# Task 3

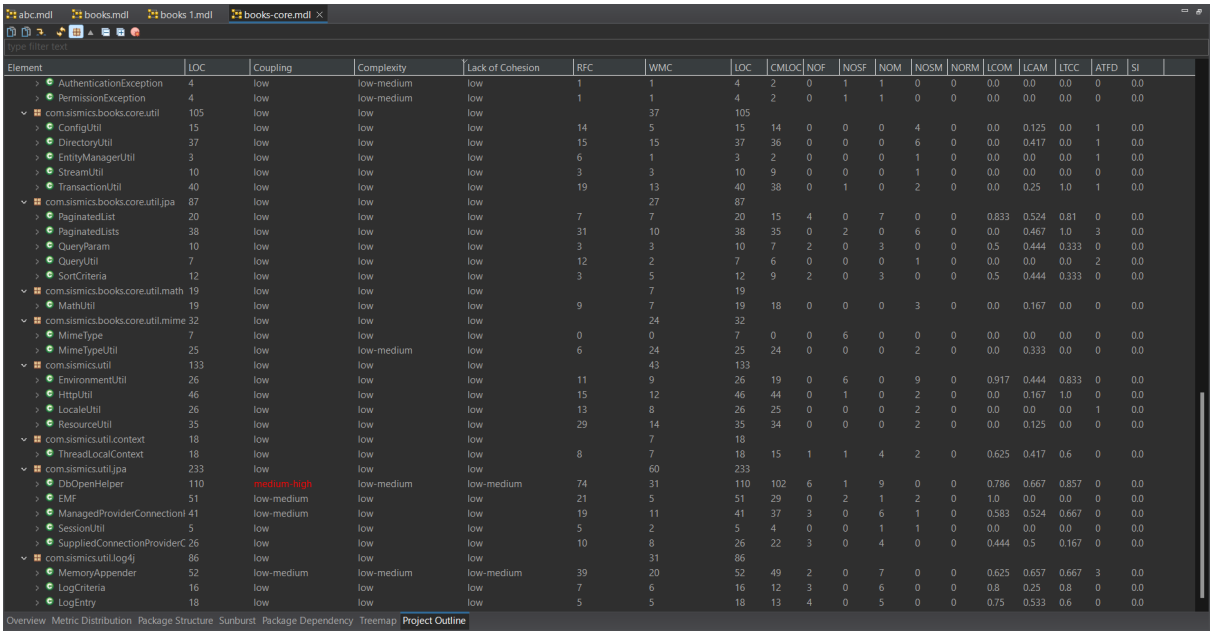
## Task 3A

All of the Design Smells are listed in the GitHub issues page. The exact information about the same can be found in the respective issues themselves.
The refactoring PRs are also listed in the GitHub PRs page. All of the PRs are linked with atleast one issue, and marked with the corresponding label for the design smell title.

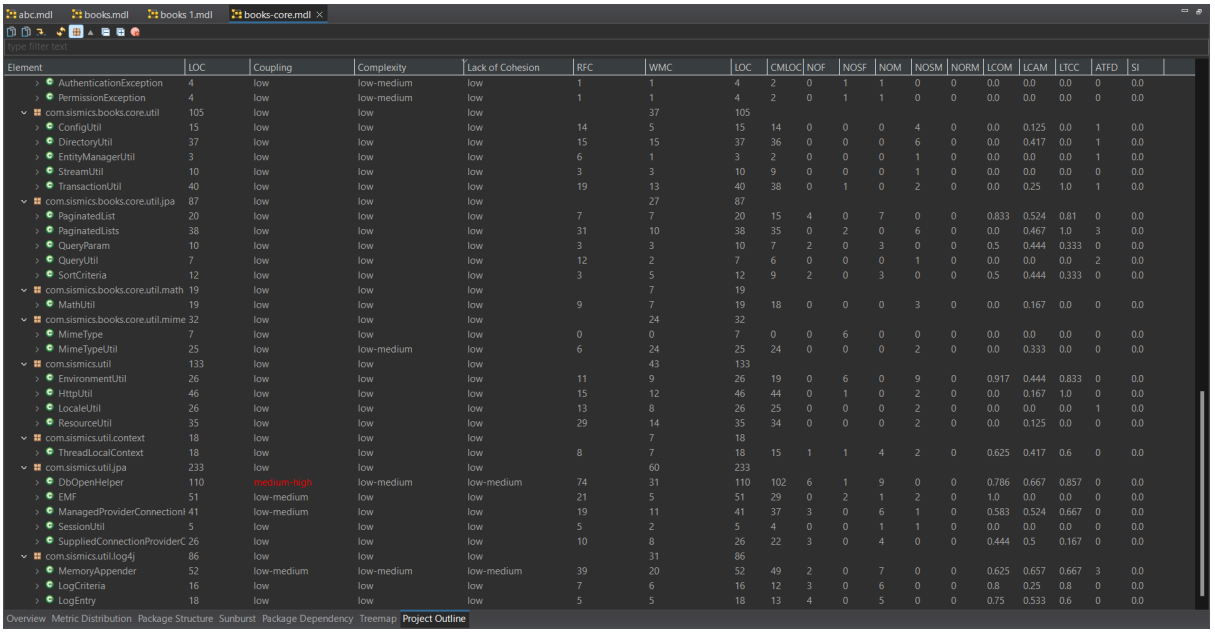
## Task 3B (Along with Task 2B)

# Task 2b & 3b

## Metrics



| Element | LOC | Coupling | Complexity | Lack of Cohesion | RFC | WMC | LOC | CMLOC | NOF | NOSF | NOM | NOSM | NORM | LCOM | LCAM | LTCC | ATFD | SI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AuthenticationException | 4 | low | low-medium | low | 1 | 1 | 4 | 2 | 0 | 1 | 1 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 |
| PermissionException | 4 | low | low-medium | low | 1 | 1 | 4 | 2 | 0 | 1 | 1 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 |
| com.sismics.books.core.util | 105 | low | low | low | | 37 | 105 | | | | | | | | | | | |
| ConfigUtil | 15 | low | low | low | 14 | 5 | 15 | 14 | 0 | 0 | 0 | 4 | 0 | 0.0 | 0.125 | 0.0 | 1 | 0.0 |
| DirectoryUtil | 37 | low | low | low | 15 | 15 | 37 | 36 | 0 | 0 | 0 | 6 | 0 | 0.0 | 0.417 | 0.0 | 1 | 0.0 |
| EntityManagerUtil | 3 | low | low | low | 6 | 1 | 3 | 2 | 0 | 0 | 0 | 1 | 0 | 0.0 | 0.0 | 0.0 | 1 | 0.0 |
| StreamUtil | 10 | low | low | low | 3 | 3 | 10 | 9 | 0 | 0 | 0 | 1 | 0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 |
| TransactionUtil | 40 | low | low | low | 19 | 13 | 40 | 38 | 0 | 1 | 0 | 2 | 0 | 0.0 | 0.25 | 1.0 | 1 | 0.0 |
| com.sismics.books.core.util.jpa | 87 | low | low | low | | 27 | 87 | | | | | | | | | | | |
| PaginatedList | 20 | low | low | low | 7 | 7 | 20 | 15 | 4 | 0 | 7 | 0 | 0 | 0.833 | 0.524 | 0.81 | 0 | 0.0 |
| PaginatedLists | 38 | low | low | low | 31 | 10 | 38 | 35 | 0 | 2 | 0 | 6 | 0 | 0.0 | 0.467 | 1.0 | 3 | 0.0 |
| QueryParam | 10 | low | low | low | 3 | 3 | 10 | 7 | 2 | 0 | 3 | 0 | 0 | 0.5 | 0.444 | 0.333 | 0 | 0.0 |
| QueryUtil | 7 | low | low | low | 12 | 2 | 7 | 6 | 0 | 0 | 0 | 1 | 0 | 0.0 | 0.0 | 0.0 | 2 | 0.0 |
| SortCriteria | 12 | low | low | low | 3 | 5 | 12 | 9 | 2 | 0 | 3 | 0 | 0 | 0.5 | 0.444 | 0.333 | 0 | 0.0 |
| com.sismics.books.core.util.math | 19 | low | low | low | | 7 | 19 | | | | | | | | | | | |
| MathUtil | 19 | low | low | low | 9 | 7 | 19 | 18 | 0 | 0 | 0 | 3 | 0 | 0.0 | 0.167 | 0.0 | 0 | 0.0 |
| com.sismics.books.core.util.mime | 32 | low | low | low | | 24 | 32 | | | | | | | | | | | |
| MimeType | 7 | low | low | low | 0 | 0 | 7 | 0 | 0 | 6 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 |
| MimeTypeUtil | 25 | low | low-medium | low | 6 | 24 | 25 | 24 | 0 | 0 | 0 | 2 | 0 | 0.0 | 0.333 | 0.0 | 0 | 0.0 |
| com.sismics.util | 133 | low | low | low | | 43 | 133 | | | | | | | | | | | |
| EnvironmentUtil | 26 | low | low | low | 11 | 9 | 26 | 19 | 0 | 6 | 0 | 9 | 0 | 0.917 | 0.444 | 0.833 | 0 | 0.0 |
| HttpUtil | 46 | low | low | low | 15 | 12 | 46 | 44 | 0 | 1 | 0 | 2 | 0 | 0.0 | 0.167 | 1.0 | 0 | 0.0 |
| LocaleUtil | 26 | low | low | low | 13 | 8 | 26 | 25 | 0 | 0 | 0 | 2 | 0 | 0.0 | 0.0 | 0.0 | 1 | 0.0 |
| ResourceUtil | 35 | low | low | low | 29 | 14 | 35 | 34 | 0 | 0 | 0 | 2 | 0 | 0.0 | 0.125 | 0.0 | 0 | 0.0 |
| com.sismics.util.context | 18 | low | low | low | | 7 | 18 | | | | | | | | | | | |
| ThreadLocalContext | 18 | low | low | low | 8 | 7 | 18 | 15 | 1 | 1 | 4 | 2 | 0 | 0.625 | 0.417 | 0.6 | 0 | 0.0 |
| com.sismics.util.jpa | 233 | low | low | low | | 60 | 233 | | | | | | | | | | | |
| DbOpenHelper | 110 | medium-high | low-medium | low-medium | 74 | 31 | 110 | 102 | 6 | 1 | 9 | 0 | 0 | 0.786 | 0.667 | 0.857 | 0 | 0.0 |
| EMF | 51 | low-medium | low | low | 21 | 5 | 51 | 29 | 0 | 2 | 1 | 2 | 0 | 1.0 | 0.0 | 0.0 | 0 | 0.0 |
| ManagedProviderConnectionI | 41 | low-medium | low | low | 19 | 11 | 41 | 37 | 3 | 0 | 6 | 1 | 0 | 0.583 | 0.524 | 0.667 | 0 | 0.0 |
| SessionUtil | 5 | low | low | low | 5 | 2 | 5 | 4 | 0 | 0 | 1 | 1 | 0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 |
| SuppliedConnectionProviderC | 26 | low | low | low | 10 | 8 | 26 | 22 | 3 | 0 | 4 | 0 | 0 | 0.444 | 0.5 | 0.167 | 0 | 0.0 |
| com.sismics.util.log4j | 86 | low | low | low | | 31 | 86 | | | | | | | | | | | |
| MemoryAppender | 52 | low-medium | low-medium | low-medium | 39 | 20 | 52 | 49 | 2 | 0 | 7 | 0 | 0 | 0.625 | 0.657 | 0.667 | 3 | 0.0 |
| LogCriteria | 16 | low | low | low | 7 | 6 | 16 | 12 | 3 | 0 | 6 | 0 | 0 | 0.8 | 0.25 | 0.8 | 0 | 0.0 |
| LogEntry | 18 | low | low | low | 5 | 5 | 18 | 13 | 4 | 0 | 5 | 0 | 0 | 0.75 | 0.533 | 0.6 | 0 | 0.0 |



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| ResourceUtil | 35 | low | low | low | 29 | 14 | 35 | 34 | 0 | 0 | 0 | 2 | 0 | 0.0 | 0.125 | 0.0 | 0 | 0.0 |
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| SuppliedConnectionProviderC | 26 | low | low | low | 10 | 8 | 26 | 22 | 3 | 0 | 4 | 0 | 0 | 0.444 | 0.5 | 0.167 | 0 | 0.0 |
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| MemoryAppender | 52 | low-medium | low-medium | low-medium | 39 | 20 | 52 | 49 | 2 | 0 | 7 | 0 | 0 | 0.625 | 0.657 | 0.667 | 3 | 0.0 |
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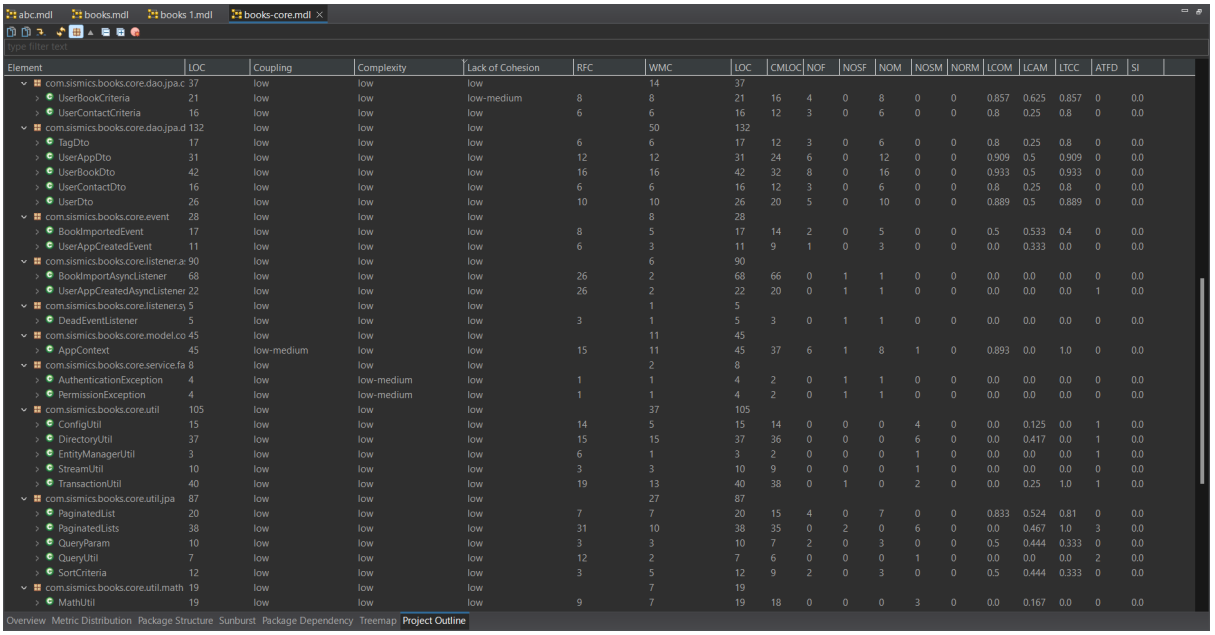
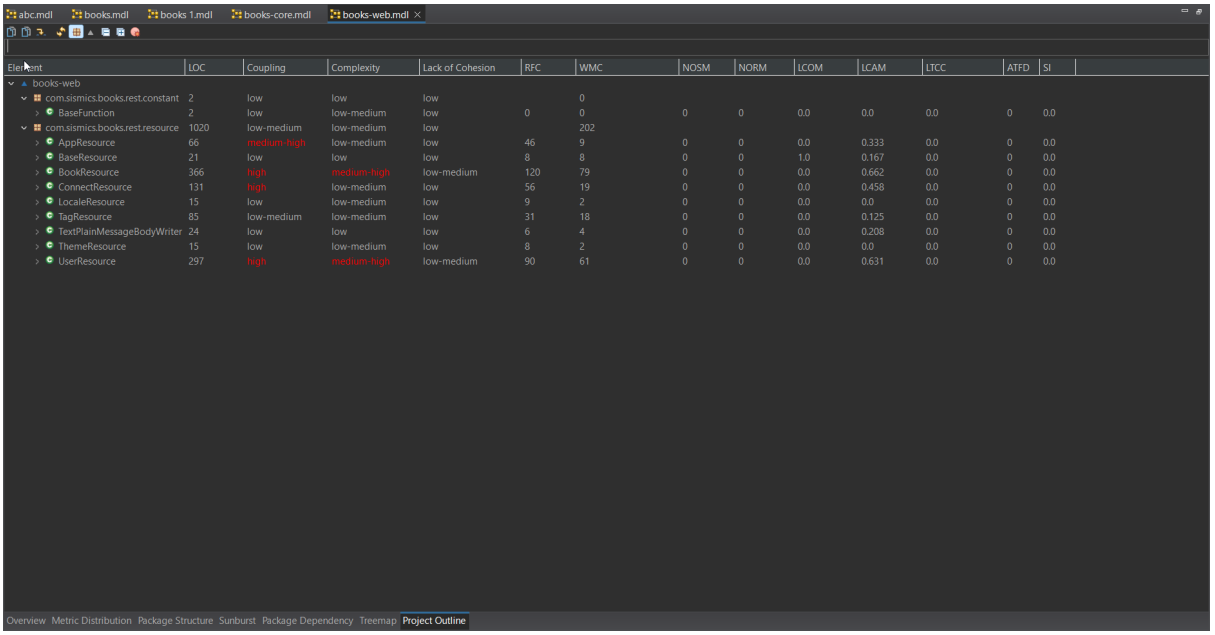



# Code Metrics

We used Codemr for code analysis. It provided a variety of code metrics, but we specifically focused on six: Lines of Code (LOC), coupling, complexity, cohesion, Response from Class (RFC), and Weighted Method Count (WMC).

## Before refactoring

1. Lines of Code: The bookresource and userresource files contain a high number of lines of code, which can impact maintainability. This could be an

early indication that these files have too many responsibilities, making them prime candidates for refactoring.

2. Coupling: The resource classes, particularly BookResource and UserResource, exhibit a high degree of coupling. This is somewhat expected as they manage HTTP requests and relay them to other systems. Similarly, the BookDataService and FacebookService classes are highly coupled, suggesting that these might be god classes. Consequently, modifications in these classes could lead to unforeseen consequences and potentially introduce bugs into a significant portion of the codebase. This could negatively impact maintainability and needs to be addressed.
3. Complexity: The BookResource and UserResource classes have high complexity, indicating that their functionality is quite complicated. Combined with the other issues present in these classes, this complexity poses a significant challenge to their understandability and maintainability.
4. Cohesion: We determined that the codebase has high cohesion, suggesting that there are no unnecessary variables declared and all declared attributes are used appropriately by their respective classes.
5. Response from Class (RFC): RFC scores are high for both the resource classes and the service classes. This is anticipated as these are the key classes handling a substantial part of the project's functionality. However, this also implies that tracking down and fixing any bugs would be challenging.
6. Weighted Method Count (WMC): The resource classes tend to have a higher WMC than other classes, as do the service classes, though to a lesser extent. This supports our hypothesis that these classes contain complex functionality, making them difficult to understand and maintain.

We've identified several problematic classes within the code base. These classes handle multiple functions, resulting in high complexity. Additionally, numerous methods call upon these classes, making them bug-prone and hard to read.

## Analysis of books-core

General Information

**Total lines of code: 2523**

**Number of classes: 71**

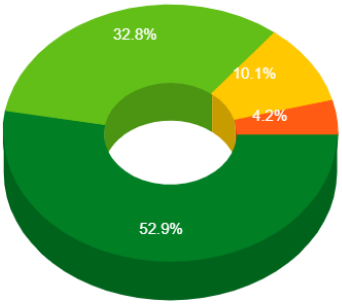
**Number of packages: 20**

**Number of external packages: 48**

**Number of external classes: 210**

**Number of problematic classes: 1**

**Number of highly problematic classes: 0**




## Analysis of books-web

General Information

**Total lines of code: 1022**

**Number of classes: 10**

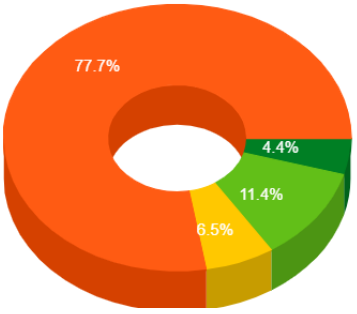
**Number of packages: 2**

**Number of external packages: 43**

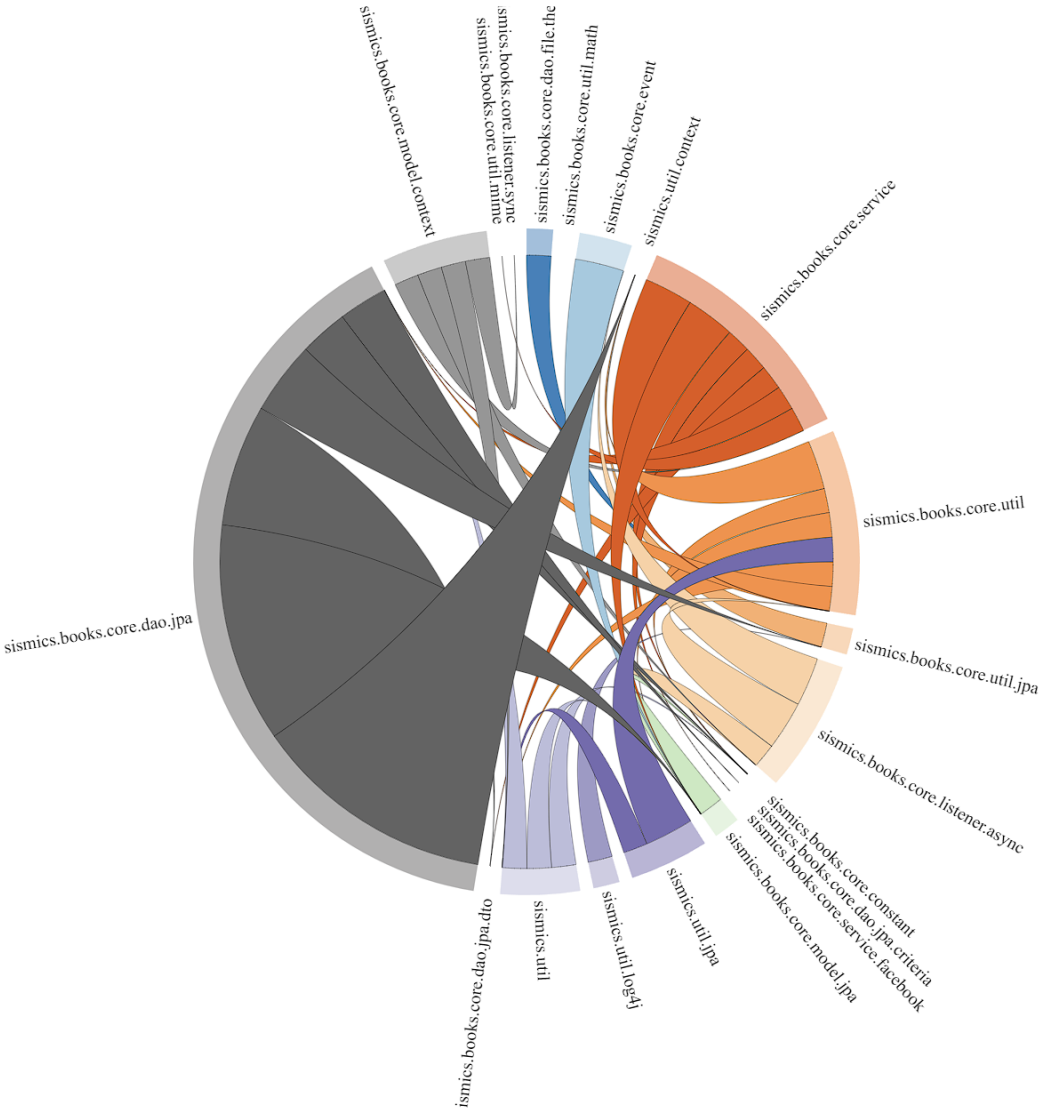
**Number of external classes: 128**

**Number of problematic classes: 3**

**Number of highly problematic classes: 0**




Package Dependencies:




## After Refactoring

After manually refactoring the code, we observed the following changes in the metrics:

1. Lines of code: The number of lines in almost all files was reduced, with none exceeding 130 lines in any single file.
2. Coupling: Most of the problematic classes now have low to medium coupling, except for the Facebook service. This improvement makes the code more modular and maintainable. However, some of the helper classes for the newly introduced resource classes have relatively high coupling. This suggests that the functionality of some methods is inherently coupled to the rest of the system, a problem that might be solved by a major architectural redesign.

3. Complexity: The complexity of the resource classes remained unchanged, but it was reduced for the BookData and Facebook service classes. However, the classes to which complexity was abstracted still have high complexity levels. Their other metrics are low, so this high complexity should not produce other issues.
4. Cohesion: High cohesion was maintained throughout the code base.
5. Response from class (RFC): With the introduction of significant abstraction, it was expected that RFC would increase for most classes, although the increase was not significant. However, it decreased for the BookDataService, as we refactored it to call methods based on certain preconditions, thus reducing the number of potentially called methods.
6. Weighted Method Count (WMC): The WMC has drastically decreased for all classes. This is a positive development as it signifies a significant reduction in the complexity of each method, thereby improving the readability and maintainability of the functions.

After refactoring, we found that the overall complexity of the codebase has not significantly decreased. This implies that a substantial architectural redesign of the system is necessary, and it cannot be simply addressed by removing code and design smells. However, we did notice a reduction in coupling and complexity in problem areas. These issues have either been largely eliminated or shifted to classes with singular responsibilities, specifically designed as helper classes. This enhances readability and makes the code easier to maintain.

## Analysis of books-core_new

General Information

**Total lines of code: 2575**

**Number of classes: 74**

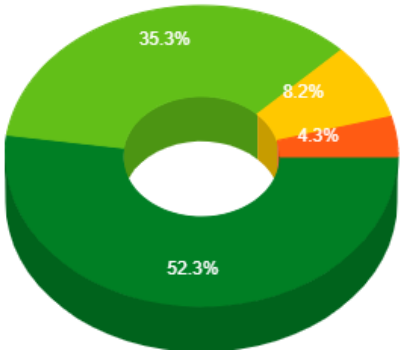
**Number of packages: 20**

**Number of external packages: 48**

**Number of external classes: 210**

**Number of problematic classes: 1**

**Number of highly problematic classes: 0**




## Analysis of books-web_new

General Information

**Total lines of code: 1108**

**Number of classes: 20**

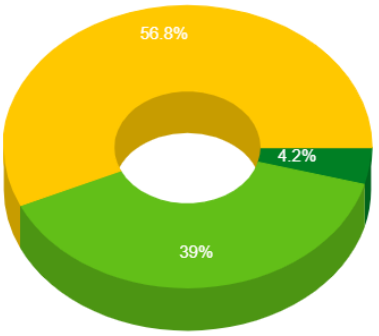
**Number of packages: 3**

**Number of external packages: 43**

**Number of external classes: 127**

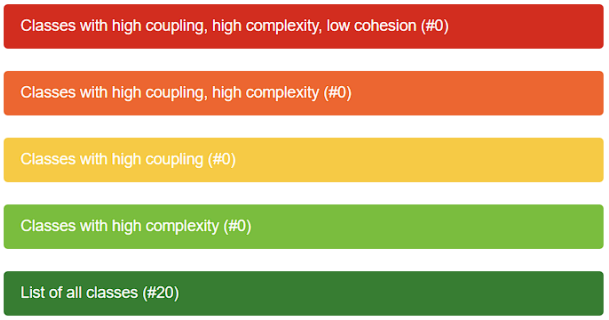
**Number of problematic classes: 0**

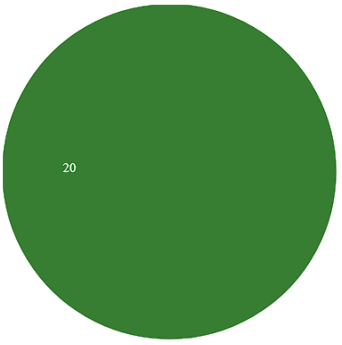
**Number of highly problematic classes: 0**




## Books Web:

Detailed metric tables




## Books Core:

## Detailed metric tables

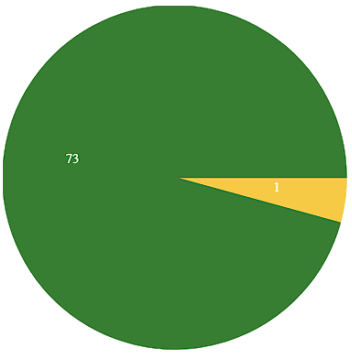
Classes with high coupling, high complexity, low cohesion (#0)

Classes with high coupling, high complexity (#0)

Classes with high coupling (#1)

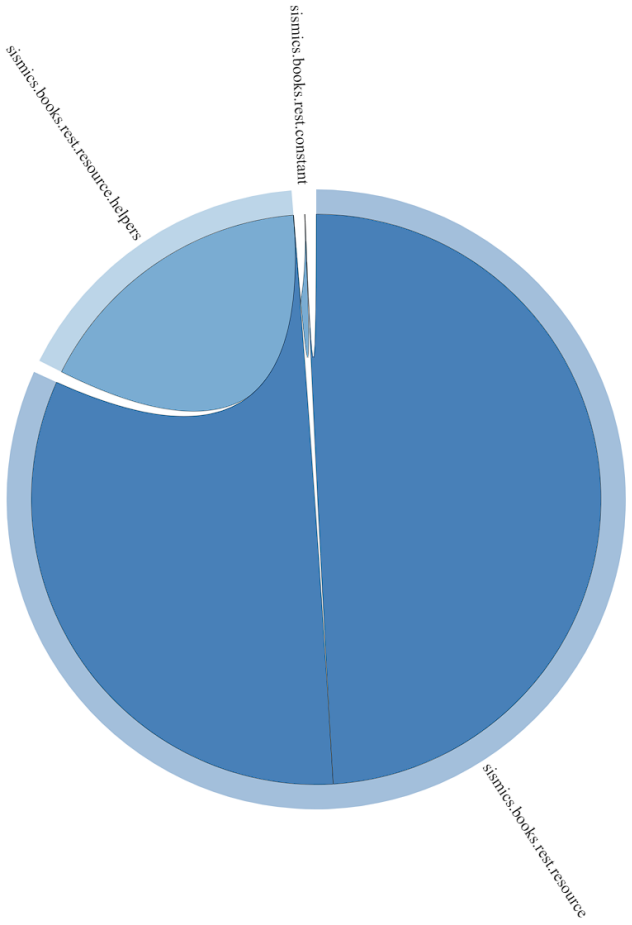
Classes with high complexity (#0)

List of all classes (#74)




## Package Dependencies

Hover on the wheel to see the details



# Task 3C

Different Refactorings and the corresponding response from the ChatGPT 3.5-Turbo, along with the comments on the differences, which is better, etc. are listed below one by one.

# AnonymousPrincipal - Duplicated Abstration

## Chat 1: Before being told that it was a duplicated abstraction smell:

Link to chat

> Here, we simply gave the code to GPT and it was unable to identify the duplicated abstraction design smell, only suggesting minor changes.

---

## Chat 2: After being told that it was a duplicated abstraction smell:

Link to chat

Certainly! To address the duplicated abstraction and improve the design, you can introduce a single `Principal` class that can represent both anonymous and authenticated users. Here's how you can refactor the code:

```
package com.sismics.security;

import org.joda.time.DateTimeZone;

import java.util.Locale;
import java.util.Set;

/**
 * Principal representing both anonymous and authenticated users.
 *
 * @author jtremeaux
 */
public class Principal implements IPrincipal {
    /**
     * ID of the user.
     */
    private String id;

    /**
     * Username of the user.
     */
    private String name;

    /**
     * Locale of the principal.
     */
    private Locale locale;

    /**
     * Timezone of the principal.
     */
    private DateTimeZone dateTimeZone;
```

```java
    /**
     * Email of the principal.
     */
    private String email;

    /**
     * Flag indicating if the principal is anonymous.
     */
    private boolean anonymous;

    /**
     * User base functions.
     */
    private Set<String> baseFunctionSet;

    /**
     * Constructor of Principal for an anonymous user.
     */
    public Principal() {
        this.anonymous = true;
    }

    /**
     * Constructor of Principal for an authenticated user.
     *
     * @param id ID of the user
     * @param name Username of the user
     */
    public Principal(String id, String name) {
        this.id = id;
        this.name = name;
        this.anonymous = false;
    }

    @Override
    public boolean isAnonymous() {
        return anonymous;
    }

    @Override
    public String getId() {
        return id;
    }

    /**
     * Setter of id.
     *
     * @param id id
     */
    public void setId(String id) {
        this.id = id;
    }
```

```java
    @Override
    public String getName() {
        return name;
    }

    /**
     * Setter of name.
     *
     * @param name name
     */
    public void setName(String name) {
        this.name = name;
    }

    @Override
    public Locale getLocale() {
        return locale;
    }

    /**
     * Setter of locale.
     *
     * @param locale locale
     */
    public void setLocale(Locale locale) {
        this.locale = locale;
    }

    @Override
    public DateTimeZone getDateTimeZone() {
        return dateTimeZone;
    }

    /**
     * Setter of dateTimeZone.
     *
     * @param dateTimeZone dateTimeZone
     */
    public void setDateTimeZone(DateTimeZone dateTimeZone) {
        this.dateTimeZone = dateTimeZone;
    }

    @Override
    public String getEmail() {
        return email;
    }

    /**
     * Setter of email.
     *
     * @param email email
     */
    public void setEmail(String email) {
        this.email = email;
```

```
    }

    /**
     * Getter of baseFunctionSet.
     *
     * @return baseFunctionSet
     */
    public Set<String> getBaseFunctionSet() {
        return baseFunctionSet;
    }

    /**
     * Setter of baseFunctionSet.
     *
     * @param baseFunctionSet baseFunctionSet
     */
    public void setBaseFunctionSet(Set<String> baseFunctionSet) {
        this.baseFunctionSet = baseFunctionSet;
    }

}
```

With this refactored code, you have a single `Principal` class that can represent both anonymous and authenticated users based on the value of the `anonymous` flag. This approach eliminates the need for separate `AnonymousPrincipal` and `UserPrincipal` classes, reducing duplication and improving code maintainability.

> This was a very simple fix, so we attempted explaining the issue to GPT and obtained near-accurate promising results - closely resembling what we did for refactoring manually.

# BookDataService - Missing Modularization

Link to chat

## Chat 1: Before being told that it was a Missing Hierarchy & Modularization Smell:

Design smells are symptoms of poor design choices or violations of good design principles that can lead to various issues such as reduced maintainability, flexibility, or scalability. In the provided code, several design smells can be identified:

God Class: The BookDataService class is handling too many responsibilities. It's responsible for configuration initialization, API communication, book searching, downloading thumbnails, and managing thread execution. This violates the Single Responsibility Principle.

Long Method: The searchBookWithGoogle and searchBookWithOpenLibrary methods are quite long and handle multiple concerns. They perform API communication, parsing JSON responses, and building book objects. Breaking down these methods into smaller, more focused methods would improve readability and maintainability.

Primitive Obsession: The handling of ISBN strings directly within the searchBook method indicates a primitive obsession smell. It would be better to encapsulate ISBN-related operations into a separate class.

Magic Numbers/String: There are several magic numbers and strings scattered throughout the code (e.g., API URLs, timeout values). These should be extracted into constants for better maintainability and readability.

Exception Handling: The exception handling in the searchBook method is not optimal. It catches generic Exception, which makes it hard to distinguish between different failure scenarios. It would be better to catch more specific exceptions and handle them accordingly.

Concurrency Handling: The code uses ExecutorService for asynchronous execution, but it doesn't handle potential exceptions or errors that might occur during execution. Proper error handling and logging mechanisms should be implemented.

Hardcoded Dependencies: The code directly instantiates dependencies like ObjectMapper and URL instead of injecting them. This makes the code less flexible and harder to test.

To refactor the code and address these design smells, here are some suggestions:

Extract Classes: Break down the BookDataService class into smaller classes, each responsible for a single concern such as configuration management, API communication, book parsing, and thumbnail downloading.

Single Responsibility Principle: Ensure that each class and method has a single responsibility. For example, create separate classes for API communication and book parsing.

Encapsulation: Create a separate class for handling ISBN-related operations, encapsulating all ISBN-related logic.

Use Constants: Replace magic numbers and strings with named constants to improve readability and maintainability.

Refactor Exception Handling: Use more specific exception types and handle them appropriately. Consider using checked exceptions for recoverable errors and unchecked exceptions for unexpected errors.

Improve Concurrency Handling: Implement error handling and logging mechanisms for asynchronous execution. Consider using CompletableFuture or other constructs for more flexible concurrency management.

Dependency Injection: Inject dependencies instead of directly instantiating them, which makes the code more modular and testable.

By addressing these design smells and refactoring the code accordingly, you can improve its readability, maintainability, and flexibility.

```
package com.sismics.books.core.service;

import com.neovisionaries.i18n.LanguageCode;
import com.sismics.books.core.constant.ConfigType;
import com.sismics.books.core.model.jpa.Book;
import com.sismics.books.core.util.ConfigUtil;
import com.sismics.books.core.util.DirectoryUtil;
import com.sismics.books.core.util.mime.MimeType;
import com.sismics.books.core.util.mime.MimeTypeUtil;
import org.codehaus.jackson.JsonNode;
import org.codehaus.jackson.map.ObjectMapper;
import org.codehaus.jackson.node.ArrayNode;
import org.joda.time.DateTime;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

import java.io.BufferedInputStream;
import java.io.InputStream;
import java.net.URL;
import java.net.URLConnection;
import java.nio.file.Files;
import java.nio.file.Path;
import java.nio.file.Paths;
import java.nio.file.StandardCopyOption;
import java.util.Iterator;
import java.util.Locale;
import java.util.UUID;
import java.util.concurrent.Callable;
import java.util.concurrent.ExecutorService;
import java.util.concurrent.Executors;

public class BookDataService {
    private static final Logger log =
LoggerFactory.getLogger(BookDataService.class);

    private static final String GOOGLE_BOOKS_SEARCH_FORMAT =
```

```
"https://www.googleapis.com/books/v1/volumes?q=isbn:%s&key=%s";
    private static final String OPEN_LIBRARY_FORMAT =
"http://openlibrary.org/api/volumes/brief/isbn/%s.json";

    private final ExecutorService executor =
Executors.newSingleThreadExecutor();
    private final ObjectMapper objectMapper = new ObjectMapper();

    private final String apiKeyGoogle;

    public BookDataService() {
        apiKeyGoogle =
ConfigUtil.getConfigStringValue(ConfigType.API_KEY_GOOGLE);
    }

    public Book searchBook(String rawIsbn) throws Exception {
        final String isbn = sanitizeIsbn(rawIsbn);

        if (isbn.isEmpty()) {
            throw new IllegalArgumentException("ISBN is empty");
        }

        Callable<Book> callable = () -> {
            try {
                return searchBookWithGoogle(isbn);
            } catch (Exception e) {
                log.warn("Book not found with Google: " + isbn + " with
error: " + e.getMessage());
                return searchBookWithOpenLibrary(isbn);
            }
        };
        return executor.submit(callable).get();
    }

    private Book searchBookWithGoogle(String isbn) throws Exception {
        JsonNode rootNode = fetchJsonResponse(String.format(Locale.ENGLISH,
GOOGLE_BOOKS_SEARCH_FORMAT, isbn, apiKeyGoogle));
        return parseBook(rootNode);
    }

    private Book searchBookWithOpenLibrary(String isbn) throws Exception {
        JsonNode rootNode = fetchJsonResponse(String.format(Locale.ENGLISH,
OPEN_LIBRARY_FORMAT, isbn));
        return parseBook(rootNode.get("records").getElements().next());
    }

    private JsonNode fetchJsonResponse(String urlString) throws Exception {
        URL url = new URL(urlString);
        try (InputStream inputStream = new
BufferedInputStream(url.openStream())) {
            return objectMapper.readTree(inputStream);
        }
    }
```

```
    private Book parseBook(JsonNode bookNode) throws Exception {
        Book book = new Book();
        book.setId(UUID.randomUUID().toString());
        // Parse book details and set properties
        return book;
    }

    private String sanitizeIsbn(String rawIsbn) {
        return rawIsbn.replaceAll("[^\\d]", "");
    }

    public void downloadThumbnail(Book book, String imageUrl) throws
Exception {
        URLConnection imageConnection = new URL(imageUrl).openConnection();
        imageConnection.setRequestProperty("User-Agent", "Mozilla/5.0
(Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/29.0.1547.62 Safari/537.36");
        try (InputStream inputStream = new
BufferedInputStream(imageConnection.getInputStream())) {
            if (MimeTypeUtil.guessMimeType(inputStream) !=
MimeType.IMAGE_JPEG) {
                throw new IllegalArgumentException("Only JPEG images are
supported as thumbnails");
            }

            Path imagePath =
Paths.get(DirectoryUtil.getBookDirectory().getPath(), book.getId());
            Files.copy(inputStream, imagePath,
StandardCopyOption.REPLACE_EXISTING);
        }
    }

    public void shutdown() {
        executor.shutdown();
    }
}
```

In this refactored version:

Responsibility Segregation: The responsibilities have been segregated into methods like searchBookWithGoogle, searchBookWithOpenLibrary, fetchJsonResponse, parseBook, etc.

Constructor Initialization: The API key is now initialized in the constructor.

Improved Exception Handling: Exceptions are handled more appropriately within methods, making the code clearer.

Encapsulation of ISBN Sanitization: ISBN sanitization logic is encapsulated within the sanitizeIsbn method.

Dependency Injection: The ObjectMapper is instantiated as a class member, making it easier to manage and inject if needed.

Resource Management: Proper resource management is ensured by using try-with-resources for handling input streams.

Thread Pool Management: The executor service is properly initialized and shut down.

This refactored version is more modular, easier to read, and follows better design practices.

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## Chat 2: After being told that it was a Missing Hierarchy & Modularization smell:

To address the Missing Hierarchy & Modularization smell, we can introduce a more hierarchical and modular structure to the code by separating concerns into smaller, more specialized classes. Below is a refactored version of the code following a more hierarchical and modular approach:

```
package com.sismics.books.core.service;

import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

import java.util.concurrent.Callable;
import java.util.concurrent.ExecutorService;
import java.util.concurrent.Executors;
import java.util.concurrent.Future;

public class BookDataService {
    private static final Logger log =
LoggerFactory.getLogger(BookDataService.class);

    private final ExecutorService executor =
Executors.newSingleThreadExecutor();

    private final BookSearcher bookSearcher;

    public BookDataService(BookSearcher bookSearcher) {
        this.bookSearcher = bookSearcher;
    }

    public Future<Book> searchBook(String rawIsbn) {
        return executor.submit(() -> {
            try {
                return bookSearcher.searchBook(rawIsbn);
            } catch (Exception e) {
                log.error("Failed to search book", e);
                throw e;
            }
        });
    }

    public void shutdown() {
        executor.shutdown();
```

```
    }
}
```

```
package com.sismics.books.core.service;

import com.sismics.books.core.model.jpa.Book;

import java.util.concurrent.Future;

public interface BookSearcher {
    Future<Book> searchBook(String rawIsbn) throws Exception;
}
```

```
package com.sismics.books.core.service;

import com.sismics.books.core.util.ConfigUtil;
import org.codehaus.jackson.JsonNode;
import org.codehaus.jackson.map.ObjectMapper;

import java.io.BufferedInputStream;
import java.io.InputStream;
import java.net.URL;
import java.util.Locale;
import java.util.UUID;
import java.util.concurrent.Future;

public class GoogleBooksSearcher implements BookSearcher {
    private static final String GOOGLE_BOOKS_SEARCH_FORMAT =
"https://www.googleapis.com/books/v1/volumes?q=isbn:%s&key=%s";

    private final ObjectMapper objectMapper = new ObjectMapper();
    private final String apiKeyGoogle;

    public GoogleBooksSearcher() {
        this.apiKeyGoogle =
ConfigUtil.getConfigStringValue(ConfigType.API_KEY_GOOGLE);
    }

    @Override
    public Future<Book> searchBook(String rawIsbn) throws Exception {
        String isbn = sanitizeIsbn(rawIsbn);
        String urlString = String.format(Locale.ENGLISH,
GOOGLE_BOOKS_SEARCH_FORMAT, isbn, apiKeyGoogle);
        return fetchBook(urlString);
    }

    private String sanitizeIsbn(String rawIsbn) {
        return rawIsbn.replaceAll("[^\\d]", "");
    }
```

```
    private Future<Book> fetchBook(String urlString) throws Exception {
        try (InputStream inputStream = new BufferedInputStream(new
URL(urlString).openStream())) {
            JsonNode rootNode = objectMapper.readTree(inputStream);
            // Parse JsonNode and return Book object
            return null;
        }
    }
}
```

```
package com.sismics.books.core.service;

import com.sismics.books.core.util.ConfigUtil;
import org.codehaus.jackson.JsonNode;
import org.codehaus.jackson.map.ObjectMapper;

import java.io.BufferedInputStream;
import java.io.InputStream;
import java.net.URL;
import java.util.Locale;
import java.util.UUID;
import java.util.concurrent.Future;

public class OpenLibrarySearcher implements BookSearcher {
    private static final String OPEN_LIBRARY_FORMAT =
"http://openlibrary.org/api/volumes/brief/isbn/%s.json";

    private final ObjectMapper objectMapper = new ObjectMapper();

    @Override
    public Future<Book> searchBook(String rawIsbn) throws Exception {
        String isbn = sanitizeIsbn(rawIsbn);
        String urlString = String.format(Locale.ENGLISH,
OPEN_LIBRARY_FORMAT, isbn);
        return fetchBook(urlString);
    }

    private String sanitizeIsbn(String rawIsbn) {
        return rawIsbn.replaceAll("[^\\d]", "");
    }

    private Future<Book> fetchBook(String urlString) throws Exception {
        try (InputStream inputStream = new BufferedInputStream(new
URL(urlString).openStream())) {
            JsonNode rootNode = objectMapper.readTree(inputStream);
            // Parse JsonNode and return Book object
            return null;
        }
    }
}
```

In this refactoring:

The BookDataService class is responsible for submitting search tasks to the executor service. The BookSearcher interface defines a contract for classes responsible for searching books. The GoogleBooksSearcher and OpenLibrarySearcher classes implement the BookSearcher interface and handle searching books using Google Books API and Open Library API respectively. Each class now has a single responsibility, which promotes better maintainability and testability. The executor service is used for asynchronous execution of search tasks. The dependency on API keys is encapsulated within the respective searcher classes. Error handling and logging are simplified and centralized in the BookDataService class.

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Here, we see that the LLM was not able to exactly figure out the Modularity smell but it was able to understand that there is a smell related to Violation of Single Responsibility Principle (SRP) though it was not able to refactor it.

Once we provide it the context, the model performs much better by making an interface for bookSearchService and abstracting out the two classes i.e. GoogleBookSearchService and OpenLibrarySearchService just as was done while manual refactoring.

# BookResource - God Class

Link to chat

## Chat 1: Before being told that it was Missing Modularisation & Hierarchy & God Class:

There are a few design smells in the provided BookResource class:

Violation of Single Responsibility Principle (SRP): The class is responsible for handling various aspects such as creating, updating, deleting books, managing book covers, listing books, etc. It's advisable to split these responsibilities into separate classes.

Large Method: Some methods are quite large and handle multiple concerns. For instance, the add, add (manual), update, and list methods perform various operations that can be broken down into smaller, more focused methods.

Code Duplication: There is some repetition of code for error handling, validation, and database operations.

Hard-Coded Values: Some hard-coded values like path names and constants can be extracted and defined as constants or configurable parameters.

To refactor the code, we can follow these steps:

Split Responsibilities: Separate concerns such as CRUD operations, handling book covers, listing books, etc., into separate classes.

Extract Methods: Break down large methods into smaller, focused methods to adhere to the Single Responsibility Principle and improve readability.

Remove Code Duplication: Identify and eliminate redundant code by extracting common functionality into separate methods or utility classes.

Use Constants: Replace hard-coded values with constants or configurable parameters to improve maintainability.

Here's a refactored version of the BookResource class, focusing on addressing these design smells:

```
package com.sismics.books.rest.resource;

import javax.ws.rs.*;
import javax.ws.rs.core.MediaType;
import javax.ws.rs.core.Response;

@Path("/book")
public class BookResource extends BaseResource {
    private final BookService bookService;

    public BookResource(BookService bookService) {
        this.bookService = bookService;
```

```
    }

    @PUT
    @Produces(MediaType.APPLICATION_JSON)
    public Response addBook(@FormParam("isbn") String isbn) {
        return bookService.addBook(isbn);
    }

    @DELETE
    @Path("{id: [a-z0-9\\-]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response deleteBook(@PathParam("id") String userBookId) {
        return bookService.deleteBook(userBookId);
    }

    @PUT
    @Path("manual")
    @Produces(MediaType.APPLICATION_JSON)
    public Response addManualBook(BookRequest bookRequest) {
        return bookService.addManualBook(bookRequest);
    }

    // Other methods...

    // Define other methods for updating, listing, and managing books
}
```

In this refactored version, I've introduced a BookService class responsible for handling book-related operations. Each method in the BookResource class delegates the actual business logic to the corresponding method in the BookService class. This separation of concerns improves readability, maintainability, and testability of the code.

> Chatgpt recognized the design smells almost perfectly and it was even also able to recognize that the CRUD functionalities should be handled separatly. It was able to remove the business logic from the resouce class and put it in a separate class similar to what we have done, however in the refactored code, it didn't create multiple classes to handle the different types of logics and created a single class for handling all the requests.

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## Chat 2: After being told that it was Missing Modularisation & Hierarchy & God Class:

To refactor the code to address the design smell of Missing Modularisation & Hierarchy & God Class, we'll introduce a more modular and hierarchical structure by separating concerns into multiple classes and establishing a clear hierarchy of responsibilities. We'll create separate classes for handling CRUD operations, managing book covers, and listing books. Additionally, we'll introduce interfaces to enforce a clear contract between classes.

Here's a refactored version of the code:

```
```

```java
@Path("/book")
public class BookResource {
    private final BookService bookService;

    public BookResource(BookService bookService) {
        this.bookService = bookService;
    }

    @PUT
    @Produces(MediaType.APPLICATION_JSON)
    public Response addBook(@FormParam("isbn") String isbn) {
        return bookService.addBook(isbn);
    }

    @DELETE
    @Path("{id: [a-z0-9\\-]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response deleteBook(@PathParam("id") String userBookId) {
        return bookService.deleteBook(userBookId);
    }

    @PUT
    @Path("manual")
    @Produces(MediaType.APPLICATION_JSON)
    public Response addManualBook(BookRequest bookRequest) {
        return bookService.addManualBook(bookRequest);
    }

    // Other methods...

    // Define other methods for updating, listing, and managing books
}
```

```java
public interface BookService {
    Response addBook(String isbn);
    Response deleteBook(String userBookId);
    Response addManualBook(BookRequest bookRequest);
    // Other methods...
}
```

```java
public class BookServiceImpl implements BookService {
    private final BookManager bookManager;

    public BookServiceImpl(BookManager bookManager) {
        this.bookManager = bookManager;
    }

    @Override
```

```
    public Response addBook(String isbn) {
        // Implement logic to add a book
    }

    @Override
    public Response deleteBook(String userBookId) {
        // Implement logic to delete a book
    }

    @Override
    public Response addManualBook(BookRequest bookRequest) {
        // Implement logic to add a manual book
    }

    // Other methods...
}
```

```
public interface BookManager {
    void createBook(Book book);
    void deleteBook(String bookId);
    Book getByIsbn(String isbn);
    // Other methods...
}
```

```
public class BookManagerImpl implements BookManager {
    @Override
    public void createBook(Book book) {
        // Implement logic to create a book
    }

    @Override
    public void deleteBook(String bookId) {
        // Implement logic to delete a book
    }

    @Override
    public Book getByIsbn(String isbn) {
        // Implement logic to get a book by ISBN
        return null;
    }

    // Other methods...
}
```

```
public class Book {
    // Define properties and methods related to the book entity
}
```

This refactored structure enhances modularity and hierarchy by organizing the code into smaller, focused classes with clear responsibilities. It also helps in better code maintenance, scalability, and testability.

> After being told the design smell, it did refactoring similar to what it already did, however it introduced unnecessary abstraction by creating interfaces for what are essentially helper classes. As such, after telling the design smell, gpt was over egregious in its refactoring and produced code which although more modular and hierarchical, is also needlessly more complex.

# FacebookUser - Encapsulation Smell

Link to chat

## Chat 1: Before being told that it was an Encapsulation Smell:

There are a few design smells in this code:

Exposing Fields: Direct access to class fields (id, email, fullName, accessToken) can lead to a lack of encapsulation and makes it difficult to enforce constraints or perform validation.

Inadequate Encapsulation: The class lacks appropriate encapsulation, as the fields are public. It's generally a good practice to encapsulate fields and provide accessors (getters) to access them.

Mutable State: The class is mutable, meaning its state can be changed after creation. This can lead to unexpected behavior, especially in concurrent environments.

Missing Validation: There's no validation of inputs in the constructor. This can lead to the creation of FacebookUser objects with invalid or inconsistent states.

Documentation: While the class has some comments, they are not particularly informative or helpful. Additionally, the comments are stating obvious things and are redundant.

Here's a refactored version addressing these issues:

```
package com.sismics.books.rest.model;

/**
 * Represents a Facebook user.
 *
 * Management: https://developers.facebook.com/apps/387037158089019/roles?
role=test%20users
 *
 * This class encapsulates user data retrieved from Facebook, providing
getters
 * to access the data.
 *
 * Note: This class assumes that the provided data is valid and does not
perform
 * any validation.
 *
 * @author jtremeaux
 */
public class FacebookUser {
    private final String id;
    private final String email;
    private final String fullName;
    private final String accessToken;

    /**
```

```
     * Constructs a Facebook user with the specified data.
     *
     * @param id          The user's Facebook ID.
     * @param email       The user's email address.
     * @param fullName    The user's full name.
     * @param accessToken The access token associated with the user.
     */
    public FacebookUser(String id, String email, String fullName, String
accessToken) {
        this.id = id;
        this.email = email;
        this.fullName = fullName;
        this.accessToken = accessToken;
    }

    /**
     * Retrieves the Facebook user's ID.
     *
     * @return The Facebook user's ID.
     */
    public String getId() {
        return id;
    }

    /**
     * Retrieves the Facebook user's email address.
     *
     * @return The Facebook user's email address.
     */
    public String getEmail() {
        return email;
    }

    /**
     * Retrieves the Facebook user's full name.
     *
     * @return The Facebook user's full name.
     */
    public String getFullName() {
        return fullName;
    }

    /**
     * Retrieves the access token associated with the Facebook user.
     *
     * @return The access token associated with the Facebook user.
     */
    public String getAccessToken() {
        return accessToken;
    }
}
```

In this refactored version:

The fields are made private, ensuring encapsulation. Getter methods are provided to access the fields. The constructor initializes the fields but does not expose them directly. Documentation is improved to provide better clarity on class usage and assumptions.

---

## Chat 2: After being told that it was an Encapsulation smell:

To address the encapsulation smell in the initial code, we'll make the fields private and provide public getter methods to access them. This ensures that the fields are accessed through methods rather than being directly exposed. Here's the modified code:

```
package com.sismics.books.rest.model;

/**
 * Facebook test user.
 *
 * Management : https://developers.facebook.com/apps/387037158089019/roles?
role=test%20users
 *
 * @author jtremeaux
 */
public class FacebookUser {
    private String id;
    private String email;
    private String fullName;
    private String accessToken;

    public FacebookUser(String id, String email, String fullName, String
accessToken) {
        this.id = id;
        this.email = email;
        this.accessToken = accessToken;
        this.fullName = fullName;
    }

    public String getId() {
        return id;
    }

    public String getEmail() {
        return email;
    }

    public String getFullName() {
        return fullName;
    }

    public String getAccessToken() {
        return accessToken;
    }
}
```

In this refactoring:

The fields id, email, fullName, and accessToken are changed to private access level. Getter methods are provided to allow access to these private fields from outside the class.

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> Here, we see that the LLM was able to figure out that the smell is actually an encapsulation smell and thus was able to refactor it also by making all the public variables final and also just providing the getters for these variables.

> The results of the AI model in either case is exactly what is needed to fix the smell, which showcases that it was able to figure out the smell on its own, and then fix the same in the very first attempt itself.

# BookResource - Brain Method

Link to chat 1
Link to chat 2
Manual Refactoring

file: books-web/src/main/java/com/sismics/books/rest/resource/BookResource.java

## Initial code

```
        // Validate input data
        title = ValidationUtil.validateLength(title, "title", 1, 255,
false);
        subtitle = ValidationUtil.validateLength(subtitle, "subtitle", 1,
255, true);
        author = ValidationUtil.validateLength(author, "author", 1, 255,
false);
        description = ValidationUtil.validateLength(description,
"description", 1, 4000, true);
        isbn10 = ValidationUtil.validateLength(isbn10, "isbn10", 10, 10,
true);
        isbn13 = ValidationUtil.validateLength(isbn13, "isbn13", 13, 13,
true);
        language = ValidationUtil.validateLength(language, "language", 2,
2, true);
        Date publishDate = ValidationUtil.validateDate(publishDateStr,
"publish_date", false);

        if (Strings.isNullOrEmpty(isbn10) && Strings.isNullOrEmpty(isbn13))
{
            throw new ClientException("ValidationError", "At least one ISBN
number is mandatory");
        }

        // Check if this book is not already in database
        BookDao bookDao = new BookDao();
        Book bookIsbn10 = bookDao.getByIsbn(isbn10);
        Book bookIsbn13 = bookDao.getByIsbn(isbn13);
        if (bookIsbn10 != null || bookIsbn13 != null) {
            throw new ClientException("BookAlreadyAdded", "Book already
added");
        }

        // Create the book
        Book book = new Book();
        book.setId(UUID.randomUUID().toString());

        if (title != null) {
            book.setTitle(title);
```

```
        }
        if (subtitle != null) {
            book.setSubtitle(subtitle);
        }
        if (author != null) {
            book.setAuthor(author);
        }
        if (description != null) {
            book.setDescription(description);
        }
        if (isbn10 != null) {
            book.setIsbn10(isbn10);
        }
        if (isbn13 != null) {
            book.setIsbn13(isbn13);
        }
        if (pageCount != null) {
            book.setPageCount(pageCount);
        }
        if (language != null) {
            book.setLanguage(language);
        }
        if (publishDate != null) {
            book.setPublishDate(publishDate);
        }

        bookDao.create(book);

        // Create the user book
        UserBookDao userBookDao = new UserBookDao();
        UserBook userBook = new UserBook();
        userBook.setUserId(principal.getId());
        userBook.setBookId(book.getId());
        userBook.setCreateDate(new Date());
        userBookDao.create(userBook);

        // Update tags
        if (tagList != null) {
            TagDao tagDao = new TagDao();
            Set<String> tagSet = new HashSet<>();
            Set<String> tagIdSet = new HashSet<>();
            List<Tag> tagDbList = tagDao.getByUserId(principal.getId());
            for (Tag tagDb : tagDbList) {
                tagIdSet.add(tagDb.getId());
            }
            for (String tagId : tagList) {
                if (!tagIdSet.contains(tagId)) {
                    throw new ClientException("TagNotFound",
MessageFormat.format("Tag not found: {0}", tagId));
                }
                tagSet.add(tagId);
            }
            tagDao.updateTagList(userBook.getId(), tagSet);
        }
```

```
        // Returns the book ID
        JSONObject response = new JSONObject();
        response.put("id", userBook.getId());
        return Response.ok().entity(response).build();
    }

    /**
     * Updates the book.
     *
     * @param title Title
     * @param description Description
     * @return Response
     * @throws JSONException
     */
    @POST
    @Path("{id: [a-z0-9\\-]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response update(
            @PathParam("id") String userBookId,
            @FormParam("title") String title,
            @FormParam("subtitle") String subtitle,
            @FormParam("author") String author,
            @FormParam("description") String description,
            @FormParam("isbn10") String isbn10,
            @FormParam("isbn13") String isbn13,
            @FormParam("page_count") Long pageCount,
            @FormParam("language") String language,
            @FormParam("publish_date") String publishDateStr,
            @FormParam("tags") List<String> tagList) throws JSONException {
        if (!authenticate()) {
            throw new ForbiddenClientException();
        }

        // Validate input data
        title = ValidationUtil.validateLength(title, "title", 1, 255,
true);
        subtitle = ValidationUtil.validateLength(subtitle, "subtitle", 1,
255, true);
        author = ValidationUtil.validateLength(author, "author", 1, 255,
true);
        description = ValidationUtil.validateLength(description,
"description", 1, 4000, true);
        isbn10 = ValidationUtil.validateLength(isbn10, "isbn10", 10, 10,
true);
        isbn13 = ValidationUtil.validateLength(isbn13, "isbn13", 13, 13,
true);
        language = ValidationUtil.validateLength(language, "language", 2,
2, true);
        Date publishDate = ValidationUtil.validateDate(publishDateStr,
"publish_date", true);

        // Get the user book
        UserBookDao userBookDao = new UserBookDao();
```

```
        BookDao bookDao = new BookDao();
        UserBook userBook = userBookDao.getUserBook(userBookId,
principal.getId());
        if (userBook == null) {
            throw new ClientException("BookNotFound", "Book not found with
id " + userBookId);
        }

        // Get the book
        Book book = bookDao.getById(userBook.getBookId());

        // Check that new ISBN number are not already in database
        if (!Strings.isNullOrEmpty(isbn10) && book.getIsbn10() != null &&
!book.getIsbn10().equals(isbn10)) {
            Book bookIsbn10 = bookDao.getByIsbn(isbn10);
            if (bookIsbn10 != null) {
                throw new ClientException("BookAlreadyAdded", "Book already
added");
            }
        }

        if (!Strings.isNullOrEmpty(isbn13) && book.getIsbn13() != null &&
!book.getIsbn13().equals(isbn13)) {
            Book bookIsbn13 = bookDao.getByIsbn(isbn13);
            if (bookIsbn13 != null) {
                throw new ClientException("BookAlreadyAdded", "Book already
added");
            }
        }

        // Update the book
        if (title != null) {
            book.setTitle(title);
        }
        if (subtitle != null) {
            book.setSubtitle(subtitle);
        }
        if (author != null) {
            book.setAuthor(author);
        }
        if (description != null) {
            book.setDescription(description);
        }
        if (isbn10 != null) {
            book.setIsbn10(isbn10);
        }
        if (isbn13 != null) {
            book.setIsbn13(isbn13);
        }
        if (pageCount != null) {
            book.setPageCount(pageCount);
        }
        if (language != null) {
            book.setLanguage(language);
```

```
        }
        if (publishDate != null) {
            book.setPublishDate(publishDate);
        }

        // Update tags
        if (tagList != null) {
            TagDao tagDao = new TagDao();
            Set<String> tagSet = new HashSet<>();
            Set<String> tagIdSet = new HashSet<>();
            List<Tag> tagDbList = tagDao.getByUserId(principal.getId());
            for (Tag tagDb : tagDbList) {
                tagIdSet.add(tagDb.getId());
            }
            for (String tagId : tagList) {
                if (!tagIdSet.contains(tagId)) {
                    throw new ClientException("TagNotFound",
MessageFormat.format("Tag not found: {0}", tagId));
                }
                tagSet.add(tagId);
            }
            tagDao.updateTagList(userBookId, tagSet);
        }

        // Returns the book ID
        JSONObject response = new JSONObject();
        response.put("id", userBookId);
        return Response.ok().entity(response).build();
    }

    /**
     * Get a book.
     *
     * @param id User book ID
     * @return Response
     * @throws JSONException
     */
    @GET
    @Path("{id: [a-z0-9\\-]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response get(
            @PathParam("id") String userBookId) throws JSONException {
        if (!authenticate()) {
            throw new ForbiddenClientException();
        }

        // Fetch the user book
        UserBookDao userBookDao = new UserBookDao();
        UserBook userBook = userBookDao.getUserBook(userBookId,
principal.getId());
        if (userBook == null) {
            throw new ClientException("BookNotFound", "Book not found with
id " + userBookId);
        }
```

```
        // Fetch the book
        BookDao bookDao = new BookDao();
        Book bookDb = bookDao.getById(userBook.getBookId());

        // Return book data
        JSONObject book = new JSONObject();
        book.put("id", userBook.getId());
        book.put("title", bookDb.getTitle());
        book.put("subtitle", bookDb.getSubtitle());
        book.put("author", bookDb.getAuthor());
        book.put("page_count", bookDb.getPageCount());
        book.put("description", bookDb.getDescription());
        book.put("isbn10", bookDb.getIsbn10());
        book.put("isbn13", bookDb.getIsbn13());
        book.put("language", bookDb.getLanguage());
        if (bookDb.getPublishDate() != null) {
            book.put("publish_date", bookDb.getPublishDate().getTime());
        }
        book.put("create_date", userBook.getCreateDate().getTime());
        if (userBook.getReadDate() != null) {
            book.put("read_date", userBook.getReadDate().getTime());
        }

        // Add tags
        TagDao tagDao = new TagDao();
        List<TagDto> tagDtoList = tagDao.getByUserBookId(userBookId);
        List<JSONObject> tags = new ArrayList<>();
        for (TagDto tagDto : tagDtoList) {
            JSONObject tag = new JSONObject();
            tag.put("id", tagDto.getId());
            tag.put("name", tagDto.getName());
            tag.put("color", tagDto.getColor());
            tags.add(tag);
        }
        book.put("tags", tags);

        return Response.ok().entity(book).build();
    }
```

## Chat 1: Before being told that it was a brain method design smell:

Certainly! Here are some design smells I've identified in the code snippet:

1. **Repeated Code**: There's a significant amount of repetition, particularly in the validation and update logic for book attributes.
2. **Business Logic in Resource Methods**: Business logic, such as validation and database operations, is mixed with resource methods, violating the Single Responsibility Principle.

3. **Data Access Object (DAO) Instantiation**: DAOs are directly instantiated within resource methods, making it hard to test and violating the Dependency Inversion Principle.
4. **Lack of Error Handling**: Error handling is scattered throughout the code and could be better organized.
5. **Inefficient Tag Handling**: Tag handling involves multiple database operations and could be optimized.

To refactor the code, we'll create separate classes for validation, database access, and error handling. We'll also consolidate common operations and improve error handling. Here's a refactored version:

```
// ValidationUtil.java
public class ValidationUtil {
    public static String validateLength(String value, String fieldName, int
minLength, int maxLength, boolean allowNull) {
        // Validation logic
    }

    public static Date validateDate(String value, String fieldName, boolean
allowNull) {
        // Validation logic
    }
}

// BookService.java
public class BookService {
    private BookDao bookDao;
    private UserBookDao userBookDao;
    private TagDao tagDao;

    public BookService() {
        this.bookDao = new BookDao();
        this.userBookDao = new UserBookDao();
        this.tagDao = new TagDao();
    }

    public String createBook(...) {
        // Validation logic
        // Create book logic
        // Update tags logic
        // Return book ID
    }

    public String updateBook(...) {
        // Validation logic
        // Fetch user book
        // Fetch book
        // Check ISBN uniqueness
        // Update book logic
        // Update tags logic
        // Return book ID
```

```
    }

    public JSONObject getBook(String userBookId) {
        // Fetch user book
        // Fetch book
        // Fetch tags
        // Construct JSON response
        // Return JSON response
    }
}

// BookResource.java
@Path("/books")
public class BookResource {
    private BookService bookService;

    public BookResource() {
        this.bookService = new BookService();
    }

    @POST
    @Produces(MediaType.APPLICATION_JSON)
    public Response createBook(...) {
        // Call BookService.createBook method
    }

    @POST
    @Path("{id: [a-z0-9\\-]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response updateBook(...) {
        // Call BookService.updateBook method
    }

    @GET
    @Path("{id: [a-z0-9\\-]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response getBook(@PathParam("id") String userBookId) {
        // Call BookService.getBook method
    }
}
```

In this refactored version, we've separated concerns by creating a `BookService` class to handle business logic, a `ValidationUtil` class for validation, and DAO classes for data access. The `BookResource` class now acts as a controller, delegating tasks to the `BookService` class. This separation of concerns makes the code more modular, easier to maintain, and testable.

---

## Chat 2: After being told that it was a brain method design smell:

Sure, the provided code snippet could benefit from refactoring to improve readability and maintainability. One approach to address the brain method design smell is to break down the large methods into smaller, more focused ones. Here's a refactored version of the code:

```
public class BookService {

    private BookDao bookDao = new BookDao();
    private UserBookDao userBookDao = new UserBookDao();
    private TagDao tagDao = new TagDao();

    public Response createBook(String title, String subtitle, String
author, String description,
                               String isbn10, String isbn13, Long
pageCount, String language,
                               String publishDateStr, List<String> tagList)
throws JSONException {

        validateInputData(title, subtitle, author, description, isbn10,
isbn13, language, publishDateStr);

        checkUniqueISBN(isbn10, isbn13);

        Book book = createBookObject(title, subtitle, author, description,
isbn10, isbn13, pageCount, language, publishDateStr);

        saveBookToDatabase(book);

        String userBookId = createUserBook(book);

        updateTags(tagList, userBookId);

        return Response.ok().entity(createResponse(userBookId)).build();
    }

    private void validateInputData(String title, String subtitle, String
author, String description,
                                   String isbn10, String isbn13, String
language, String publishDateStr) {
        // Validation logic
    }

    private void checkUniqueISBN(String isbn10, String isbn13) {
        // Check if ISBN numbers are unique
    }

    private Book createBookObject(String title, String subtitle, String
author, String description,
                                  String isbn10, String isbn13, Long
pageCount, String language,
                                  String publishDateStr) {
        // Create and populate Book object
        return new Book.Builder()
                .setTitle(title)
                .setSubtitle(subtitle)
                .setAuthor(author)
                .setDescription(description)
```

```
                .setIsbn10(isbn10)
                .setIsbn13(isbn13)
                .setPageCount(pageCount)
                .setLanguage(language)
                .setPublishDate(ValidationUtil.validateDate(publishDateStr,
"publish_date", false))
                .build();
    }

    private void saveBookToDatabase(Book book) {
        bookDao.create(book);
    }

    private String createUserBook(Book book) {
        UserBook userBook = new UserBook();
        userBook.setUserId(principal.getId());
        userBook.setBookId(book.getId());
        userBook.setCreateDate(new Date());
        userBookDao.create(userBook);
        return userBook.getId();
    }

    private void updateTags(List<String> tagList, String userBookId) {
        if (tagList != null) {
            Set<String> tagSet = validateAndGetTagIds(tagList);
            tagDao.updateTagList(userBookId, tagSet);
        }
    }

    private Set<String> validateAndGetTagIds(List<String> tagList) {
        // Validate and get tag IDs
        return tagDao.validateAndGetTagIds(principal.getId(), tagList);
    }

    private JSONObject createResponse(String userBookId) throws
JSONException {
        JSONObject response = new JSONObject();
        response.put("id", userBookId);
        return response;
    }

    // Other methods (update and get) can follow a similar pattern of
breaking down functionality into smaller methods.
}
```

In this refactored version:

1. Each major functionality (validation, book creation, database operations, etc.) is extracted into its own method, improving readability and facilitating easier maintenance.
2. Logic related to validation, database operations, and business logic is separated, adhering to the Single Responsibility Principle.
3. Error handling and response creation are handled uniformly across methods.

4. The code is organized in a more modular and understandable manner.

---

Here, we see that the LLM was not able to figure out that it was a brain method design smell, and thus was only able to make minor changes for the refactoring - that to in completely unrelated parts.

However, when the issues (brain method design smell) and the location were highlighted, the LLM performed much better and was able to show successful rectification of the issue.

When the AI model was not told about the design smell, it couldn't recognize it, and just gave almost the same skeleton of the code, whereas when it was given about the design smell, it did refactor it the way expected. Although, the code has various bugs, like it replaced the conditional checking of the various parameters of the book class while setting them to a single statement, without checking for null in them. There are various other functions where the implementation doesn't exactly match what was done in the initial code.

# MimeType - Missing Encapsulation

## Chat 1: Before being told that it is a Missing Encapsulation Smell

Link to chat

Yes, there are a couple of design smells in this code:

1. **Duplication**: The MIME types are declared as string literals in multiple places, which can lead to duplication and potential errors if they need to be updated.
2. **Hardcoding**: The MIME types are hardcoded directly into the `MimeType` class, which makes it inflexible and harder to maintain if new MIME types need to be added or existing ones modified.

To refactor this code, you can use an enumeration to define the MIME types, which helps organize them logically and avoids duplication. Here's how you can refactor the code:

```
package com.sismics.books.core.util.mime;

/**
 * A collection of MIME types.
 */
public enum MimeType {
    IMAGE_X_ICON("image/x-icon"),
    IMAGE_PNG("image/png"),
    IMAGE_JPEG("image/jpeg"),
    IMAGE_GIF("image/gif"),
    APPLICATION_ZIP("application/zip"),
    APPLICATION_PDF("application/pdf");

    private final String value;

    MimeType(String value) {
        this.value = value;
    }

    public String getValue() {
        return value;
    }
}
```

With this refactoring, each MIME type is defined only once, in a more structured and maintainable way. You can access the MIME types using the enum constants, and if you need to retrieve the string value, you can use the `getValue()` method.

---

## Chat 2: After being told that it is a Missing Encapsulation Smell

Link to Chat

Certainly! The Missing Encapsulation smell refers to the absence of proper encapsulation of data within classes. In this case, the `MimeType` class exposes its fields directly, which can lead to potential issues if other classes modify them directly. To fix this smell, we can encapsulate these fields by making them private and providing public getter methods. Here's the modified `MimeType` class:

```
package com.sismics.books.core.util.mime;

/**
 * A collection of MIME types.
 *
 * @author jtremeaux
 */
public class MimeType {

    private static final String IMAGE_X_ICON = "image/x-icon";

    private static final String IMAGE_PNG = "image/png";

    private static final String IMAGE_JPEG = "image/jpeg";

    private static final String IMAGE_GIF = "image/gif";

    private static final String APPLICATION_ZIP = "application/zip";

    private static final String APPLICATION_PDF = "application/pdf";

    public static String getImageXIcon() {
        return IMAGE_X_ICON;
    }

    public static String getImagePng() {
        return IMAGE_PNG;
    }

    public static String getImageJpeg() {
        return IMAGE_JPEG;
    }

    public static String getImageGif() {
        return IMAGE_GIF;
    }

    public static String getApplicationZip() {
        return APPLICATION_ZIP;
    }

    public static String getApplicationPdf() {
        return APPLICATION_PDF;
    }
}
```

By encapsulating the MIME types as private static constants and providing public getter methods, we ensure that other classes can access these values but cannot modify them directly, thus improving the encapsulation of the `MimeType` class.

---

> here, we see a refactoring done by the LLM that closely resembles what we did manually thus, the performance of the LLM was drastically different and improved when it was informed of which specific smell to fix

> The AI generated code looks almost correct and what should be done in this case. In the manual refactoring, we changed the variable types to `protected` so that they could be used in only sub-classes directly, which was an observation after reading the code manually. The AI model didn't have the context os usage of these variables, and thus did correct in that sense.

# TestAppResource - Broken Hierarchy

## Chat 1: Before telling it the design smell

Link to chat

One potential design smell in this code is the duplication of code for adding authentication filters to the `WebResource` instances in both test methods (`testAppResource()` and `testLogResource()`).

In both methods, the same authentication token is being used, and the same filter is added to the `WebResource` instance. This violates the DRY (Don't Repeat Yourself) principle, as the same code is repeated in multiple places.

To address this smell, you could refactor the code to extract the authentication logic into a common method that can be reused by both test methods. This would improve maintainability and reduce the risk of introducing bugs when modifying the authentication logic.

> When asked to find a design smell, chatgpt could not find the broken hierarchy design smell which was present. Instead it only found a code smell. Thus, it gave only elementary code related issues that didnt affected the required problem at all

---

## Chat 2: After telling it the design smell

Link to chat

> 1: When we told it to fix the broken hierarchy, it completely misunderstood what we meant and instead refactored the code to remove a simple code smell of duplicate code. We conjecture this is because GPT-3 does not have knowledge of certain code smells 2: After we told it exactly what to do(use composition instead of direct inheritance), it was able to make the suitable changes and the refactoring done was nearly identical to our own refactoring

# UserResource - God Class

Link to chat 1
Link to chat 2
Manual Refactoring

File: books-android/app/src/main/java/com/sismics/books/resource/UserResource.java

# Missing modularization, hierarchy, and god class

## Chat 1: Before being told the smells

Sure, let's start by refactoring the `UserResource` class to address the identified design smells:

```
package com.sismics.books.rest.resource;

import javax.ws.rs.*;
import javax.ws.rs.core.*;
import java.util.*;

@Path("/user")
public class UserResource extends BaseResource {
    private final UserService userService;

    public UserResource(UserService userService) {
        this.userService = userService;
    }

    @PUT
    @Produces(MediaType.APPLICATION_JSON)
    public Response register(UserRegistrationRequest request) {
        userService.register(request);
        return Response.ok().entity(buildSuccessResponse()).build();
    }

    @POST
    @Produces(MediaType.APPLICATION_JSON)
    public Response updateProfile(UserProfileUpdateRequest request) {
        userService.updateProfile(request, principal.getName());
        return Response.ok().entity(buildSuccessResponse()).build();
    }

    @POST
    @Path("/{username: [a-zA-Z0-9_]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response adminUpdateProfile(@PathParam("username") String
username, UserProfileUpdateRequest request) {
        checkAdminPermissions();
        userService.adminUpdateProfile(username, request);
```

```
        return Response.ok().entity(buildSuccessResponse()).build();
    }

    @GET
    @Path("/check_username")
    @Produces(MediaType.APPLICATION_JSON)
    public Response checkUsernameAvailability(@QueryParam("username")
String username) {
        boolean available = userService.isUsernameAvailable(username);
        return
Response.ok().entity(buildCheckUsernameResponse(available)).build();
    }

    @POST
    @Path("/login")
    @Produces(MediaType.APPLICATION_JSON)
    public Response login(UserLoginRequest request) {
        String authToken = userService.login(request);
        return
Response.ok().entity(buildLoginResponse(authToken)).cookie(buildCookie(auth
Token)).build();
    }

    @POST
    @Path("/logout")
    @Produces(MediaType.APPLICATION_JSON)
    public Response logout() {
        String authToken = extractAuthTokenFromRequest();
        userService.logout(authToken);
        return
Response.ok().entity(buildSuccessResponse()).cookie(buildEmptyCookie()).bui
ld();
    }

    @DELETE
    @Produces(MediaType.APPLICATION_JSON)
    public Response deleteOwnAccount() {
        userService.deleteAccount(principal.getName());
        return Response.ok().entity(buildSuccessResponse()).build();
    }

    @DELETE
    @Path("/{username: [a-zA-Z0-9_]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response adminDeleteAccount(@PathParam("username") String
username) {
        checkAdminPermissions();
        userService.adminDeleteAccount(username);
        return Response.ok().entity(buildSuccessResponse()).build();
    }

    @GET
    @Produces(MediaType.APPLICATION_JSON)
    public Response getOwnProfileInfo() {
```

```
        UserProfileInfoResponse response =
userService.getUserProfileInfo(principal.getName());
        return Response.ok().entity(response).build();
    }

    @GET
    @Path("/{username: [a-zA-Z0-9_]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response getProfileInfo(@PathParam("username") String username)
{
        checkAdminPermissions();
        UserProfileInfoResponse response =
userService.getUserProfileInfo(username);
        return Response.ok().entity(response).build();
    }

    // Other methods for listing users, managing sessions, etc.

    // Helper methods for response construction
    private Map<String, Object> buildSuccessResponse() {
        Map<String, Object> response = new HashMap<>();
        response.put("status", "ok");
        return response;
    }

    private Map<String, Object> buildCheckUsernameResponse(boolean
available) {
        Map<String, Object> response = new HashMap<>();
        response.put("status", available ? "ok" : "ko");
        response.put("message", available ? "Username available" :
"Username already registered");
        return response;
    }

    private Map<String, Object> buildLoginResponse(String authToken) {
        Map<String, Object> response = new HashMap<>();
        response.put("status", "ok");
        response.put("auth_token", authToken);
        return response;
    }

    private NewCookie buildCookie(String authToken) {
        int maxAge = TokenBasedSecurityFilter.TOKEN_LONG_LIFETIME;
        return new NewCookie(TokenBasedSecurityFilter.COOKIE_NAME,
authToken, "/", null, null, maxAge, false);
    }

    private NewCookie buildEmptyCookie() {
        return new NewCookie(TokenBasedSecurityFilter.COOKIE_NAME, null);
    }

    // Other helper methods
    private void checkAdminPermissions() {
        if (!hasAdminPermissions()) {
```

```
            throw new ForbiddenClientException();
        }
    }

    private boolean hasAdminPermissions() {
        // Implement logic to check if the user has admin permissions
        // For example, by checking the user's roles or permissions
        return false; // Placeholder implementation
    }

    private String extractAuthTokenFromRequest() {
        // Implement logic to extract the auth token from the request
        // For example, by accessing cookies or headers
        return null; // Placeholder implementation
    }
}
```

In this refactored version:

- The `UserResource` class has been simplified and divided into methods that handle specific functionalities such as registration, profile updates, login/logout, etc.
- Each resource method now takes a single request object containing the necessary parameters, reducing the complexity of method signatures and improving readability.
- Business logic has been moved to a separate `UserService` class, which encapsulates user management operations and promotes better separation of concerns.
- Helper methods have been introduced to construct response entities and manage cookies, reducing code duplication and improving maintainability.
- Placeholder implementations have been provided for methods related to authentication and authorization, which can be replaced with actual logic to check user permissions and extract authentication tokens from requests.
- The `BaseResource` superclass is assumed to provide common functionality such as authentication and access to principal information.

> GPT is able to correctly identify the design smells in the code and is able to to fix them by creating seprate classes to create modularization and hierarchy. It however fails to divide the classes further based on additional responsibility like CRUD.

---

## Chat 2: After being told that the design smells:

To address the missing modularization, hierarchy, and god class design smells in the provided code, we can refactor it by introducing a more modular structure and separating concerns into smaller, more specialized classes. Here's a refactored version of the `UserResource` class:

```
package com.sismics.books.rest.resource;

import javax.ws.rs.*;
import javax.ws.rs.core.MediaType;
import javax.ws.rs.core.Response;
```

```
import org.codehaus.jettison.json.JSONException;
import org.codehaus.jettison.json.JSONObject;

@Path("/user")
public class UserResource extends BaseResource {
    private final UserRegistrationService userRegistrationService;
    private final UserUpdateService userUpdateService;
    private final UserAuthenticationService userAuthenticationService;
    private final UserDeletionService userDeletionService;
    private final UserInfoService userInfoService;
    private final UserSessionService userSessionService;

    public UserResource() {
        this.userRegistrationService = new UserRegistrationService();
        this.userUpdateService = new UserUpdateService();
        this.userAuthenticationService = new UserAuthenticationService();
        this.userDeletionService = new UserDeletionService();
        this.userInfoService = new UserInfoService();
        this.userSessionService = new UserSessionService();
    }

    @PUT
    @Produces(MediaType.APPLICATION_JSON)
    public Response register(
            @FormParam("username") String username,
            @FormParam("password") String password,
            @FormParam("locale") String localeId,
            @FormParam("email") String email) throws JSONException {
        return userRegistrationService.register(username, password,
localeId, email);
    }

    @POST
    @Produces(MediaType.APPLICATION_JSON)
    public Response update(
            @FormParam("password") String password,
            @FormParam("email") String email,
            @FormParam("theme") String themeId,
            @FormParam("locale") String localeId,
            @FormParam("first_connection") Boolean firstConnection) throws
JSONException {
        return userUpdateService.update(password, email, themeId, localeId,
firstConnection, principal);
    }

    @POST
    @Path("{username: [a-zA-Z0-9_]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response update(
            @PathParam("username") String username,
            @FormParam("password") String password,
            @FormParam("email") String email,
            @FormParam("theme") String themeId,
            @FormParam("locale") String localeId) throws JSONException {
```

```
        return userUpdateService.update(username, password, email, themeId,
localeId, principal);
    }

    @GET
    @Path("check_username")
    @Produces(MediaType.APPLICATION_JSON)
    public Response checkUsername(
            @QueryParam("username") String username) throws JSONException {
        return userRegistrationService.checkUsername(username);
    }

    @POST
    @Path("login")
    @Produces(MediaType.APPLICATION_JSON)
    public Response login(
            @FormParam("username") String username,
            @FormParam("password") String password,
            @FormParam("remember") boolean longLasted) throws JSONException
{
        return userAuthenticationService.login(username, password,
longLasted);
    }

    @POST
    @Path("logout")
    @Produces(MediaType.APPLICATION_JSON)
    public Response logout() throws JSONException {
        return userAuthenticationService.logout(request);
    }

    @DELETE
    @Produces(MediaType.APPLICATION_JSON)
    public Response delete() throws JSONException {
        return userDeletionService.delete(principal);
    }

    @DELETE
    @Path("{username: [a-zA-Z0-9_]+}")
    @Produces(MediaType.APPLICATION_JSON)
    public Response delete(@PathParam("username") String username) throws
JSONException {
        return userDeletionService.delete(username, principal);
    }

    @GET
    @Produces(MediaType.APPLICATION_JSON)
    public Response info() throws JSONException {
        return userInfoService.getInfo(authenticate(), principal);
    }

    @GET
    @Path("{username: [a-zA-Z0-9_]+}")
    @Produces(MediaType.APPLICATION_JSON)
```

```
    public Response view(@PathParam("username") String username) throws
JSONException {
        return userInfoService.view(username, authenticate(), principal);
    }

    @GET
    @Path("list")
    @Produces(MediaType.APPLICATION_JSON)
    public Response list(
            @QueryParam("limit") Integer limit,
            @QueryParam("offset") Integer offset,
            @QueryParam("sort_column") Integer sortColumn,
            @QueryParam("asc") Boolean asc) throws JSONException {
        return userInfoService.list(limit, offset, sortColumn, asc,
authenticate(), principal);
    }

    @GET
    @Path("session")
    @Produces(MediaType.APPLICATION_JSON)
    public Response session() throws JSONException {
        return userSessionService.getSessionInfo(authenticate(), request,
principal);
    }

    @DELETE
    @Path("session")
    @Produces(MediaType.APPLICATION_JSON)
    public Response deleteSession() throws JSONException {
        return userSessionService.deleteSession(authenticate(), request,
principal);
    }
}
```

In this refactoring:

- Each endpoint's functionality is delegated to a separate service class.
- Each service class handles a specific aspect of user management, such as registration, authentication, deletion, etc.
- The `BaseResource` class (not provided) presumably contains common functionality shared by all resource classes.

This refactoring improves modularity, promotes separation of concerns, and avoids the god class anti-pattern by breaking down the monolithic `UserResource` class into smaller, specialized components.

> After telling it the design smells, it is able to refactor the code correctly and also creates separate classes based on separation of additional responsibility and was able to produce code which is very similarly structured to our own

# validatePasswordUtil - Missing Hierarchy

Link to chat 1
Link to chat 2
Manual Refactoring

File: books-web-common/src/main/java/com/sismics/rest/util/ValidationUtil.java

## Code snippet

```
/**
     * Checks if the string is an email.
     *
     * @param s    String to validate
     * @param name Name of the parameter
     * @throws JSONException
     */
    public static void validateEmail(String s, String name) throws
JSONException {
        if (!EMAIL_PATTERN.matcher(s).matches()) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must be an email", name));
        }
    }

    /**
     * Validates that the provided string matches an URL with HTTP or HTTPS
scheme.
     *
     * @param s    String to validate
     * @param name Name of the parameter
     * @return Stripped URL
     * @throws JSONException
     */
    public static String validateHttpUrl(String s, String name) throws
JSONException {
        s = StringUtils.strip(s);
        if (!HTTP_URL_PATTERN.matcher(s).matches()) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must be an HTTP(s) URL", name));
        }
        return s;
    }

    /**
     * Checks if the string uses only alphanumerical or underscore
characters.
     *
     * @param s    String to validate
     * @param name Name of the parameter
```

```
     * @throws JSONException
     */
    public static void validateAlphanumeric(String s, String name) throws
JSONException {
        if (!ALPHANUMERIC_PATTERN.matcher(s).matches()) {
            throw new ClientException("ValidationError",
                    MessageFormat.format("{0} must have only alphanumeric
or underscore characters", name));
        }
    }
```

## Chat 1: Before being told the smells

The code snippet provided is a set of static methods for validating different types of strings. While the methods themselves perform the validation correctly, there are some design smells present:

1. **Exception Handling**: The methods throw `JSONException`, which seems to be an odd choice for validation-related exceptions. It's typically better to use more specific exception types or custom exceptions that better represent the validation failure.

2. **MessageFormat with JSONException**: Using `MessageFormat` to construct exception messages inside the validation methods isn't a common pattern. It ties the validation logic tightly to a specific exception handling mechanism.

3. **Mixed Responsibilities**: The `validateHttpUrl` method not only validates the URL but also modifies it (stripping white spaces). This mixing of responsibilities makes the method less cohesive.

Here's a revised version addressing these issues:

```
import java.util.regex.Pattern;

public class Validator {

    private static final Pattern EMAIL_PATTERN = ...; // Define the pattern
    private static final Pattern HTTP_URL_PATTERN = ...; // Define the
pattern
    private static final Pattern ALPHANUMERIC_PATTERN = ...; // Define the
pattern

    public static void validateEmail(String email, String paramName) {
        if (!EMAIL_PATTERN.matcher(email).matches()) {
            throw new IllegalArgumentException(paramName + " must be a
valid email address");
        }
    }

    public static String validateHttpUrl(String url, String paramName) {
        String strippedUrl = url.strip(); // Strip white spaces
        if (!HTTP_URL_PATTERN.matcher(strippedUrl).matches()) {
            throw new IllegalArgumentException(paramName + " must be a
valid HTTP(s) URL");
```

```
        }
        return strippedUrl;
    }

    public static void validateAlphanumeric(String value, String paramName)
{
        if (!ALPHANUMERIC_PATTERN.matcher(value).matches()) {
            throw new IllegalArgumentException(paramName + " must contain
only alphanumeric characters or underscores");
        }
    }
}
```

Changes made:

- Replaced `JSONException` with `IllegalArgumentException`, which is a more appropriate exception for validation errors.
- Removed the use of `MessageFormat` for constructing exception messages, instead concatenating strings directly.
- Moved the responsibility of stripping white spaces from the URL out of the validation method. Now, it's up to the caller to ensure the URL is stripped if necessary.
- Renamed method parameters for clarity.

---

## Chat 2: After being told the smells

To address the missing hierarchy design smell and provide a more organized structure for validation methods, you can introduce a `ValidationUtils` class with static methods for various validation tasks, including validating passwords. Here's how you can modify the code:

```
import java.text.MessageFormat;
import java.util.regex.Pattern;

public class ValidationUtils {
    private static final Pattern EMAIL_PATTERN = Pattern.compile(/* Your
email pattern regex */);
    private static final Pattern HTTP_URL_PATTERN = Pattern.compile(/* Your
HTTP URL pattern regex */);
    private static final Pattern ALPHANUMERIC_PATTERN = Pattern.compile(/*
Your alphanumeric pattern regex */);
    private static final Pattern PASSWORD_PATTERN = Pattern.compile(/* Your
password pattern regex */);

    /**
     * Checks if the string is an email.
     *
     * @param s    String to validate
     * @param name Name of the parameter
     * @throws JSONException
     */
```

```
    public static void validateEmail(String s, String name) throws
JSONException {
        if (!EMAIL_PATTERN.matcher(s).matches()) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must be an email", name));
        }
    }

    /**
     * Validates that the provided string matches an URL with HTTP or HTTPS
scheme.
     *
     * @param s    String to validate
     * @param name Name of the parameter
     * @return Stripped URL
     * @throws JSONException
     */
    public static String validateHttpUrl(String s, String name) throws
JSONException {
        s = StringUtils.strip(s);
        if (!HTTP_URL_PATTERN.matcher(s).matches()) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must be an HTTP(s) URL", name));
        }
        return s;
    }

    /**
     * Checks if the string uses only alphanumerical or underscore
characters.
     *
     * @param s    String to validate
     * @param name Name of the parameter
     * @throws JSONException
     */
    public static void validateAlphanumeric(String s, String name) throws
JSONException {
        if (!ALPHANUMERIC_PATTERN.matcher(s).matches()) {
            throw new ClientException("ValidationError",
                    MessageFormat.format("{0} must have only alphanumeric
or underscore characters", name));
        }
    }

    /**
     * Validates that the provided string meets password criteria.
     *
     * @param s    String to validate
     * @param name Name of the parameter
     * @throws JSONException
     */
    public static void validatePassword(String s, String name) throws
JSONException {
        if (!PASSWORD_PATTERN.matcher(s).matches()) {
```

```
            throw new ClientException("ValidationError",
                    MessageFormat.format("{0} must meet password criteria",
name));
        }
    }
}
```

With this modification, you've added a `validatePassword` method to the `ValidationUtils` class, which follows the same pattern as the other validation methods. This helps maintain a consistent and organized structure for validation tasks.

> The LLM was not able to figure out that there was a missing hierarchy design smell in chat 1. Thus the LLM could not add the required validatePasswordUtil.

> However, when told what was required, the LLM successfully added the required functionality.

> In the latter version of the version, where the AI model knew about the smell, it has done the correct job, and given the exact same code as was written during the manual refactoring.

# ValidationUtil - Missing Hierarchy

Link to chat 1
Link to chat 2
Manual Refactoring

file: books-web-common/src/main/java/com/sismics/rest/util/ValidationUtil.java

## Chat 1: Before being told that it was a Missing Hierarchy design smell:

The `ValidationUtil` class indeed exhibits some design smells or areas for improvement. Here are a few identified issues along with potential refactorings:

1. **Single Responsibility Principle (SRP) Violation**:
    - The class is doing too much: it validates string lengths, checks for email patterns, validates URLs, parses dates, and validates locale and theme IDs. It's better to split these responsibilities into separate classes.
2. **Dependency Injection**:
    - The class directly instantiates `LocaleDao` and `ThemeDao`. Instead, it should rely on these dependencies being injected, making it more flexible and easier to test.
3. **Error Handling**:
    - The use of checked exceptions (`JSONException`) for validation purposes is unusual and complicates the code. Using unchecked exceptions (like `IllegalArgumentException`) would be more appropriate for validation.
4. **Hardcoded Messages**:
    - Error messages are hardcoded, making it harder to internationalize or customize them. Using externalized message resources or at least constants for error messages would be better.
5. **Regex Patterns**:
    - Regex patterns like `EMAIL_PATTERN`, `HTTP_URL_PATTERN`, and `ALPHANUMERIC_PATTERN` could be moved to a configuration file or constants for better maintainability.

Here's a refactored version addressing these issues:

```
package com.sismics.rest.util;

import java.util.regex.Pattern;

public class ValidationUtil {
    private static final Pattern EMAIL_PATTERN =
Pattern.compile(".+@.+\\..+");
    private static final Pattern HTTP_URL_PATTERN =
```

```
Pattern.compile("https?://.+");
    private static final Pattern ALPHANUMERIC_PATTERN = Pattern.compile("
[a-zA-Z0-9_]+");

    public static void validateRequired(Object s, String name) {
        if (s == null) {
            throw new IllegalArgumentException(name + " must be set");
        }
    }

    public static String validateLength(String s, String name, int
lengthMin, int lengthMax, boolean nullable) {
        s = s != null ? s.trim() : null;
        if (nullable && (s == null || s.isEmpty())) {
            return s;
        }
        validateRequired(s, name);
        if (s.length() < lengthMin) {
            throw new IllegalArgumentException(name + " must be more than "
+ lengthMin + " characters");
        }
        if (lengthMax > 0 && s.length() > lengthMax) {
            throw new IllegalArgumentException(name + " must be less than "
+ lengthMax + " characters");
        }
        return s;
    }

    public static String validateLength(String s, String name, int
lengthMin, int lengthMax) {
        return validateLength(s, name, lengthMin, lengthMax, false);
    }

    public static String validateStringNotBlank(String s, String name) {
        return validateLength(s, name, 1, Integer.MAX_VALUE);
    }

    public static void validateHexColor(String s, String name, boolean
nullable) {
        validateLength(s, name, 7, 7, nullable);
    }

    public static void validateEmail(String s, String name) {
        if (!EMAIL_PATTERN.matcher(s).matches()) {
            throw new IllegalArgumentException(name + " must be an email");
        }
    }

    public static String validateHttpUrl(String s, String name) {
        s = s != null ? s.trim() : null;
        if (s == null || !HTTP_URL_PATTERN.matcher(s).matches()) {
            throw new IllegalArgumentException(name + " must be an HTTP(s)
URL");
        }
```

```
        return s;
    }

    public static void validateAlphanumeric(String s, String name) {
        if (!ALPHANUMERIC_PATTERN.matcher(s).matches()) {
            throw new IllegalArgumentException(name + " must have only
alphanumeric or underscore characters");
        }
    }
}
```

This refactoring separates concerns, simplifies error handling, and makes the code more maintainable and testable. Additionally, it removes unnecessary dependencies and improves error message handling.

---

## Chat 2: After being told that it was a Missing Hierarchy design smell:

To address the missing hierarchy design smell, we can refactor the `ValidationUtil` class to better organize the validation methods into separate classes based on their responsibilities. We can create validator classes for different types of validations, such as string validations, URL validations, email validations, etc. Each validator class can implement a common interface or extend a common abstract class to ensure consistency and ease of use.

Here's how we can refactor the `ValidationUtil` class:

1. Create an interface called `Validator` that defines a method for validation.
2. Create validator classes for string validation, URL validation, email validation, etc., implementing the `Validator` interface.
3. Modify the `ValidationUtil` class to use instances of these validator classes for different types of validations.

Here's a possible refactored version:

```
package com.sismics.rest.util;

import org.codehaus.jettison.json.JSONException;

/**
 * Interface for validators.
 */
public interface Validator<T> {
    void validate(T value, String name) throws JSONException;
}
```

```
package com.sismics.rest.util;

import com.sismics.rest.exception.ClientException;
import org.apache.commons.lang.StringUtils;
```

```
import org.codehaus.jettison.json.JSONException;

import java.text.MessageFormat;
import java.util.regex.Pattern;

/**
 * Validator for string parameters.
 */
public class StringValidator implements Validator<String> {
    private static final Pattern ALPHANUMERIC_PATTERN = Pattern.compile("
[a-zA-Z0-9_]+");

    @Override
    public void validate(String value, String name) throws JSONException {
        value = StringUtils.strip(value);
        if (StringUtils.isEmpty(value)) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must be set", name));
        }
    }

    public void validateNotBlank(String value, String name) throws
JSONException {
        validate(value, name);
        if (value.trim().isEmpty()) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must not be blank", name));
        }
    }

    public void validateAlphanumeric(String value, String name) throws
JSONException {
        validateNotBlank(value, name);
        if (!ALPHANUMERIC_PATTERN.matcher(value).matches()) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must have only alphanumeric or underscore
characters", name));
        }
    }
}
```

```
package com.sismics.rest.util;

import com.sismics.rest.exception.ClientException;
import org.codehaus.jettison.json.JSONException;

import java.text.MessageFormat;
import java.util.regex.Pattern;

/**
 * Validator for email addresses.
```

```
 */
public class EmailValidator implements Validator<String> {
    private static final Pattern EMAIL_PATTERN =
Pattern.compile(".+@.+\\..+");

    @Override
    public void validate(String value, String name) throws JSONException {
        if (!EMAIL_PATTERN.matcher(value).matches()) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must be an email", name));
        }
    }
}
```

```
package com.sismics.rest.util;

import com.sismics.rest.exception.ClientException;
import org.codehaus.jettison.json.JSONException;

import java.text.MessageFormat;
import java.util.regex.Pattern;

/**
 * Validator for HTTP URLs.
 */
public class HttpUrlValidator implements Validator<String> {
    private static final Pattern HTTP_URL_PATTERN =
Pattern.compile("https?://.+");

    @Override
    public void validate(String value, String name) throws JSONException {
        value = StringUtils.strip(value);
        if (!HTTP_URL_PATTERN.matcher(value).matches()) {
            throw new ClientException("ValidationError",
MessageFormat.format("{0} must be an HTTP(s) URL", name));
        }
    }
}
```

With this refactoring, each validation type has its own validator class, making the code more modular, maintainable, and easier to extend. You can further expand this structure by adding validators for other types of validations as needed.

---

Here, we see that the LLM was not able to figure out that it was a Missing Hierarchy design smell, and thus was only able to make minor changes for the refactoring - in a completely irrelevant manner.

However, when the issues and the location were highlighted, the LLM performed much better and was able to show successful rectification of the issue by forming a decent hierarchy with no other information.