Photo Gallery Application – Project Report

1. Introduction

Project Title: Smart Photo Gallery Application

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Project Overview:

The Smart Photo Gallery application is a Java-based software designed to manage multimedia content efficiently. It allows users to capture photos and videos, apply filters, store images, sort them using multiple criteria, and receive real-time notifications.

Objective:

The primary objective of this project is to **implement at least six design patterns** learned in the course and integrate them into a cohesive application. The project demonstrates the practical use of **Facade, Observer, Singleton, Strategy, Factory, and Decorator patterns**.

Key Features:

- Simplified camera interface using **Facade**.
- Real-time notifications using **Observer**.
- Centralized image repository using **Singleton**.
- Dynamic image sorting using **Strategy**.
- Filter creation using **Factory**.
- Image filter stacking using **Decorator**.

2. Body

2.1 Architecture and Design Patterns

2.1.1 Facade Pattern

- **Class:** CameraFacade
- **Description:** Provides a simplified interface to capture photos and record videos, integrating the BasicCamera with subsystems (FocusSystem, FlashSystem, StorageSystem).

Code Snippet:

```
CameraFacade camera = new CameraFacade();

camera.takePhoto("holiday.jpg");

camera.recordMovie();
```

2.1.2 Observer Pattern

- **Classes:** ImageGallery (Subject), UserObserver (Observer)
- **Description:** Users subscribe to image gallery updates. When a new image is added, all observers are notified automatically.

Code Snippet:

```
gallery.addObserver(new UserObserver("Alice"));

gallery.addNewImage("sunset.jpg"); // triggers notifications
```

2.1.3 Singleton Pattern

- **Class:** AppManager
- **Description:** Ensures a single instance of the image repository exists, managing all images centrally.

Code Snippet:

```
AppManager manager = AppManager.getInstance();

manager.addImage(new GalleryImage("holiday.jpg", LocalDate.now(), 5));
```

2.1.4 Strategy Pattern

- **Classes:** ImageSorter, SortByDate, SortByName, SortByRating
- **Description:** Sorting behavior is interchangeable at runtime, allowing images to be sorted by multiple criteria.

Code Snippet:

```
ImageSorter sorter = new ImageSorter();

sorter.setStrategy(new SortByRating());

sorter.sortImages(manager.getImages());
```

2.1.5 Factory Pattern

- **Class:** FilterFactory
- **Description:** Creates filter objects dynamically based on a filter type (GRAYSCALE, SEPIA).

Code Snippet:

```
DisplayableImage gray = FilterFactory.create(FilterType.GRAYSCALE, originalImage);
```

2.1.6 Decorator Pattern

- **Classes:** ImageFilterDecorator, GrayscaleFilter, SepiaFilter
- **Description:** Allows dynamic addition of filter behaviors to images without modifying the original image class.

Code Snippet:

```
DisplayableImage sepiaOnGray = new SepiaFilter(grayImage);
sepiaOnGray.display();
```

2.1.7 Visitor Pattern

Classes: ImageVisitor, AbstractImageVisitor, AverageRatingVisitor, BatchExportVisitor, GalleryImage

Description: Allows operations to be performed on GalleryImage objects without exposing their internal state. Supports calculating average rating, batch exporting, or future operations.

Code Snippet – Average Rating Visitor:

```
AverageRatingVisitor avgVisitor = new AverageRatingVisitor();
for (GalleryImage img : manager.getImages()) {
   img.accept(avgVisitor);
}
System.out.println("Average Rating: " + avgVisitor.getAverage());
```

Code Snippet – Batch Export Visitor:

```
BatchExportVisitor exportVisitor = new BatchExportVisitor();
for (GalleryImage img : manager.getImages()) {
```

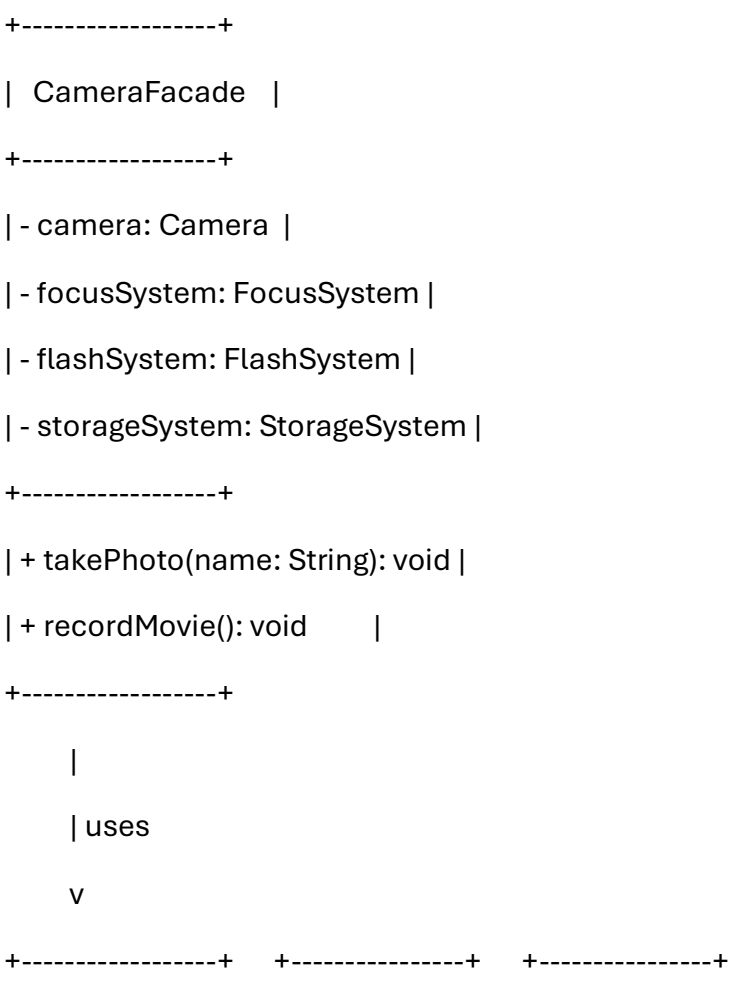
```
    img.accept(exportVisitor);
}
```

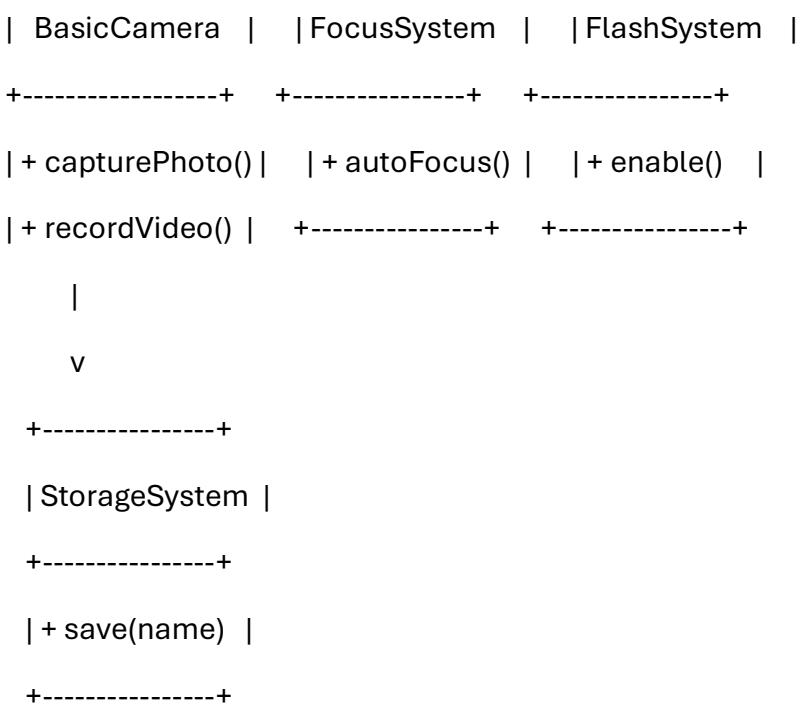
Integration with Other Patterns:

- Works seamlessly with **Singleton** AppManager to access all images.
- Independent of **Observer**, **Facade**, **Strategy**, **Decorator**, and **Factory**, but can be applied after sorting or filtering.
- Maintains **encapsulation**, demonstrating clean separation of concerns.

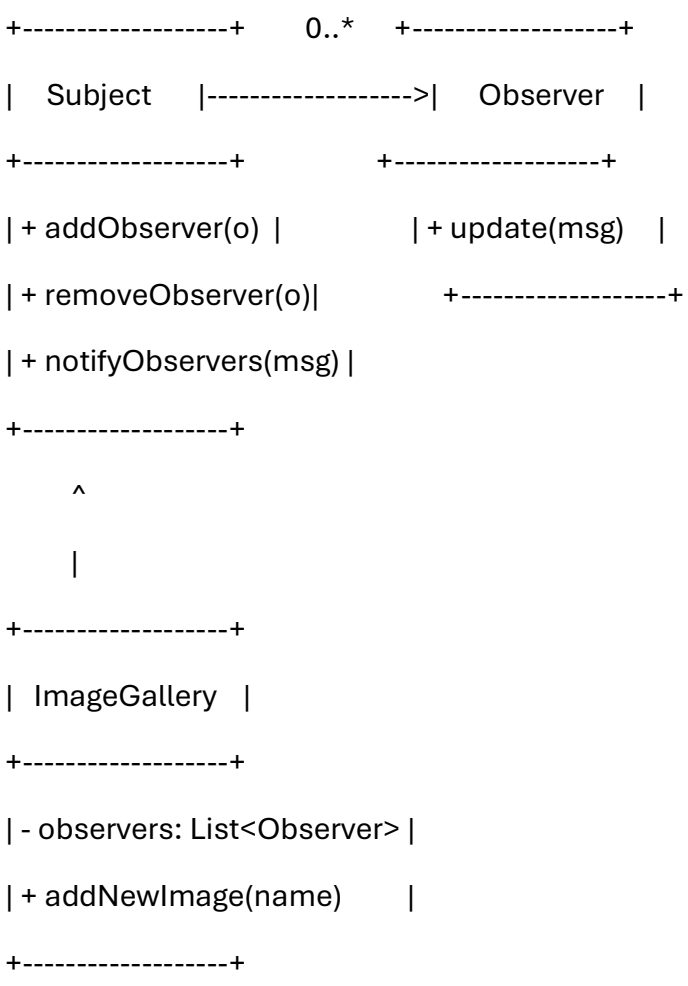
2.2 UML Diagrams

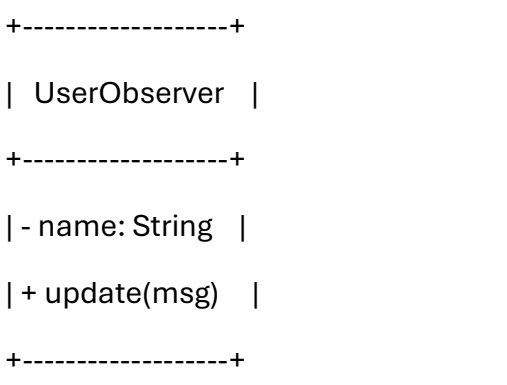
1. Facade Pattern – CameraFacade



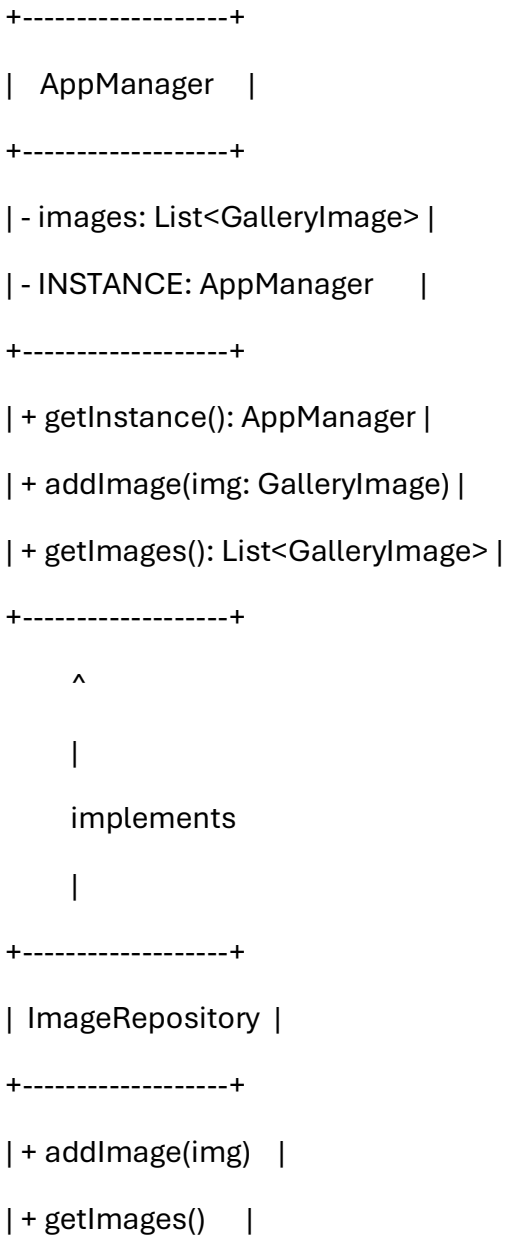


2. Observer Pattern – ImageGallery / UserObserver





3. Singleton Pattern – AppManager



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4. Strategy Pattern – ImageSorter / SortByDate / SortByName / SortByRating

+-------------------+

| SortStrategy |

+-------------------+

| + sort(images: List<GalleryImage>) |

+-------------------+

^

|

+-------------------+

| SortByDate |

+-------------------+

| + sort(images) |

+-------------------+

+-------------------+

| SortByName |

+-------------------+

| + sort(images) |

+-------------------+

+-------------------+

| SortByRating |

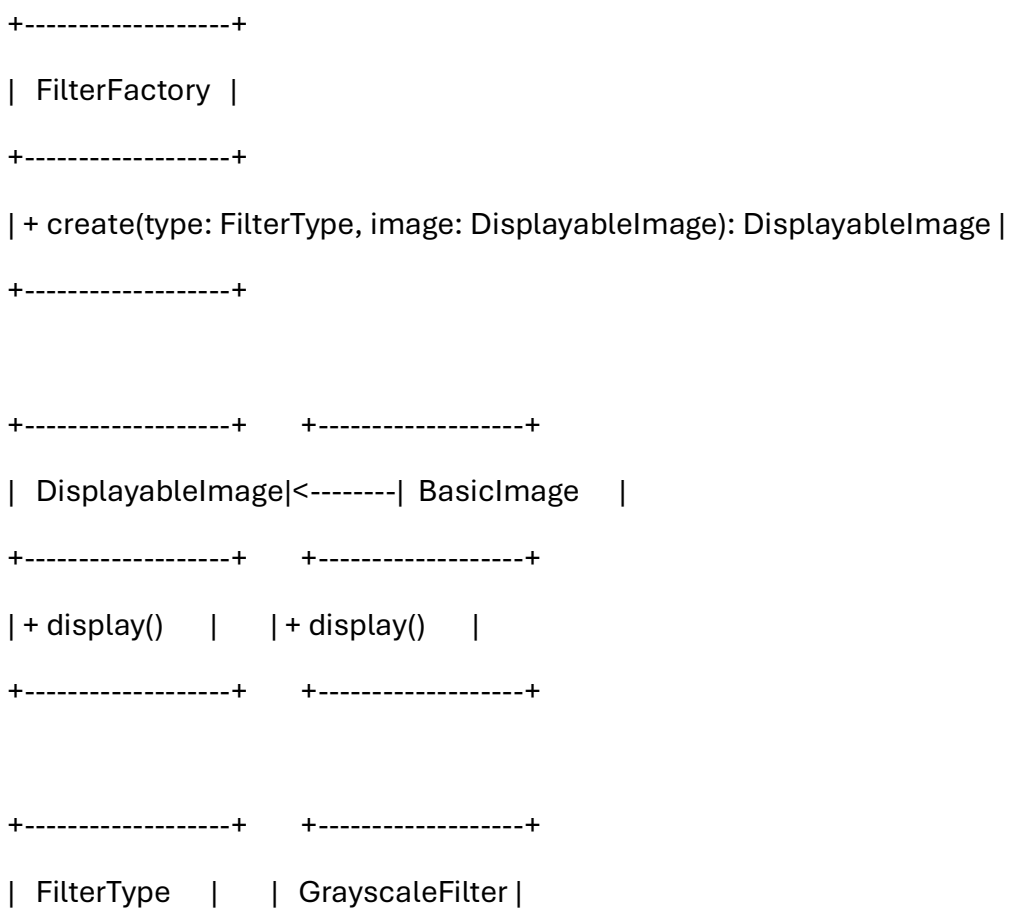
+-------------------+

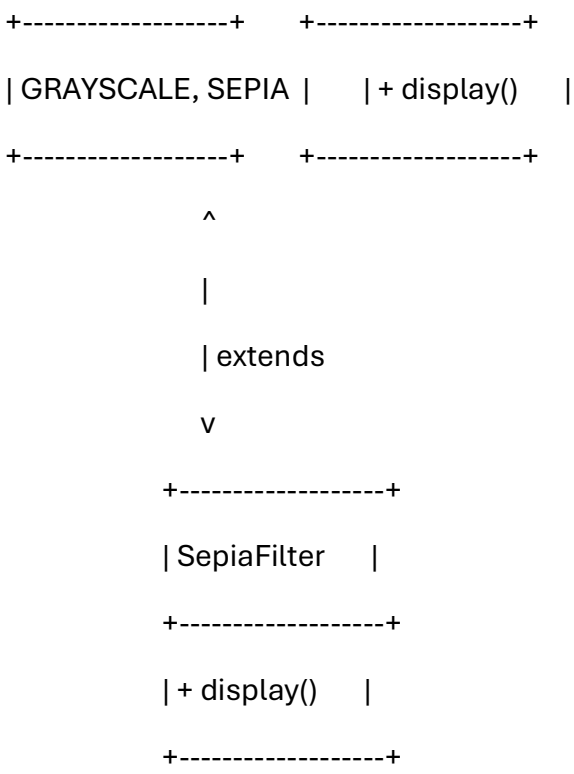
| + sort(images) |

+-------------------+

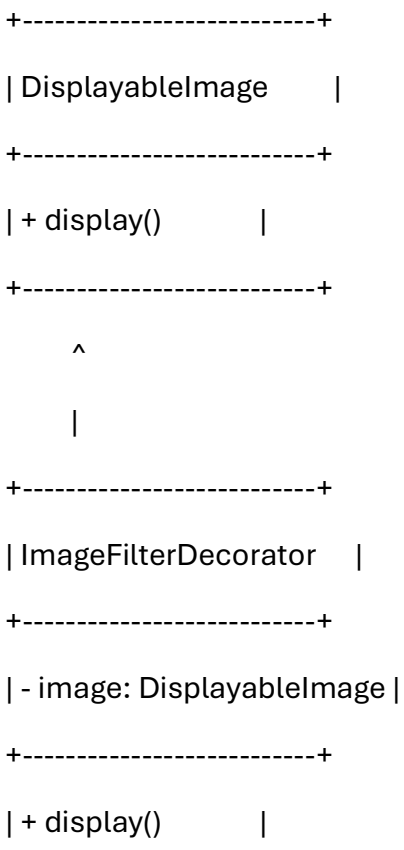
+-------------------+

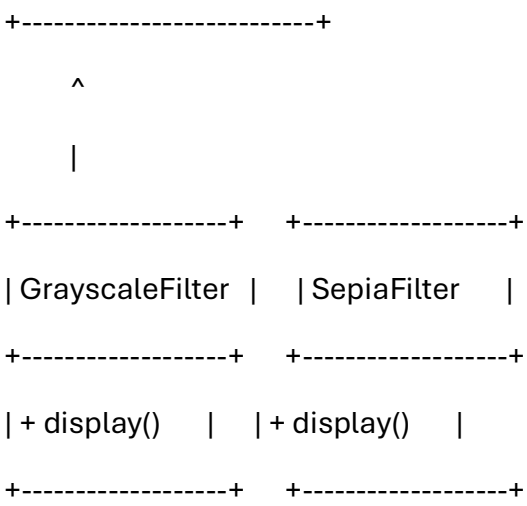
5. Factory Pattern – FilterFactory





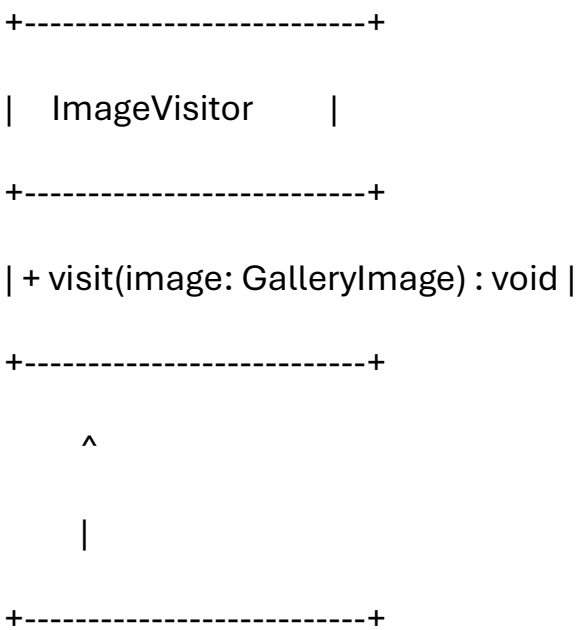
6. Decorator Pattern – GrayscaleFilter / SepiaFilter

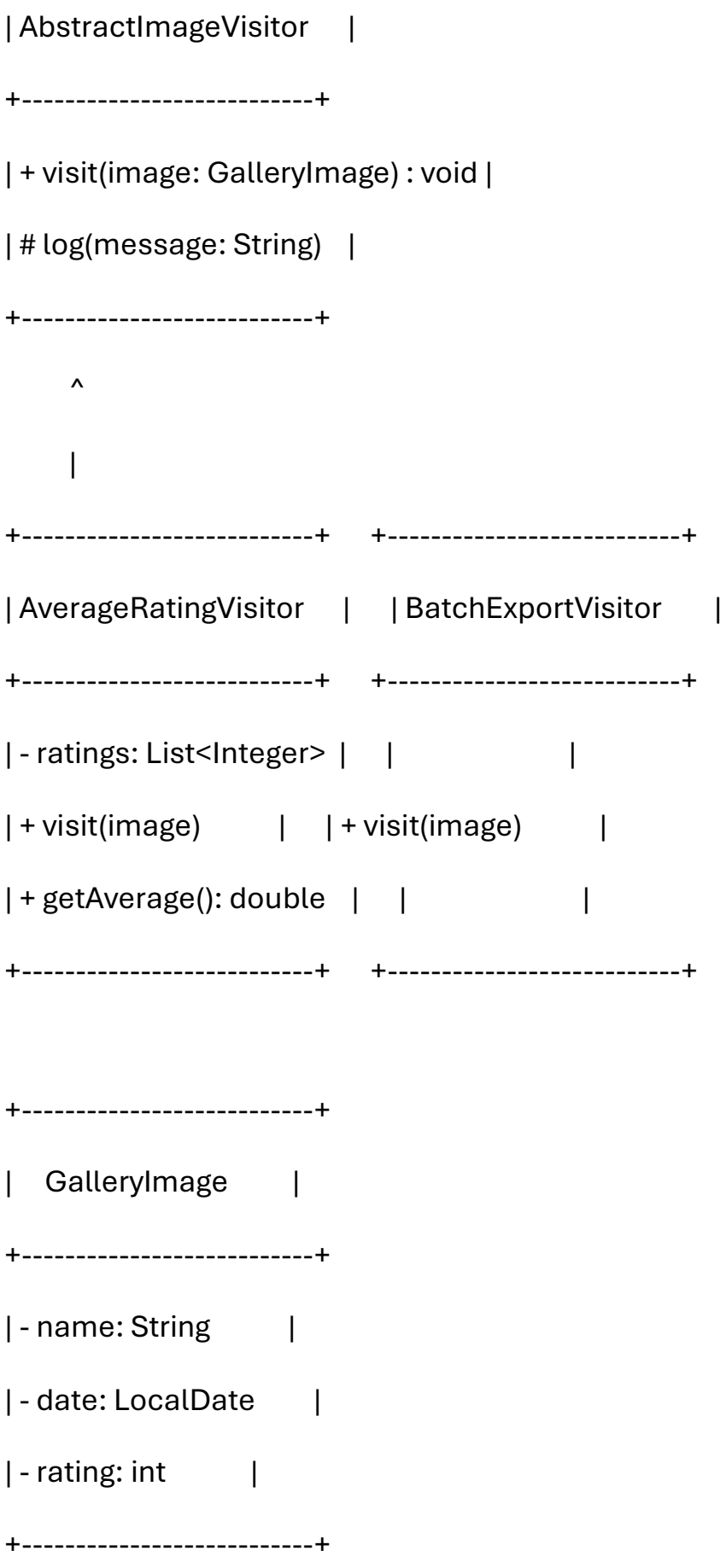




- Facade: CameraFacade simplifies camera usage and uses subsystems.
- Observer: ImageGallery (Subject) notifies UserObserver instances.
- Singleton: AppManager manages the image repository.
- Strategy: ImageSorter can swap sorting strategies dynamically.
- Factory: FilterFactory creates filter objects from a type.
- Decorator: ImageFilterDecorator adds filter functionality without changing original image.

7. Visitor pattern




| AbstractImageVisitor |
+----------+
| + visit(image: GalleryImage) : void |
| # log(message: String) |
+----------+
^
|
+----------+ +----------+
| AverageRatingVisitor | | BatchExportVisitor |
+----------+ +----------+
- ratings: List<Integer>		
+ visit(image)		+ visit(image)
+ getAverage(): double		
+----------+ +----------+
+----------+
| GalleryImage |
+----------+
| - name: String |
| - date: LocalDate |
| - rating: int |
+----------+

| + accept(visitor: ImageVisitor) |

| + displayInfo() |

| + getName() |

| + getDate() |

| + getRating() |

| + setDate(date) |

| + setRating(rating) |

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2.3 Screenshots

User Registration and Observer Notifications

```
[INFO 2025-11-15 21:01:25] User1 subscribed to gallery updates.
[INFO 2025-11-15 21:01:25] User2 subscribed to gallery updates.
```

[INFO 2025-11-15 21:01:25] User1 subscribed to gallery updates.

[INFO 2025-11-15 21:01:25] User2 subscribed to gallery updates.

- Shows users subscribing to gallery notifications.

Taking Photos (Facade + Manager + Observer)

```
FocusSystem: Auto-focused.
FlashSystem: Flash enabled.
BasicCamera: Photo captured!
StorageSystem: Saved Holiday
[INFO 2025-11-15 21:01:25] Facade: Photo process simplified.
AppManager: Image added to repository.
ImageGallery: New image added: Holiday
[User1] Notification: New image added: Holiday
[User2] Notification: New image added: Holiday
```

FocusSystem: Auto-focused.

FlashSystem: Flash enabled.

BasicCamera: Photo captured!

StorageSystem: Saved Holiday

[INFO 2025-11-15 21:01:25] Facade: Photo process simplified.

AppManager: Image added to repository.

ImageGallery: New image added: Holiday

[User1] Notification: New image added: Holiday

[User2] Notification: New image added: Holiday

- Demonstrates **camera subsystem via Facade**, **image management via Singleton**, and **Observer notifications**.
- Repeat for other photos like Family and Birthday.

Applying Filters (Decorator + Factory)

```
[INFO 2025-11-15 21:01:25] Applying Grayscale:
Displaying original image: unnamed
Applying Grayscale Filter
[INFO 2025-11-15 21:01:25] Applying Sepia on top of grayscale:
Displaying original image: unnamed
Applying Grayscale Filter
Applying Sepia Filter
```

[INFO 2025-11-15 21:01:25] Applying Grayscale:

Displaying original image: unnamed

Applying Grayscale Filter

[INFO 2025-11-15 21:01:25] Applying Sepia on top of grayscale:

Displaying original image: unnamed

Applying Grayscale Filter

Applying Sepia Filter

- Demonstrates **Decorator stacking filters** and **Factory creating filter objects**.

Sorting Images (Strategy Pattern)

```
--- Sort by Date ---
Images sorted by date.
Image: Holiday, Date: 2025-11-09, Rating: 5
Image: Family, Date: 2025-10-20, Rating: 4
Image: Birthday, Date: 2025-09-15, Rating: 3

--- Sort by Rating ---
Images sorted by rating.
Image: Holiday, Date: 2025-11-09, Rating: 5
Image: Family, Date: 2025-10-20, Rating: 4
Image: Birthday, Date: 2025-09-15, Rating: 3

--- Sort by Name ---
Images sorted by name.
Image: Holiday, Date: 2025-11-09, Rating: 5
Image: Family, Date: 2025-10-20, Rating: 4
Image: Birthday, Date: 2025-09-15, Rating: 3
```

--- Sort by Date --- Images sorted by date. Image: Holiday, Date: 2025-11-09, Rating: 5 Image: Family, Date: 2025-10-20, Rating: 4 Image: Birthday, Date: 2025-09-15, Rating: 3

--- Sort by Rating --- Images sorted by rating. Image: Holiday, Date: 2025-11-09, Rating: 5 Image: Family, Date: 2025-10-20, Rating: 4 Image: Birthday, Date: 2025-09-15, Rating: 3

--- Sort by Name --- Images sorted by name. Image: Holiday, Date: 2025-11-09, Rating: 5 Image: Family, Date: 2025-10-20, Rating: 4 Image: Birthday, Date: 2025-09-15, Rating: 3

- Demonstrates **Strategy pattern** by swapping sorting criteria dynamically.

Visitor output:

```
--- Visitor: Average Rating ---
Average Rating: 4.0

--- Visitor: Export All Images ---
Exporting image info: Holiday | Rating: 5
Exporting image info: Family | Rating: 4
Exporting image info: Birthday | Rating: 3
```

2.4 Application Workflow

1. User registers in the gallery → UserObserver subscribes.
2. User takes photo or records video → CameraFacade manages the process.
3. Image is added to AppManager → Singleton ensures central management.
4. Observers are notified → ImageGallery triggers update() in UserObserver.
5. User applies filters → Factory creates filter, Decorator applies it.
6. User sorts images → Strategy pattern dynamically changes sorting behavior
7. Visitor pattern can analyze image properties or perform batch operations → Visitors (AverageRatingVisitor, BatchExportVisitor) traverse GalleryImage objects without exposing internal state.

3. Conclusion

The project demonstrates a **well-integrated system using six design patterns**. Each pattern is **operational and contributes to the functionality**:

- **Facade** simplifies complex camera operations.

- **Observer** ensures real-time updates to users.
- **Singleton** centralizes image management.
- **Strategy** allows flexible sorting options.
- **Factory** provides dynamic filter creation.
- **Decorator** enables stacking multiple filters dynamically.
- **Visitor** allows batch operations and analysis without breaking encapsulation.

The architecture is modular, maintainable, and extensible for future features.

4. Further Work

- **Visitor Pattern Integration:** Analyze image properties or perform batch operations without exposing internal state.
- **Additional Filters:** Add more filters like Blur, Brightness, Contrast using Factory + Decorator.
- **UI Enhancement:** Create GUI for real-time interaction instead of console output.(Currently, the application runs in the console. For future work, we plan to implement a **GUI using JavaFX or Swing**, which would allow users to click buttons for capturing photos, applying filters, sorting images, and viewing notifications visually. This will improve usability and provide a real-time interactive experience.)
- **Video Processing:** Extend filters and sorting to videos.
- **Persistence:** Save gallery state to a database for permanent storage.
- **AI Features:** Integrate AI-based image tagging and recommendation system.

5. Source Code

- com.project.camera → Camera subsystem and Facade
- com.project.controller → GalleryController
- com.project.filters → Factory and Decorators
- com.project.manager → Singleton repository
- com.project.observer → Observer pattern classes
- com.project.sorting → Strategy pattern classes
- com.project.visitor → Visitor pattern classes (ImageVisitor, AbstractImageVisitor, AverageRatingVisitor, BatchExportVisitor)
- com.project.util → Logging utility