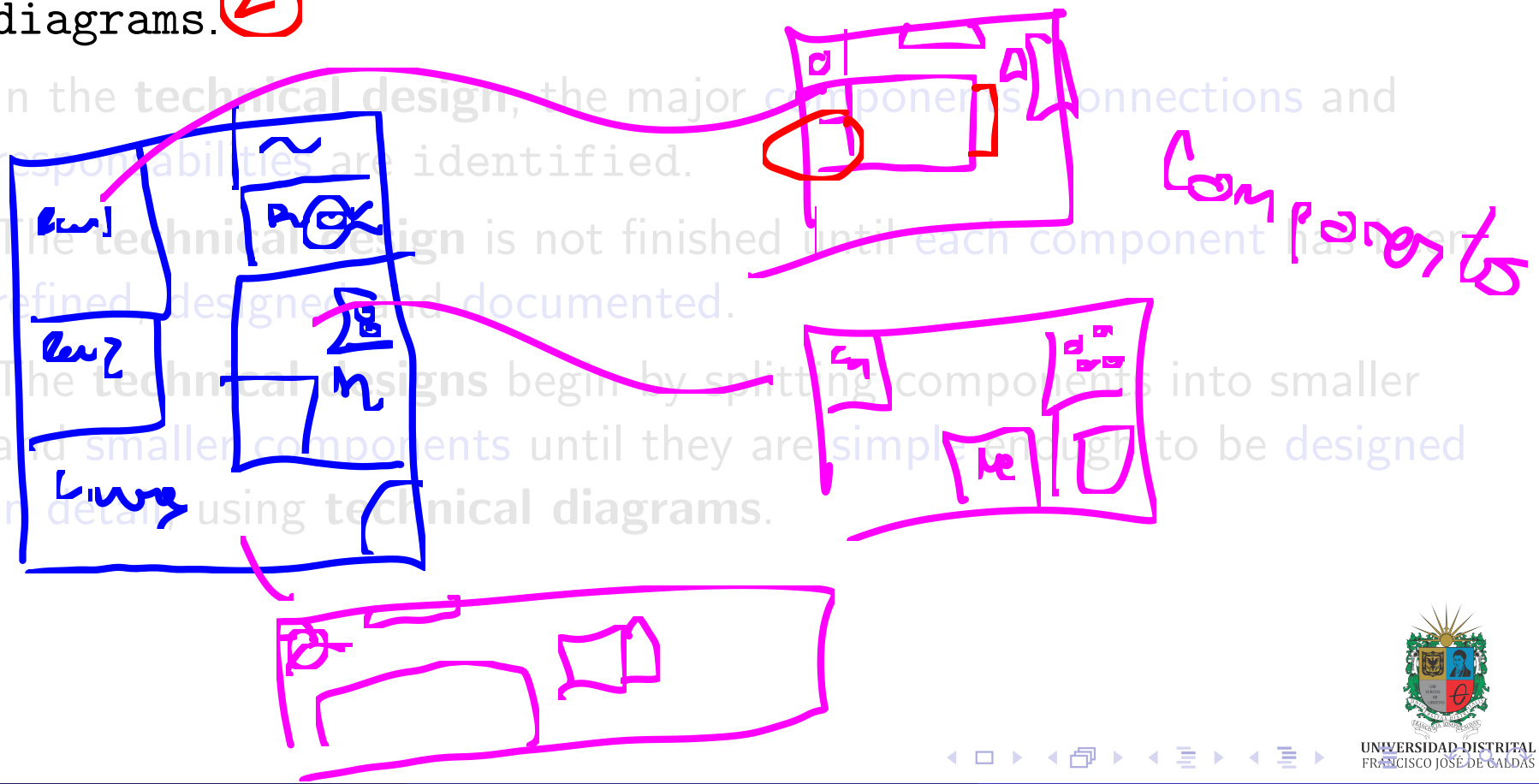

- In the **technical design**, the major components, connections and responsabilities are identified.
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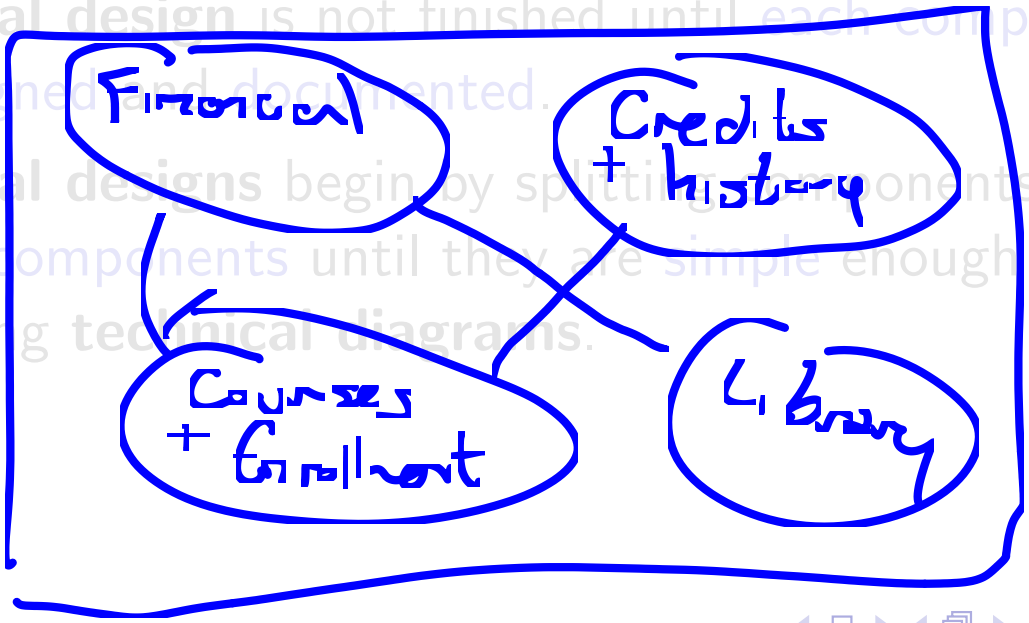

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Compromise in Requirements and Design

- **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`.

Security
+ auth → speed
- performance
slow

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Trade-Offs

- **Trade-offs** are inevitable in software design. **Quality attributes** are often competing and contradictory.
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sec. 0.6

Fast 0.9

Friendly 0.2

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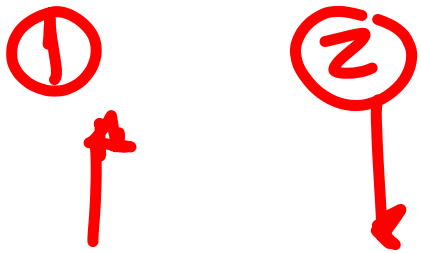

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Context and Consequences

- **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.
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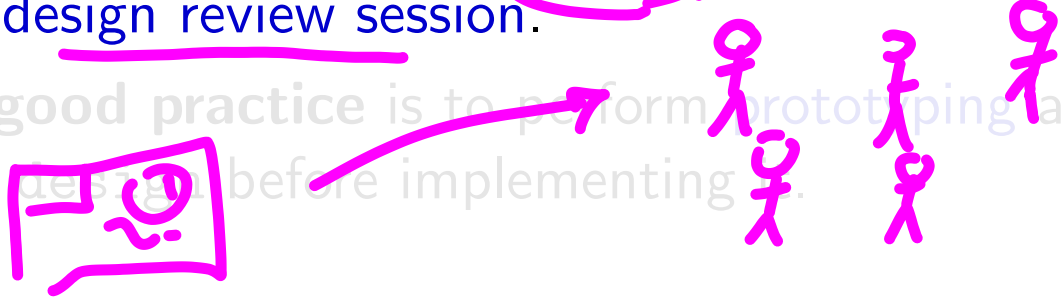

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code

(Figma)

Balsamiq

mockups

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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.
- 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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+ ⇒ global quality

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Req Func.
- show schedule
- enroll course
- pay debt

Req. non-Func.
- Resp < 300 ms
- Support > 5000 users
- Enqueue re los requests

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Outline

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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).

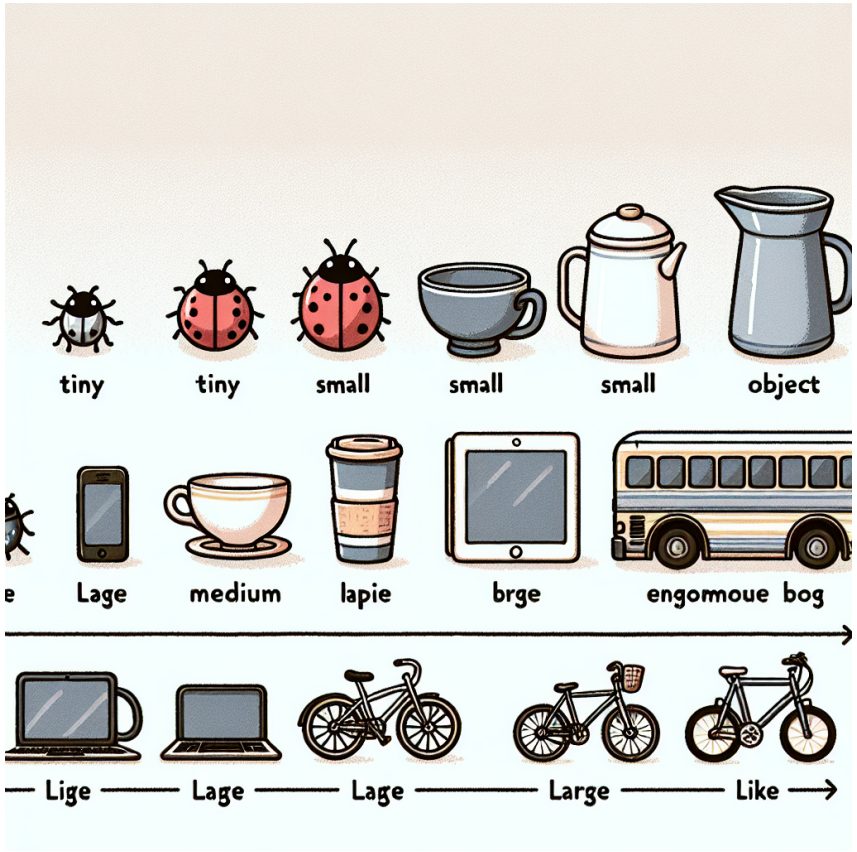

Figure: Prompt: Draw several objects sorted by size.

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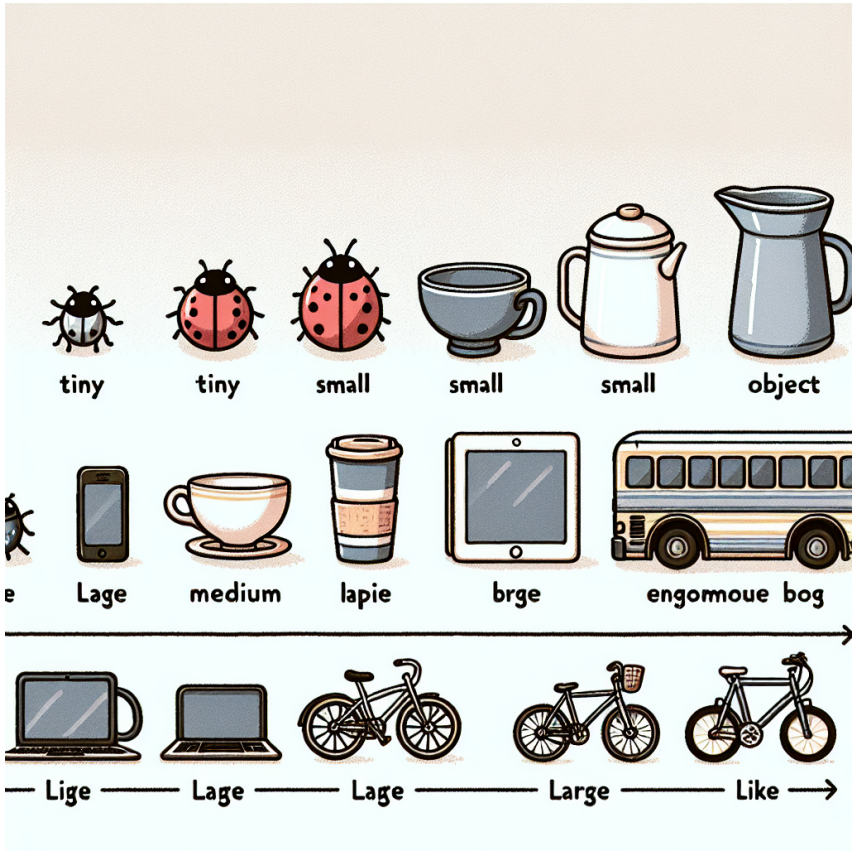

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Basics of Object-Oriented Design II

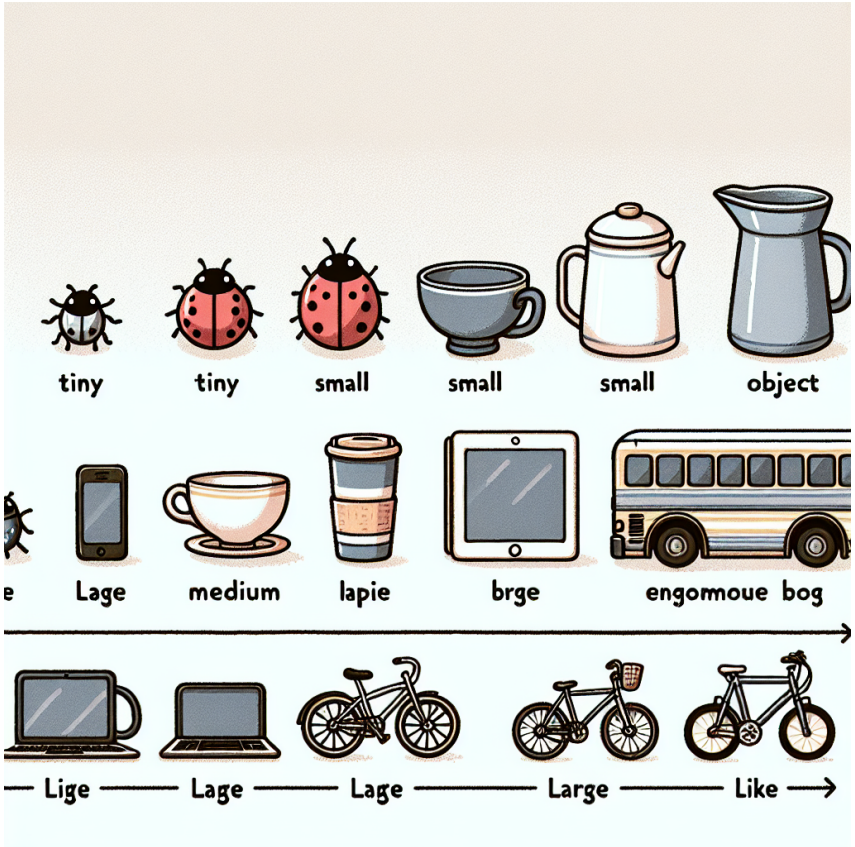
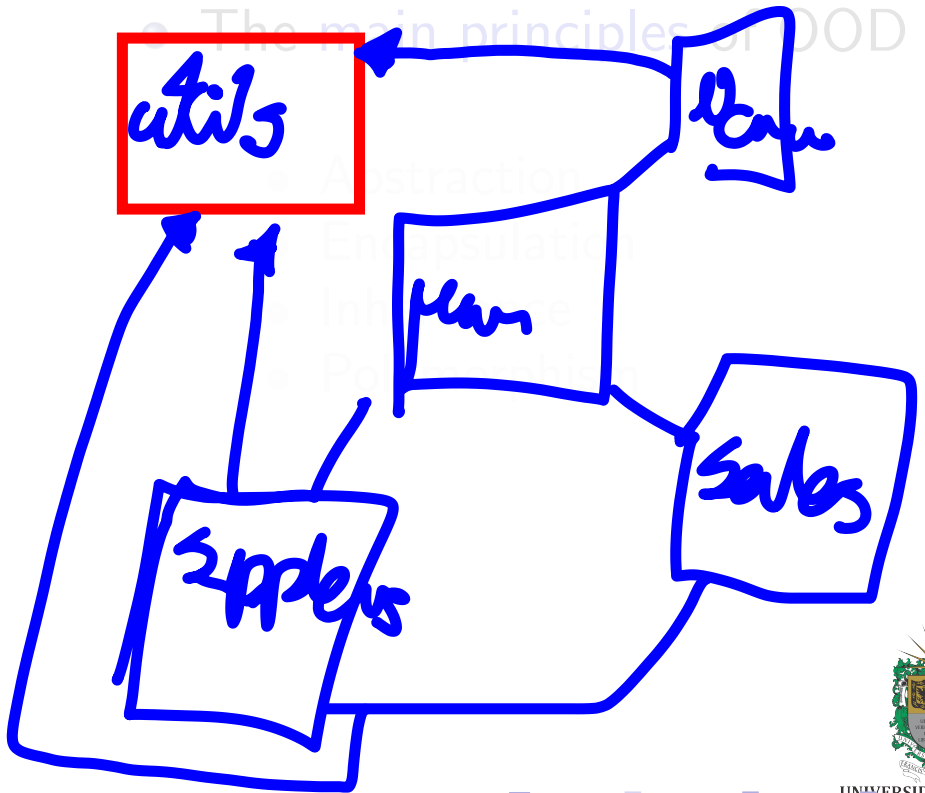
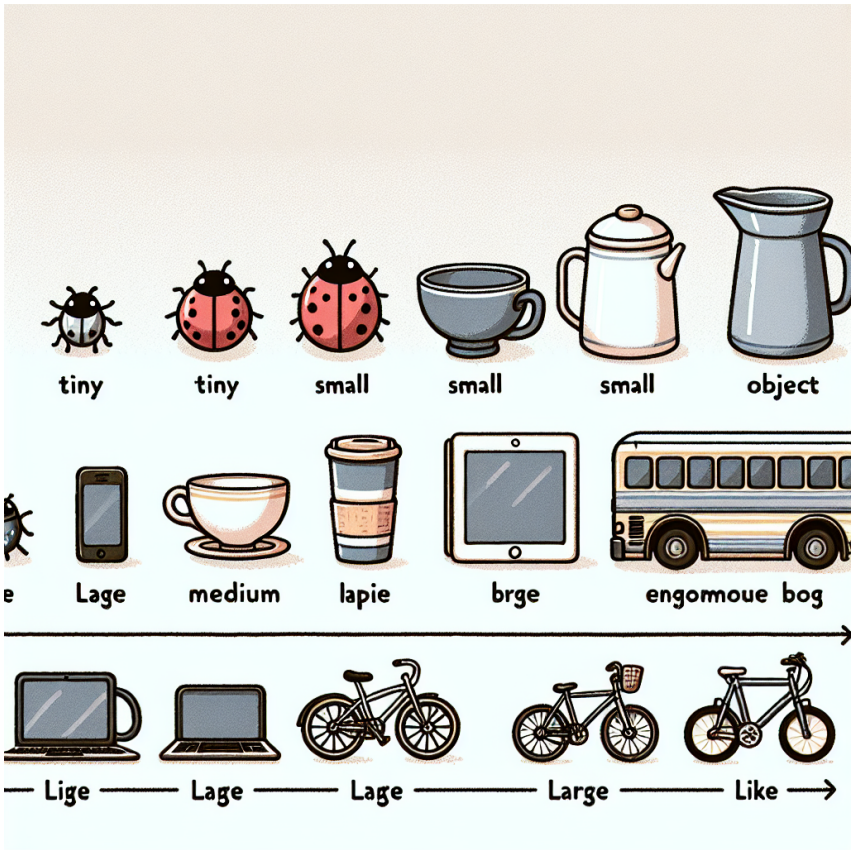


Figure: Prompt: Draw several objects sorted by size.

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



Basics of Object-Oriented Design II



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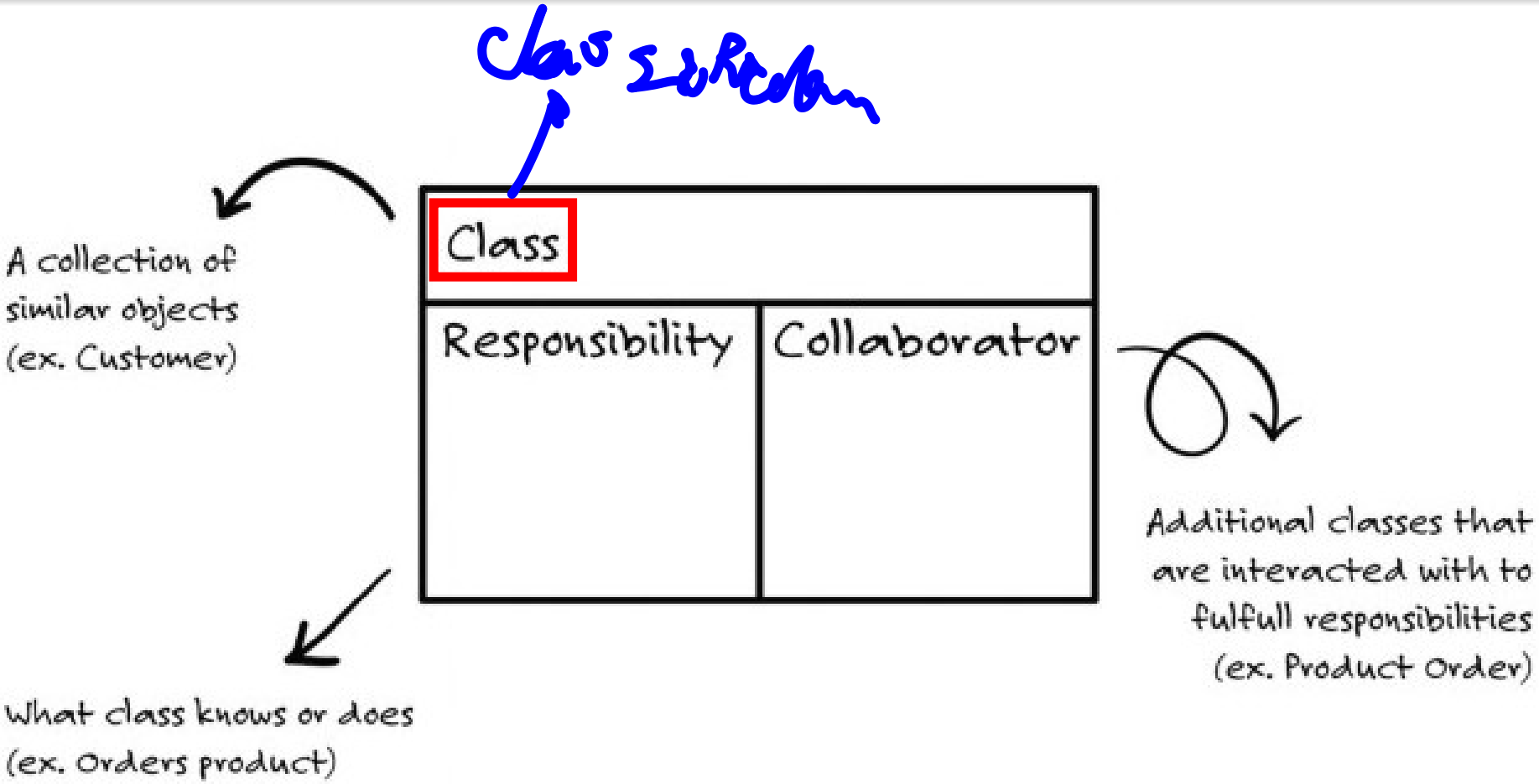
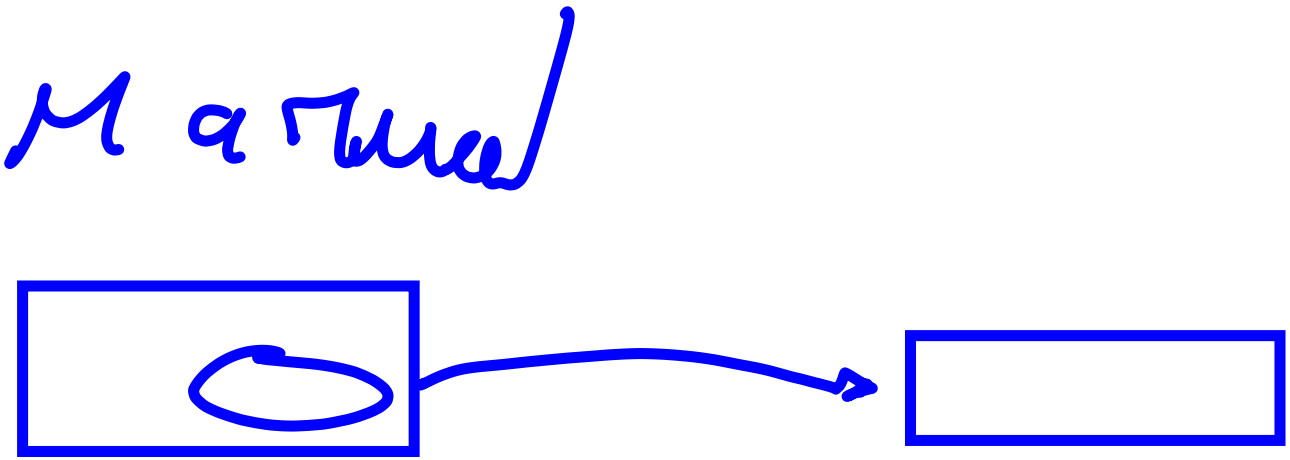
CRC Cards


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

Prototyping and Simulation

- **CRC cards** are useful tools, especially for prototyping and simulation during `conceptual design`.
- **CRC cards** are excellent tools to bring to software development team meetings. All the cards can be placed on the table to `facilitate discussion` or `simulate` 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*

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