

CMPS411
Fall 2018

Lecture 7

Assigning Responsibilities to Classes

Objectives

- The quality of the **overall software design** **depends on how we assign *responsibilities to the objects*.**
 - What methods belong to which class?
 - How objects should interact?
- Relationship between use case and classes
- What are in a use case?
- How does a use case achieve its goal?
- Coupling
- Cohesion

Responsibilities and Methods

There are two types of Responsibilities.

- **Knowing**

- about private encapsulated data
- about related objects
- about things it can derive or calculate
- Attributes of class.

- **Doing**

- doing something itself
- initiating action in other objects
- controlling and coordinating activities in other objects
- methods of a class

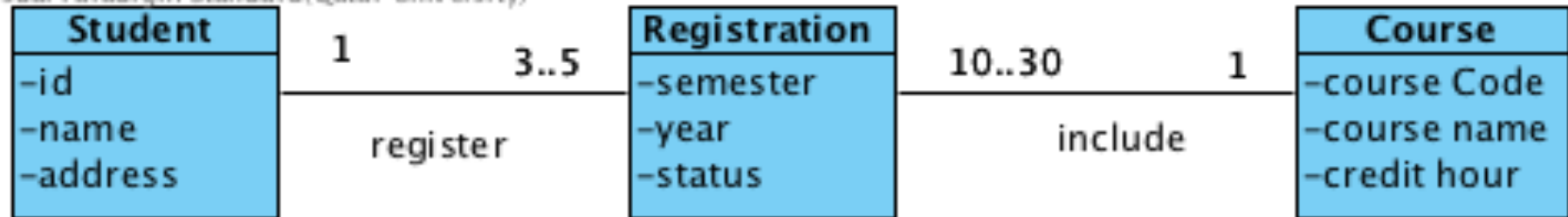
Responsibility Driven Design

- Responsibilities implemented by methods
- Some methods **act alone** and do a task
- Some **collaborate with other objects** to fulfill their responsibility
 - Example: Sale class has `getTotal()` method, the `getTotal()` collaborates with `SalesLineItem` objects to fulfill this responsibility
 - `SalesLineItem` objects has `getSubtotal()` methods
- Why assigning responsibilities to classes is important:
 - Reduce the degree of dependency of a software component on other.
 - We want less dependency
 - The classes should be focused, that means, a given class performs tasks which are very related to each other
 - The classes cannot do tasks those are unrelated.

Assigning a Method to Class

- Problem: What is a basic principle by which to assign a method (responsibilities) to objects?
- Solution (advice): Assign a method (responsibility) to the class that has the information needed to fulfill it
- **Example:** Which of the following classes will get the responsibilities to find the credit hour of a course? *Student, Course, or Registration class?*

Visual Paradigm Standard(Qatar University)

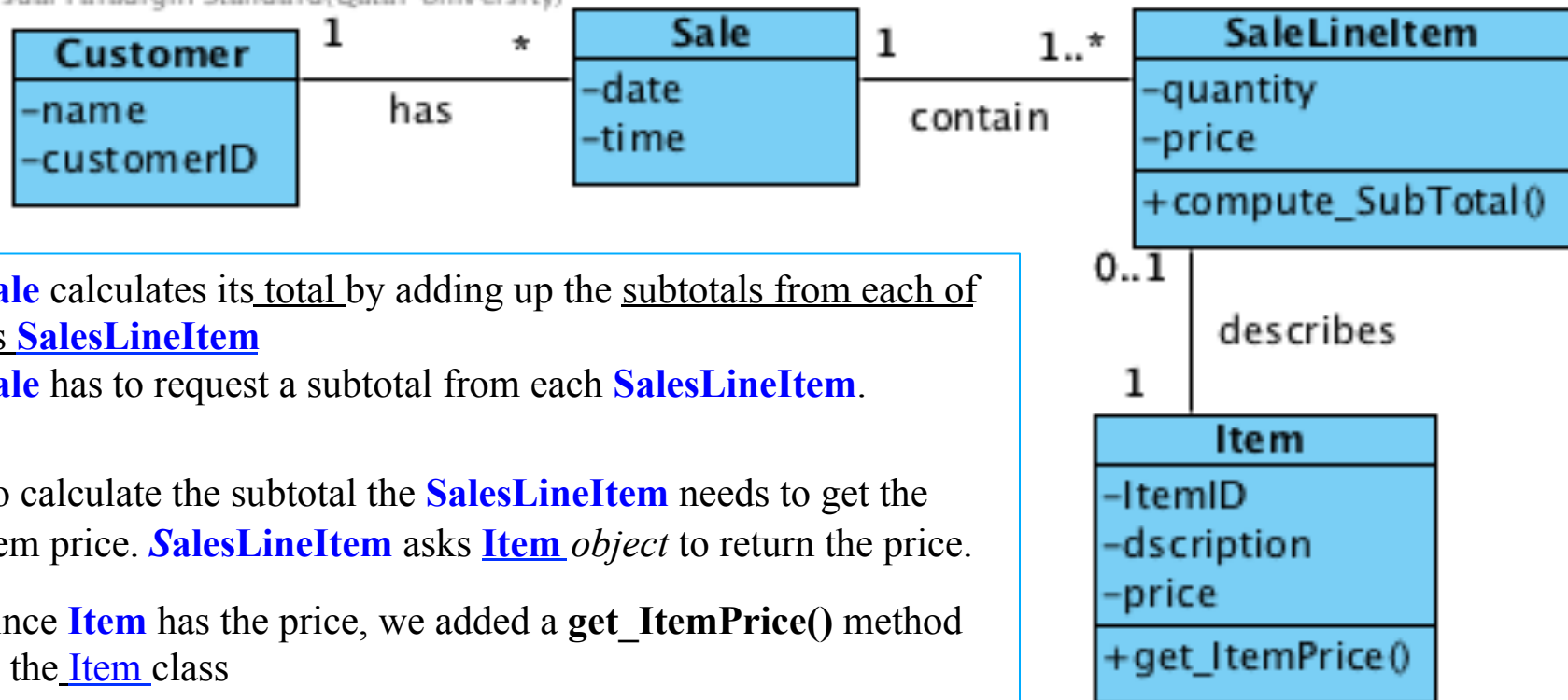


- **Course** class will get this responsibility because it knows the credit hour
- “Objects **do things (method)** related to the information they have.”

Example 1: Assigning Responsibilities

- Which of the following classes will be assigned the responsibilities to find the total sale for a customer:
- Customer**, **Sale**, **SaleLineItem**, or **Item**? Why?

Visual Paradigm Standard(Qatar University)

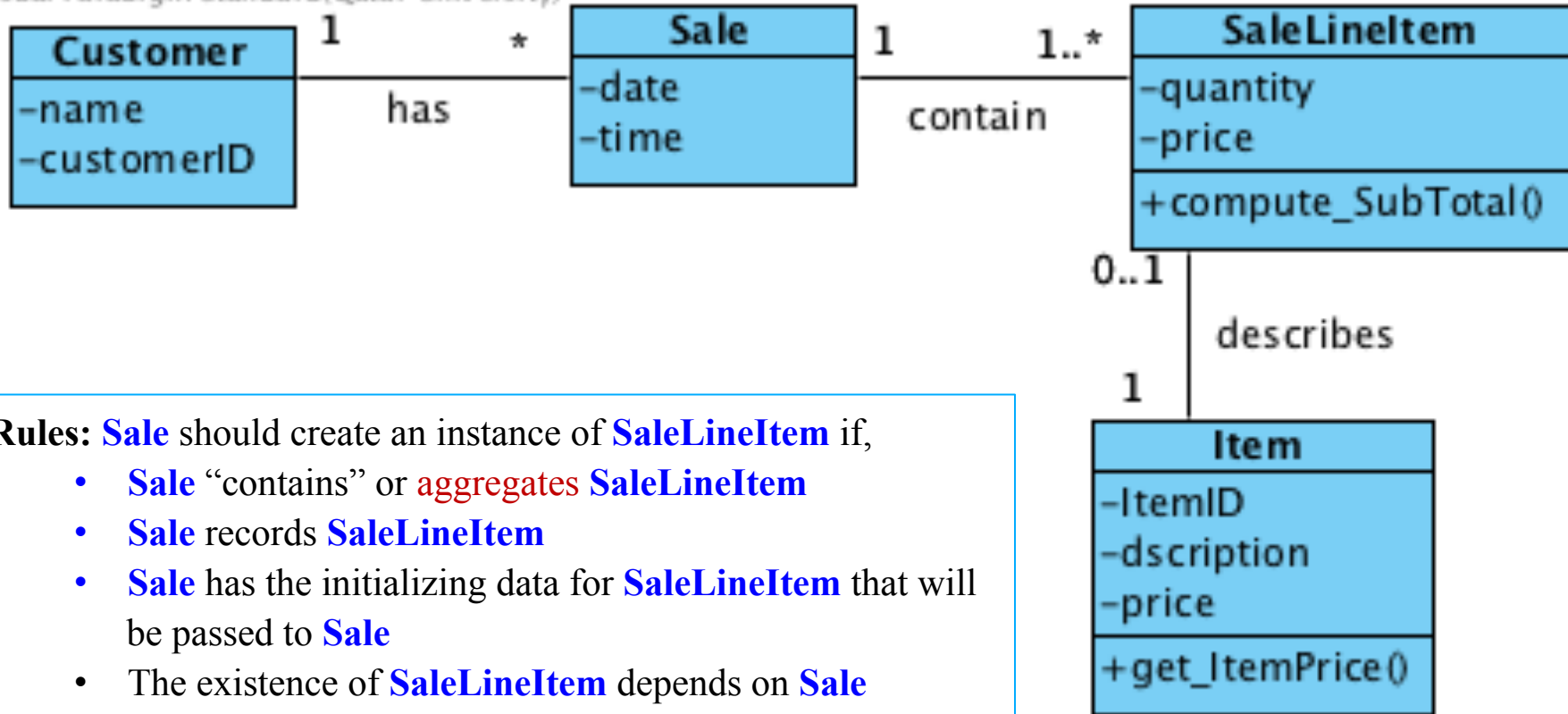


- Sale** calculates its total by adding up the subtotals from each of its SalesLineItem
- Sale** has to request a subtotal from each **SalesLineItem**.
- To calculate the subtotal the **SalesLineItem** needs to get the item price. **SalesLineItem** asks **Item** *object* to return the price.
- Since **Item** has the price, we added a `get_ItemPrice()` method to the **Item** class

Example 2: Assigning Responsibilities

- Which of the following classes will get the responsibility to create SaleLineItem object?
- **Customer, Sale, SaleLineItem, or Item?**

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Rules: **Sale** should create an instance of **SaleLineItem** if,

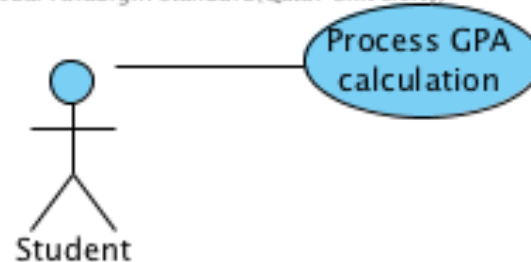
- **Sale** “contains” or **aggregates** **SaleLineItem**
- **Sale** records **SaleLineItem**
- **Sale** has the initializing data for **SaleLineItem** that will be passed to **Sale**
- The existence of **SaleLineItem** depends on **Sale**
- **Sale** closely uses **SaleLineItem**

Example 3: Assigning Responsibilities

Use case – Class Diagram - Responsibilities

- Assume a student wants to know his/her GPA
- The followings are the use case diagram and the use case specification
- Your tasks:
 - Find the classes in this use case
 - Assign responsibilities to classes in order to compute GPA
 - How to do this?

Visual Paradigm Standard(Qatar University)



Actor Action	System Response
1. The Student wants to know his/her GPA	
2. The Student enters ID	3. Find exam result of each courses that the student has registration
	4. Find credit hour of each course that the student has registration
	4. Compute GPA
	5. Store GPA
	6. Display GPA

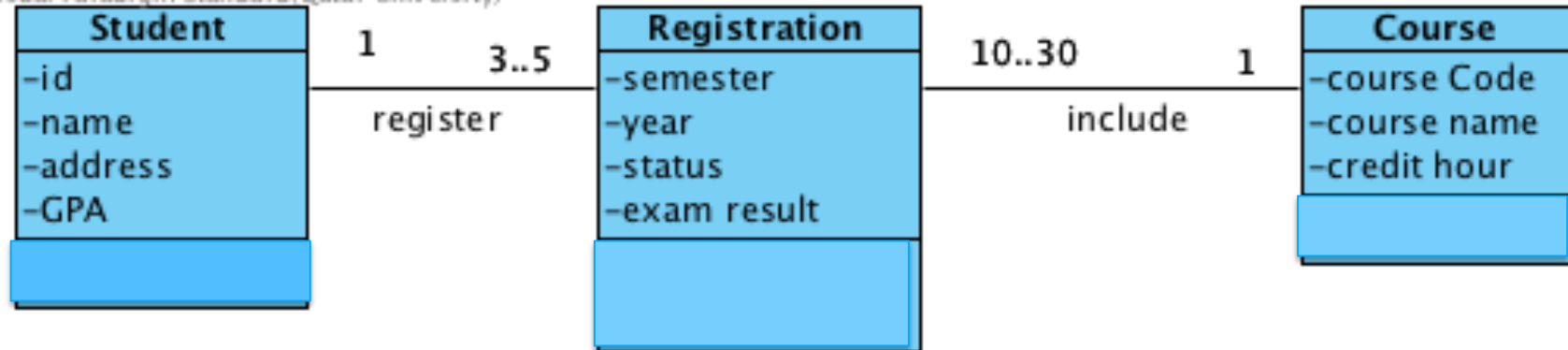
Example 3: Finding Classes

Actor Action	System Response
1. The Student wants to know his/her GPA	
2. The Student enters ID	3. Find exam result of each <u>courses</u> that the <u>student</u> has <u>registration</u>
	4. Find credit hour of each <u>course</u> that the <u>student</u> has <u>registration</u>
	4. Compute GPA
	5. Store GPA
	6. Display GPA

- In the use case specification, we have three candidate classes: Course, Student, Registration
- Candidate attributes: **Exam results**, **credit hour**, **GPA**
- Candidate associations: **Student has Registration for Courses**
- Which class will have which attributes?

Example 3: Making Association

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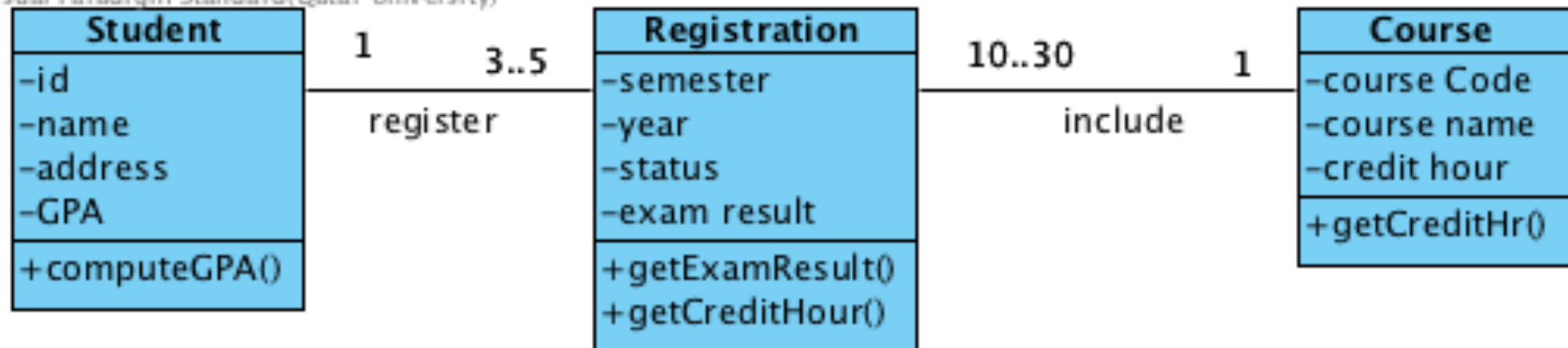


- Which information is needed to **compute GPA**?
- The system needs to find the exam result of each course that the student has registered and the credit hour of each course
- How to assign responsibilities to achieve the above?
 - Which class will have the responsibility to **get the exam result** of each course?
 - Which class should have the responsibility to **find the credit hour** of each course?
 - Finally, which class will have the responsibility to **compute GPA**?

Example 3: Assigning Responsibilities

- The student object will ask the registration object to send the *exam result* of the registered course and the *credit hour* of each course
- The registration object does not have the *credit hour* of each course so it sends message to the course to get the *credit hour*
- The registration object sends the *exam result* and the *credit hour* of each course to the student object
- The student object now compute the *GPA* based on the *exam result* and *credit hour* of each registered course

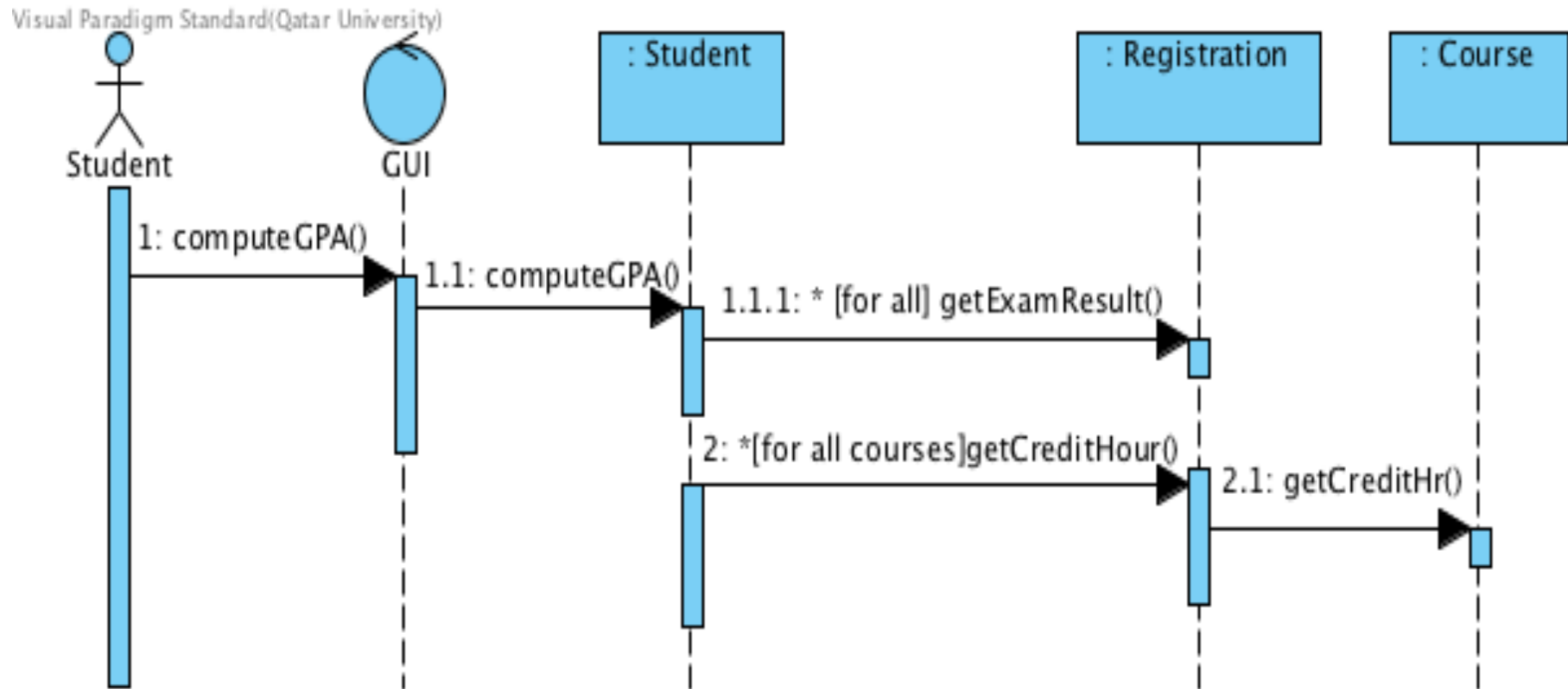
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Example 3: Lesson Learned

- Student is an actor and also is a class. Why?
- Use case “Process GPA Calculation” is not a single method, but a collection of methods.
- The use case needs many objects in order to achieve its goal
- Classes were assigned responsibilities based on having the required information in them.
 - Which responsibilities were assigned to which classes?
 - How and why?
- Objects collaborate with each other in a use case to fulfill the goal.
- How to develop and document such collaboration?

Example 3: Design Sequence Diagram



We will discuss Design Sequence Diagram in Lecture - 8

Assigning Responsibilities and Coupling

- Correct responsibilities to classes reduce coupling between classes
- *Coupling* is a measure of how strongly one class is connected to, has knowledge of, or relies upon other classes.
- Assign responsibilities to classes so that *coupling* remains low.
- Use this principle to evaluate alternatives.
- Strong Coupling is bad because classes are affected by changes in related classes
- Classes are harder for the designers/programmers to understand in isolation
- Hard to maintain classes
- Harder to re-use classes because it requires the presence of classes that it depends on
- In order to achieve low coupling, assign responsibilities such a way that a class is not dependent on many classes

Coupling Types

- Common Types of Coupling (X & Y types)
 - X has an attribute Y
 - X has a method that references Y
 - Method parameter of type Y
 - Local variable of type Y
 - Method return value of type Y
 - X is a direct/indirect subclass of Y
 - X implements a Y interface

Benefits of Low Coupling

- It reduces time, effort and defects involved in modifying software
- Classes are more
 - Independent
 - Easier to reuse
 - Easier to understand
 - Easier to maintain
- Coupling to stable class libraries is more acceptable
 - Such as Java libraries (more stable)
- Avoid coupling to frequently changing classes
 - result in frequent changes to your classes
- Manage classes
 - Can Avoid coupling to APIs for proprietary software
 - Can result in vendor lock in

Assigning Responsibilities and Cohesion

- Problem: How to keep objects focused, understandable, and manageable?
- Solution (advice): Assign responsibilities so that **cohesion remains high**. Use this principle to evaluate alternatives.

Cohesion measures the degree to which the tasks performed by a single class are **functionally related**.

=> **Single Responsibility Principle**



A class with high cohesion has a **relatively small number of methods, with highly related functionality, and does not do too much work.**

Levels of Cohesion

- Very Low cohesion
 - Class has numerous **unrelated responsibilities**
- Low cohesion
 - Responsibilities for a complex task are in one class
- Moderate (most common) cohesion
 - Sole responsibilities in a few areas related to the class but not to each other
- High cohesion
 - Moderate responsibilities in one area and collaborates with others
- Cohesive classes should have few methods.

High Cohesion

- Cohesion:
 - How functionally related are the operations of a software element?
 - How much work is a software element doing?
- Example:
 - The “Big” class: 100 methods, 2000 lines of code
 - The “Small” class 10 methods, 200 lines of code.
 - “Big” is probably **covering many different areas of responsibility**
 - Examples: database access AND random number generation
 - Big has less focus or functional cohesion than small
- An object that has **too many different kinds of responsibilities probably has to collaborate with many other objects**
 - Low cohesion → High coupling, Both bad.

Benefits of High Cohesion

- **Benefits of high cohesion:**
 - Clarity and ease of comprehension of the design is increased.
 - Likelihood of reuse is increased
 - Maintenance and enhancements are simplified.
 - Low coupling is often supported.
- **Disadvantages of low cohesion:**
 - Increased difficulty in understanding classes.
 - Increased difficulty in maintaining a system, because application changes affect multiple classes, and because changes in one class require changes in related classes.
 - Increased difficulty in reusing a class because most applications won't need the arbitrary set of operations provided by a class.

Use Case Can Not Be Method

- A use case cannot be a method of a class
- A use case is a complete functionality that embodies several methods
- How and from where do you find the responsibilities of a use case?
- The responsibilities of a use case are specified in the normal scenario of the use case specification (Actor-Action-System-Response Table)
- The following is a use case for: **Pay for Regular Customer**
- Each of the seven system responses is an ideal candidate to become a method of a class or a database operation. Example:
 - **prepare()** can be a method of the class **Invoice**
 - **issueTicket()** can be a method of the class **Ticket**

Actor action	System response
1. The customer enters ID and PIN	2. Find the account details
	3. Prepare an invoice
	4. Computes 10% discount
	5. Issue the invoice
	6. Forward the invoice to ACS
	7. Attach the invoice with the account
	8. Prepare and issue ticket.