Lecture 4: Design Patterns

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Intro to Design Patterns

Announcements

- Can use draw.io or google drawings instead of excalidraw if you want
  - Use whatever tool you like!
- Suggest Github for version management!

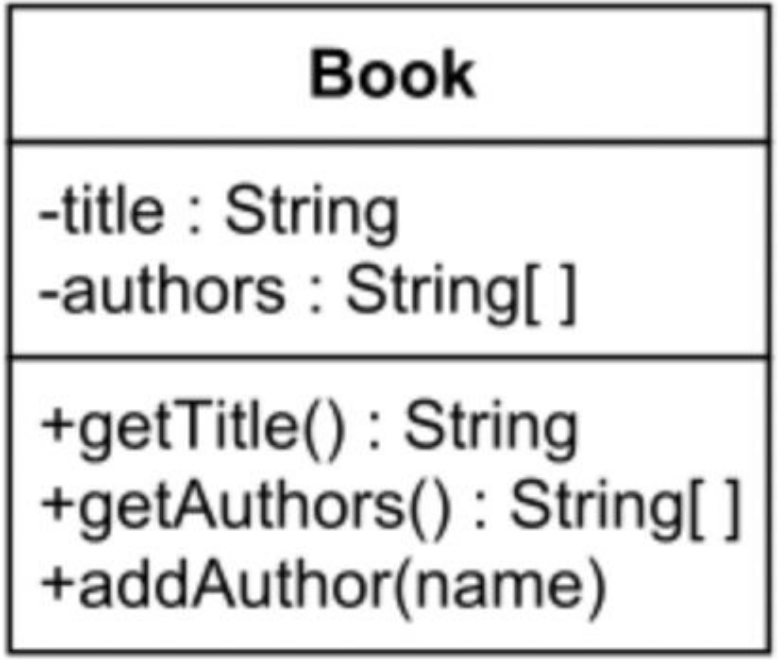
UML

Classes:

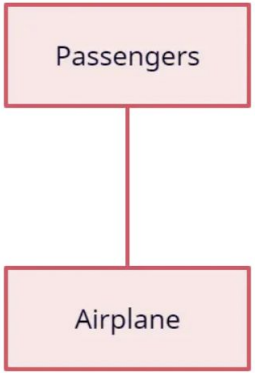
- Top section: class name
- Middle section: class attributes
- Bottom section: class methods or operatio

Private: denoted by -

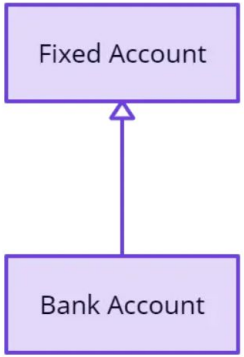
Public: denoted by +



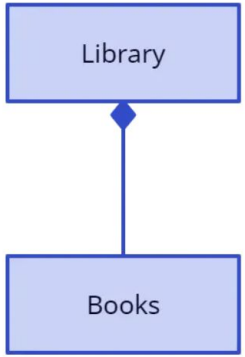
UML (One version)



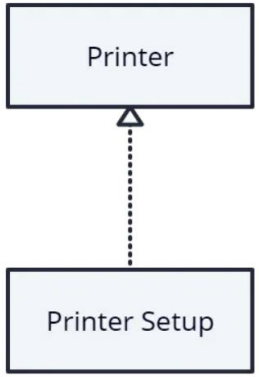
association



inheritance



composition



use of interface

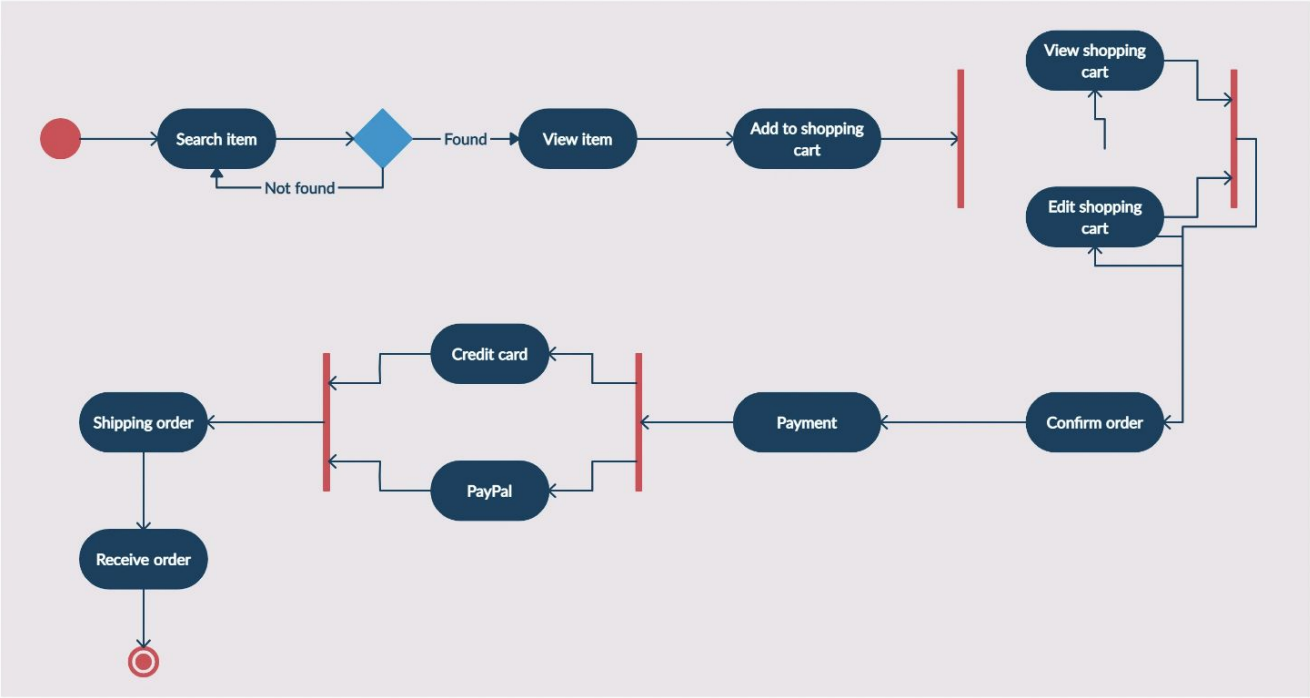
UML: Behavioral vs Structural

- **Structural diagrams** show the objects in the modeled system.
  - Classes, Interfaces
  - Later: Higher-level like Queues, CDN, etc

- **Behavioral diagrams** show what should happen in a system.
  - They describe how the objects interact with each other to create a functioning system
  - usually for just one user journey per diagram

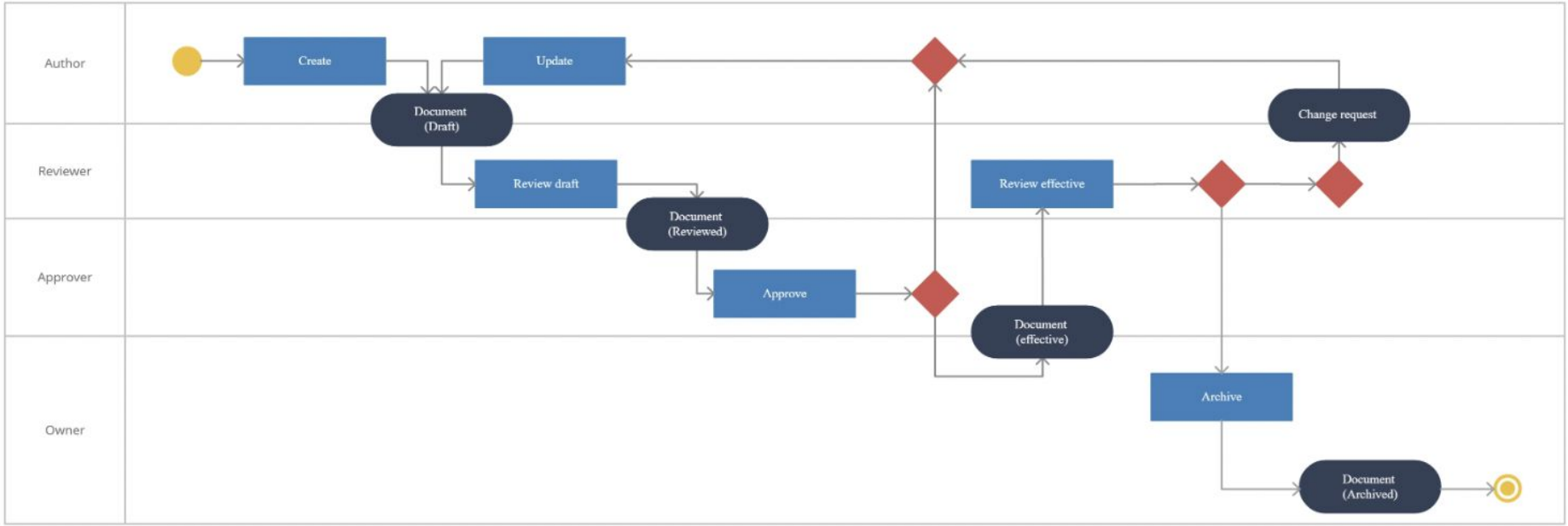
UML: Behavioral

ONLINE SHOPPING SYSTEM for ABC Co.

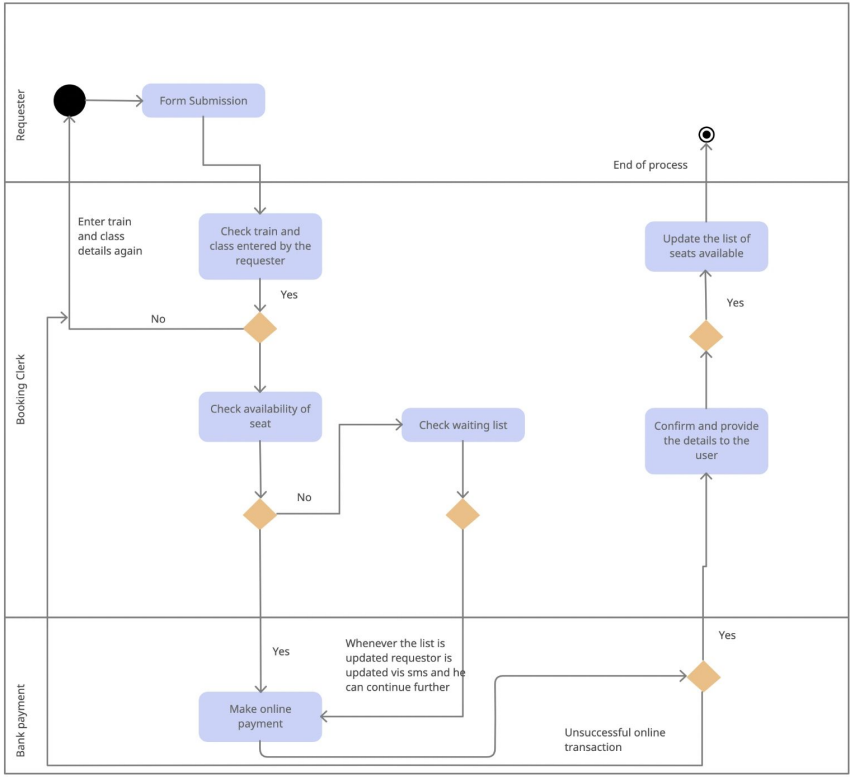


UML: Behavioral

DOCUMENT MANAGEMENT SYSTEM for ABC Co.



UML: Behavioral (train booking)



UML: Behavioral

Symbol	Name	Use
	Start/ Initial Node	Used to represent the starting point or the initial state of an activity
Activity	Activity / Action State	Used to represent the activities of the process
Action	Action	Used to represent the executable sub-areas of an activity
	Control Flow / Edge	Used to represent the flow of control from one action to the other
	Object Flow / Control Edge	Used to represent the path of objects moving through the activity
	Activity Final Node	Used to mark the end of all control flows within the activity
	Flow Final Node	Used to mark the end of a single control flow
	Decision Node	Used to represent a conditional branch point with one input and multiple outputs
	Merge Node	Used to represent the merging of flows. It has several inputs, but one output.
	Fork	Used to represent a flow that may branch into two or more parallel flows
	Merge	Used to represent two inputs that merge into one output

Design patterns

What's a Design Pattern?

- Design patterns are typical solutions to commonly occurring problems in software design.
- Patterns are blueprints that you can customize to solve a recurring design problem in your code.
- The pattern is not a specific piece of code, but a general concept for solving a particular problem.
    - You can't just find a pattern and copy it into your program, the way you can with off-the-shelf functions or libraries.

What does a Design Pattern consist of?

Most patterns are described formally so people can reproduce them in many contexts.

- **Intent** of the pattern briefly describes both the problem and the solution.
- **Motivation** further explains the problem and the solution the pattern makes possible.
- **Structure** of classes shows each part of the pattern and how they are related.
- **Code example** makes it easier to grasp the idea behind the pattern.

Patterns: How High-Level are they?

- The most basic and low-level patterns are often called **idioms**.
  - They usually apply only to a single programming language.
  - Python: `new_list = [elem.strip() for elem in old_list]`
- Most design patterns we will learn are higher-level
  - Not language-specific
  - Refer to the structure of a set of classes, or the structure of the whole system.

Who invented patterns?

- No one, and everyone!
- Patterns are typical solutions to common problems in object-oriented design.
- When a solution gets repeated over and over in various projects, someone eventually gives it a name and describes the solution in detail.
- That’s basically how a pattern gets discovered.

Why learn patterns?

- You might manage to work as a programmer for many years without knowing a single pattern.
  - you might be implementing some patterns without even knowing it!
- So why would you spend time learning them?
  - Design patterns are a toolkit of tried and tested solutions to common problems in software design.
  - Knowing patterns teaches you how to solve all sorts of problems using principles of object-oriented design.
- Design patterns define a common language that you and your teammates can use to communicate more efficiently.
  - You can say, “Oh, just use a Singleton for that,” and everyone will understand the idea behind your suggestion. No need to explain what a singleton is if you know the pattern and its name.

Design Patterns

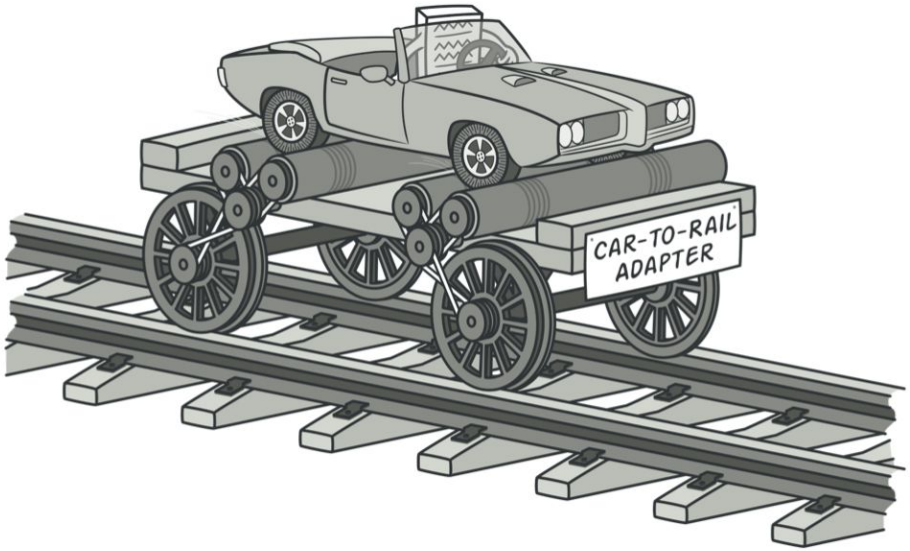
- Patterns can be categorized by their purpose
- We will cover three types:
  - **Structural patterns** explain how to assemble objects and classes into larger structures, while keeping the structures flexible and efficient.
  - **Creational patterns** provide object creation mechanisms that increase flexibility and reuse of existing code.
  - **Behavioral patterns** take care of effective communication and the assignment of responsibilities between objects.

Our First Design Pattern: Adapter

Adapter Design Pattern

Also known as: Wrapper

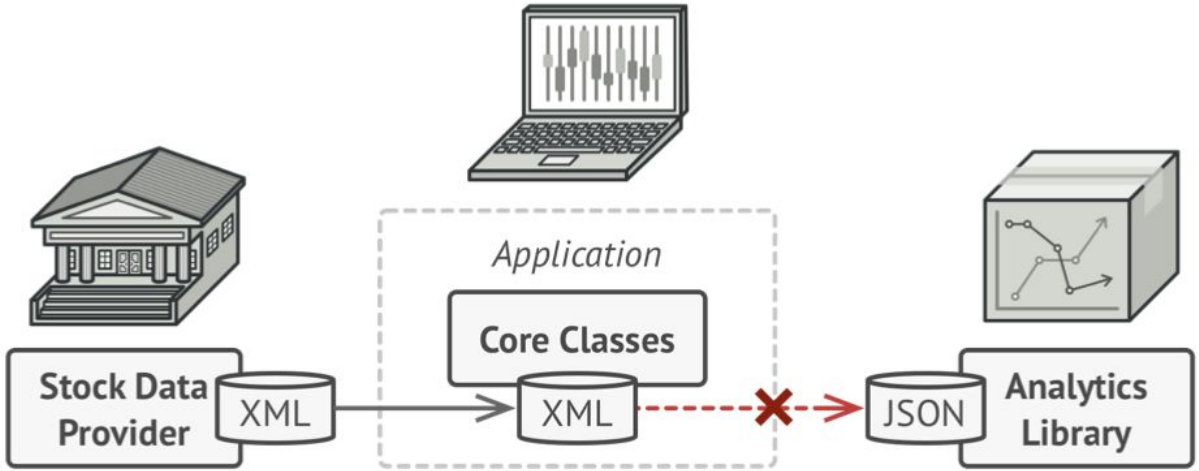
Adapter is a structural design pattern that allows objects with incompatible interfaces to collaborate.



Adapter: Problem

- Imagine that you're creating a stock market monitoring app.
- The app:
  1) downloads the stock data from multiple sources in XML format
  2) displays nice-looking charts and diagrams for the user.
- At some point, you decide to improve the app by integrating a smart 3rd-party analytics library.
- But there's a catch: the analytics library only works with data in JSON format.

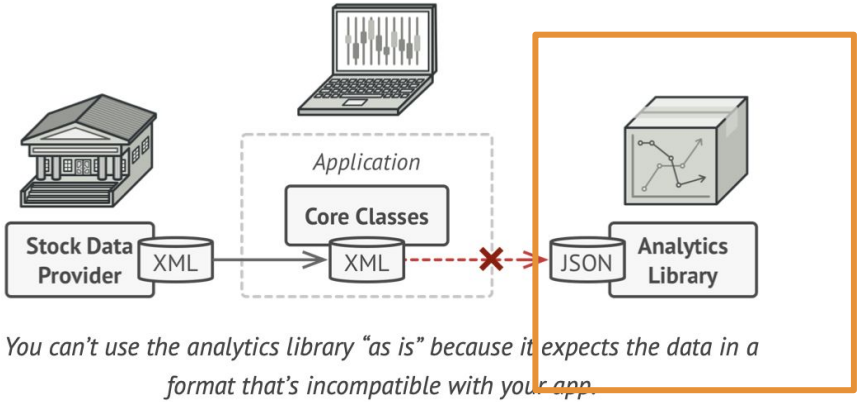
Adapter: Problem



You can't use the analytics library "as is" because it expects the data in a format that's incompatible with your app.

Adapter: Solution?

- You could change the external analytics library to work with XML.
- However, this might break some existing code that relies on the library.
- And worse, you might not have access to the library's source code in the first place, making this approach impossible.



You can't use the analytics library "as is" because it expects the data in a format that's incompatible with your app.

Adapter: Solution

- You can create an **adapter**.
- This is a special object that **converts the interface of one object so that another object can understand it**.
- An adapter **wraps** one of the objects to hide the complexity of conversion happening behind the scenes.
- The wrapped object isn't aware of the adapter.
- Adapters can not only convert data into various formats but can also help objects with different interfaces collaborate.

Adapter: Solution

1. The adapter gets an interface, compatible with one of the existing objects.

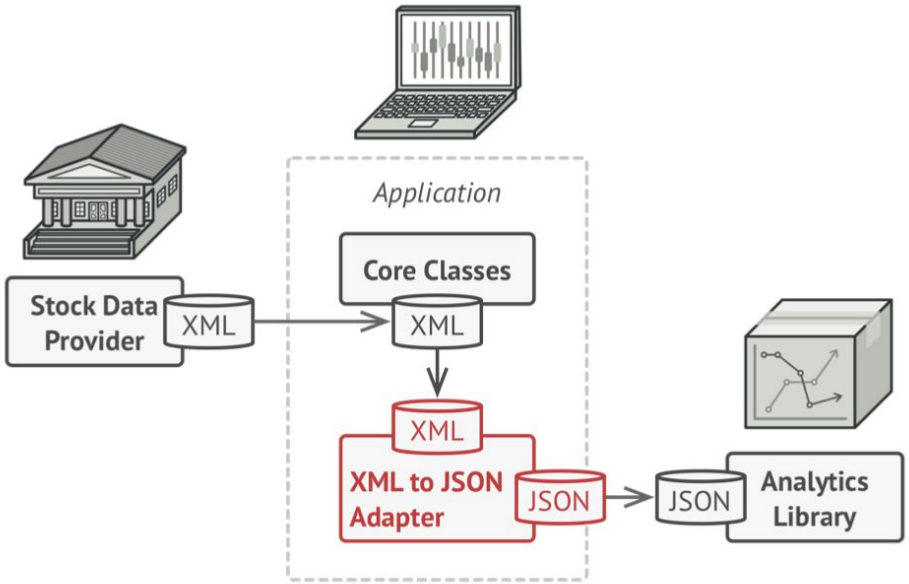
2. Using this interface, the existing object can safely call the adapter's methods.

3. Upon receiving a call, the adapter passes the request to the second object, but in a format and order that the second object expects.

Sometimes it's even possible to create a two-way adapter that can convert the calls in both directions.

Adapters - Solution

To solve the dilemma of incompatible formats, you can create XML-to-JSON adapters for every class of the analytics library that your code works with directly. Then you adjust your code to communicate with the library only via these adapters.



Adapter: Pros

- Single Responsibility Principle.
  - You can separate the interface or data conversion code from the primary business logic
- Open/Closed Principle. You can introduce new types of adapters into the program without breaking the existing client code

Adapter: Cons

- The overall complexity of the code increases because you need to introduce a set of new interfaces and classes.
- Sometimes it’s simpler just to change the service class so that it matches the rest of your code.

Adapter: In-Class Exercise

- Wrap an object that operates in meters and kilometers with an adapter that converts all of the data to imperial units such as feet and miles.
- Class MphSpeedometer:
  - Returns in miles per hour
- You have a CarDisplay that you want to be in Kilometers per hour
  - Make the adapter class!
- Starter Code in Class Github!
  - Adapter.py
  - Fine to work in groups but be sure you actually can code it yourself too!
  - Use PEP8 or Google Python Style for your code!
- When done: Start on Project 1