Design Patterns

# Special Feature

* *“Needs a mechanism to define and organize custom clash rules and switch between them. This would affect how assessments for different courses are allowed to clash with one another.”*

## Additional Context

* From the constraints:
  + *“When a clash is encountered involving a Group 1 assessment, the assessment is not scheduled but rather, the schedule request is sent to the admin for approval. Once approved, it is set. If rejected, the staff members attached to such a course are notified and required to reschedule the assessment.”*

## Solution

### Strategy Pattern

* Rules are defined as interchangeable concrete classes that all implement a shared ClashRule interface. Users can add new rules to or select existing rules from a centralized registry.

### State Pattern

* Assessments transition amongst different states depending during creation.
  + If no clash is detected, automatically transition to the **Approved** state.
  + Otherwise, transition to the **PendingApproval** state and create a scheduling request. Alerts to staff and admins managed by the Observer pattern.
  + Admins may then choose to transition the Assessment to either the **Approved** or **Rejected** state. (Send notifications as necessary.)

### Factory Pattern

* Centralizes the creation of new clash rules.
* May also serve as the registry for created rules, allowing for the use of a get\_clash\_rule(id: int) method.

### Observer Pattern

* Monitors the creation of new assessments and alerts both the admin and relevant staff member(s) when a clash is detected.

# Structural Changes

(Improve the project

## Repository Layer

* Connects the Model (data structure) layer to the Service (business logic) layer.
* Isolates data(base) access logic from the rest of the code.
* Particularly data structure logic (i.e., models) and business logic (i.e., controllers).
* Used to simplify CRUD (create, read, update, delete) operations.
* ***Used to comply with the single-responsibility principle.***

## Service Layer

* Connects the Repository (data access) layer to the Controller (HTTP request) layer.
* Isolates/abstracts business logic (the core of application behaviour) from the rest of the code.
* Performs more complicated logic than simple CRUD operations.
  + (E.g., sending notifications, validating business rules, or managing transactions.)
* ***Used to comply with the single-responsibility principle.***

## Builder Pattern

* Provides additional construction support for classes with a larger number of parameters or that require additional logic to be constructed correctly.
  + (e.g., Assessment, which has a large number of (optional) attributes and require additional logic regarding clashes.)

# Sources

* [What Is The Repository Pattern And How To Use It In Python? - Pybites](https://pybit.es/articles/repository-pattern-in-python/)
* [The Factory and Repository Pattern with SQLAlchemy and Pydantic | by Lawson Taylor | Medium](https://medium.com/@lawsontaylor/the-factory-and-repository-pattern-with-sqlalchemy-and-pydantic-33cea9ae14e0)

# ChatGPT on MVCSR:

## Query:

what are the responsibilities of the model, repository, service, controller, and view, and how are they ordered from lowest level to highest level?

## Response:

In a typical Model-View-Controller-Service-Repository (MVCSR) architecture, each layer has distinct responsibilities, which help organize code, separate concerns, and improve scalability and maintainability. Here's a breakdown of each component, their responsibilities, and their order from the lowest level (closest to the database) to the highest level (closest to the user).

**1. Model (Lowest Level)**

* **Responsibilities**:
  + Defines the structure of data and the rules governing it.
  + Represents the data objects that are mapped to database tables or documents (e.g., a User model for a users table).
  + Implements data-related logic, such as validation rules and default values.
  + Sometimes includes methods specific to the model, like relationships to other models (e.g., a User having a relationship with Orders).
* **Typical Content**:
  + Attributes defining data fields.
  + Methods for basic operations on the data (e.g., set\_password, check\_password).
* **Level**: **Lowest** – Closest to the database, abstracting raw data into meaningful entities.

**2. Repository**

* **Responsibilities**:
  + Manages data access and performs database operations.
  + Encapsulates all code that interacts with the database (queries, inserts, updates, deletes).
  + Abstracts the persistence layer (database) and offers a higher-level API for working with the data.
  + Provides methods like find\_by\_id, find\_all, or more specialized queries (e.g., find\_user\_by\_email).
* **Typical Content**:
  + CRUD operations for specific models, sometimes specialized for certain use cases.
  + Uses models to access the data but abstracts away low-level database logic from the rest of the application.
* **Level**: Second-Lowest – Interfaces with the model but abstracts direct database access for higher layers.

**3. Service**

* **Responsibilities**:
  + Contains business logic, which is the core of application behavior.
  + Orchestrates operations that might involve multiple models or repositories.
  + Provides methods like register\_user, authenticate\_user, or process\_order, which involve more than simple CRUD operations.
  + Can perform complex logic, such as sending notifications, validating business rules, or managing transactions.
* **Typical Content**:
  + High-level methods implementing application logic.
  + Calls repository methods to fetch or store data, manipulates models, and returns processed information.
* **Level**: Mid-Level – Interfaces with repositories and models, providing higher-level methods to the controllers.

**4. Controller**

* **Responsibilities**:
  + Manages HTTP requests from the client and directs them to the appropriate service methods.
  + Processes input from the request, such as URL parameters, JSON payloads, or form data.
  + Calls service methods to retrieve data or perform operations and handles the response.
  + Converts service responses to a format appropriate for the client (e.g., JSON for REST APIs).
  + Typically, minimal logic – its main role is coordination.
* **Typical Content**:
  + Methods that handle specific routes, e.g., login\_user, register\_user, or get\_user\_by\_id.
  + Calls service methods and decides on HTTP response codes.
* **Level**: Second-Highest – Interfaces with the service layer and serves as an intermediary between services and views.

**5. View (Highest Level)**

* **Responsibilities**:
  + Presents data to the user, typically in the form of HTML, JSON, or XML.
  + In web applications, the view can be an HTML template rendered with data passed from the controller.
  + For API responses, the view may be omitted or handled within the controller, which directly sends JSON or XML.
  + Decouples the presentation logic from the business logic, allowing different representations of the same data.
* **Typical Content**:
  + HTML templates (for server-rendered applications).
  + JSON structure definitions or serializers if using a REST API.
* **Level**: **Highest** – Interfaces directly with the end-user, translating data and responses into a user-consumable format.

**Ordering from Lowest to Highest Level**

**1. Model** ⟶ **2. Repository** ⟶ **3. Service** ⟶ **4. Controller** ⟶ **5. View**

This ordering follows a pattern of abstraction:

* **Models** provide raw data structures and relationships.
* **Repositories** handle database interactions and provide access to models.
* **Services** encapsulate business logic and coordinate repositories.
* **Controllers** handle client requests, orchestrating service calls and responses.
* **Views** provide a formatted response to the user or client application, consuming data from the controller layer.

**Example: User Authentication Flow**

Let's walk through an example to illustrate the responsibilities:

1. **User Model**: Defines attributes like id, email, and password\_hash.
2. **User Repository**: Provides methods like find\_user\_by\_email(email), which queries the database for a user by email.
3. **User Service**: Defines the authenticate\_user(email, password) method, which:
   * Retrieves the user from the repository.
   * Verifies the password and returns the user if authentication succeeds.
4. **User Controller**: Exposes an endpoint for /login:
   * Calls authenticate\_user in the service.
   * Returns a success response with user data or an error message.
5. **User View**: (API-based) Returns the JSON response to the client app:
   * { "user\_id": 123, "message": "Login successful" }.

* Each layer has a clearly defined role, with only minimal overlap, making the codebase modular, testable, and maintainable.