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HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

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TRƯỜNG ĐẠI HỌC
BÁCH KHOA HÀ NỘI
HANOI UNIVERSITY
OF SCIENCE AND TECHNOLOGY

LAPTOP CONSULTATION SYSTEM INTERGRATING INFORMATION RETRIEVAL & LARGE LANGUAGE MODEL

Group: 7

Team members:

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OUTLINE

I. Introduction

Project Objectives:

- Develop a system for collecting laptop data from the web
- Efficiently store and manage data using PostgreSQL
- Provide basic product filtering functionalities
- Enable intelligent product search based on user queries using embedding techniques and AI.

Significance:

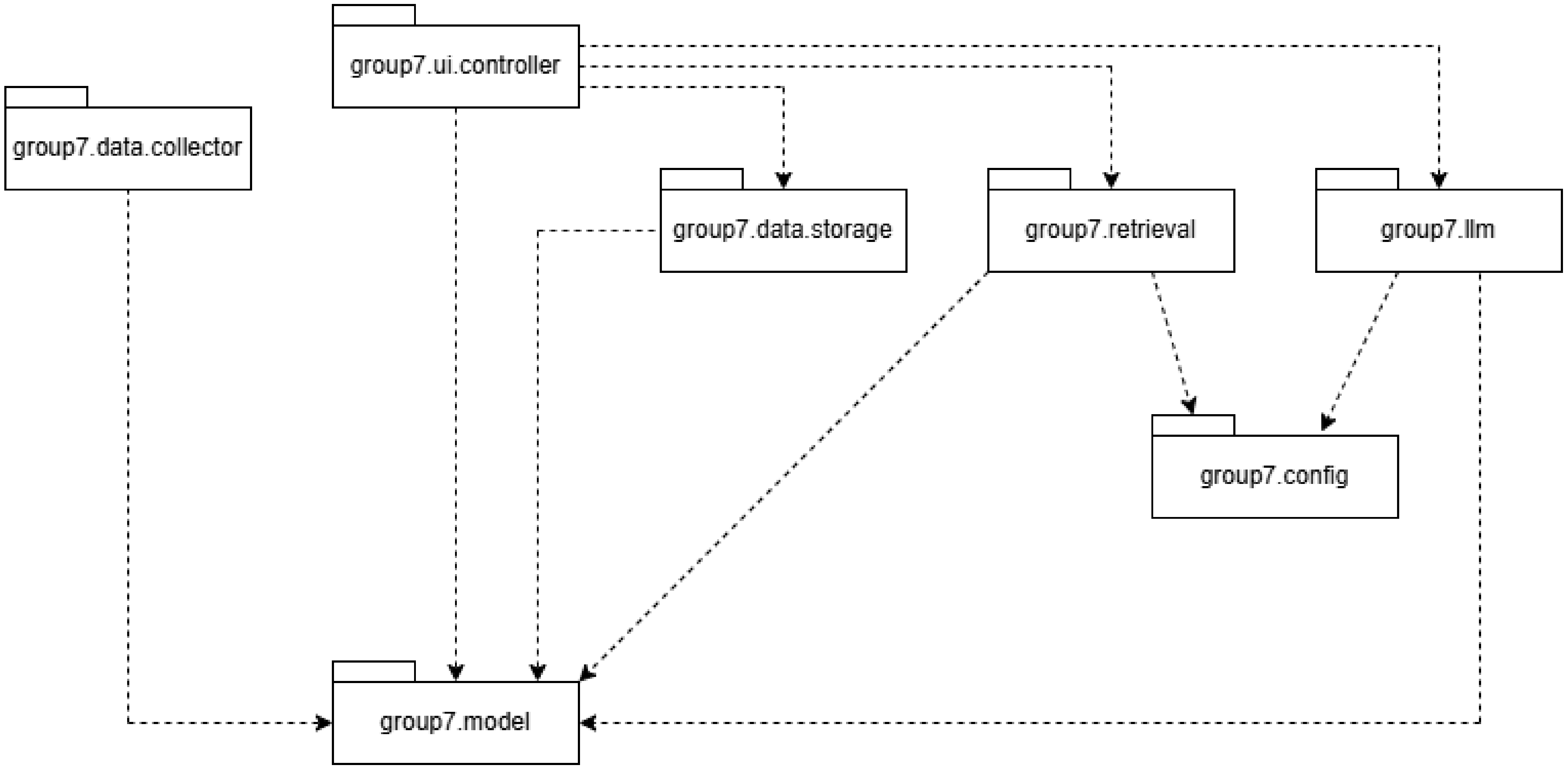
- Help users find suitable laptops based on their needs.
- Automate the process of collecting and analyzing product data.
- Apply modern AI technologies to provide smart product recommendations.

II. System architecture overview

System Architecture Description:

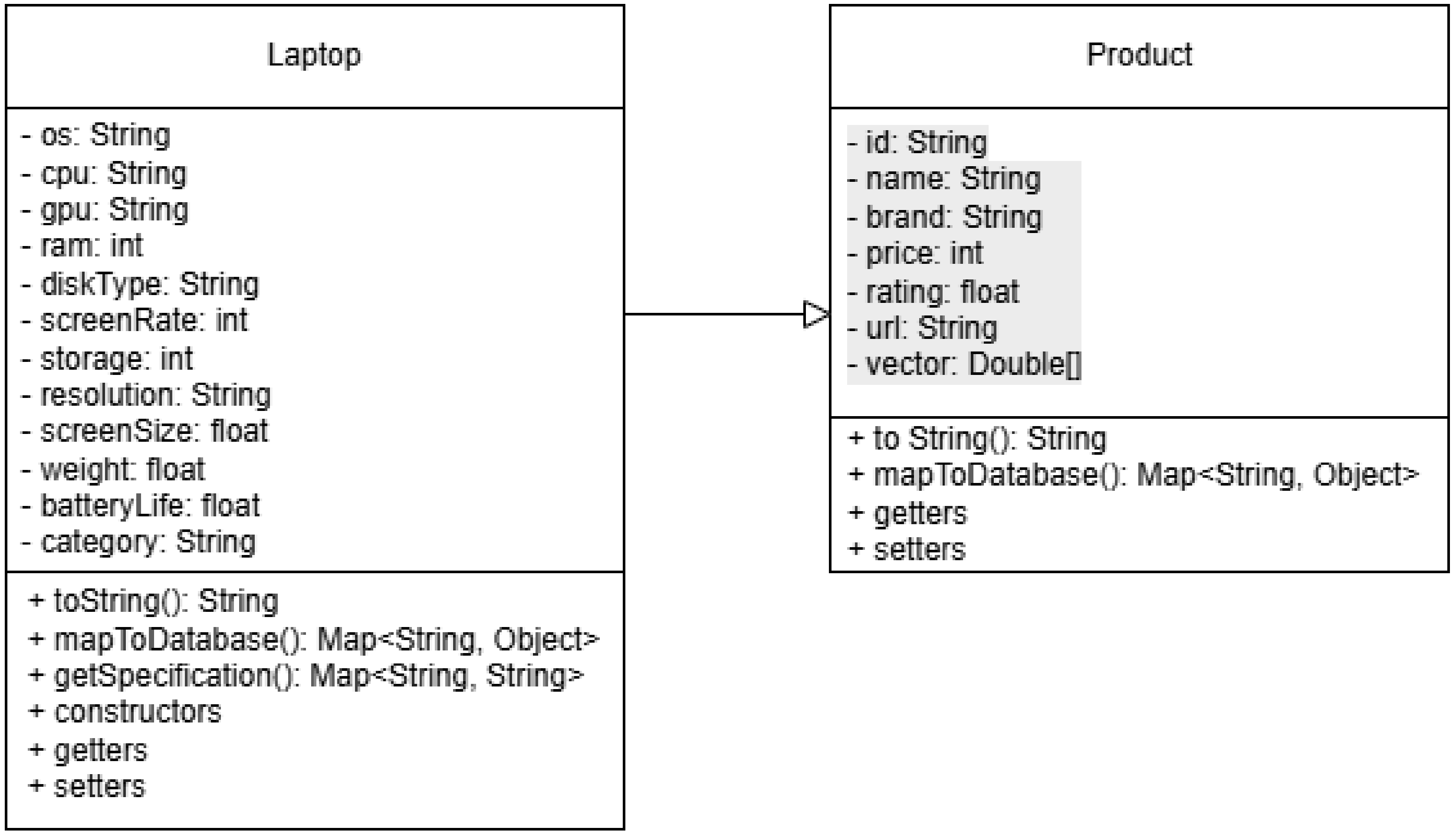
- **Data Collection:** Utilizes Selenium (`DataCollector`) to scrape data from laptop
- **Search and Recommendation:** Combines vector embeddings (`EmbeddingService`) and an AI model (`MistralClient`) to process user queries.
- **Product Modeling:** The `Laptop` class inherits from `Product`, storing detailed technical specifications.

II. System architecture overview



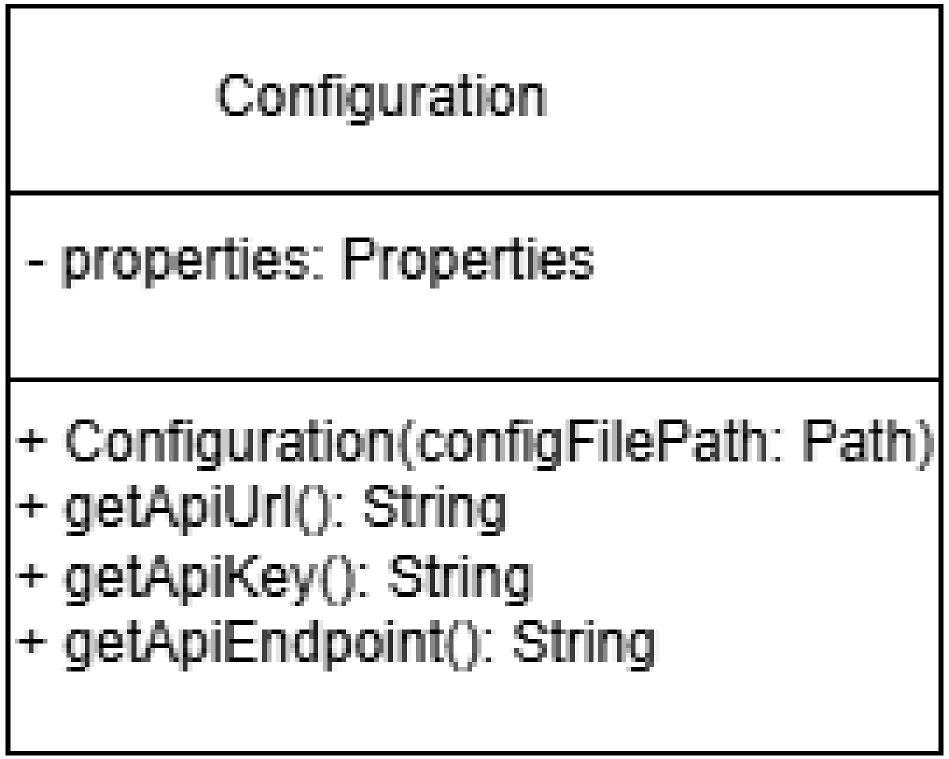
II. System architecture overview

Package: `group7.model`



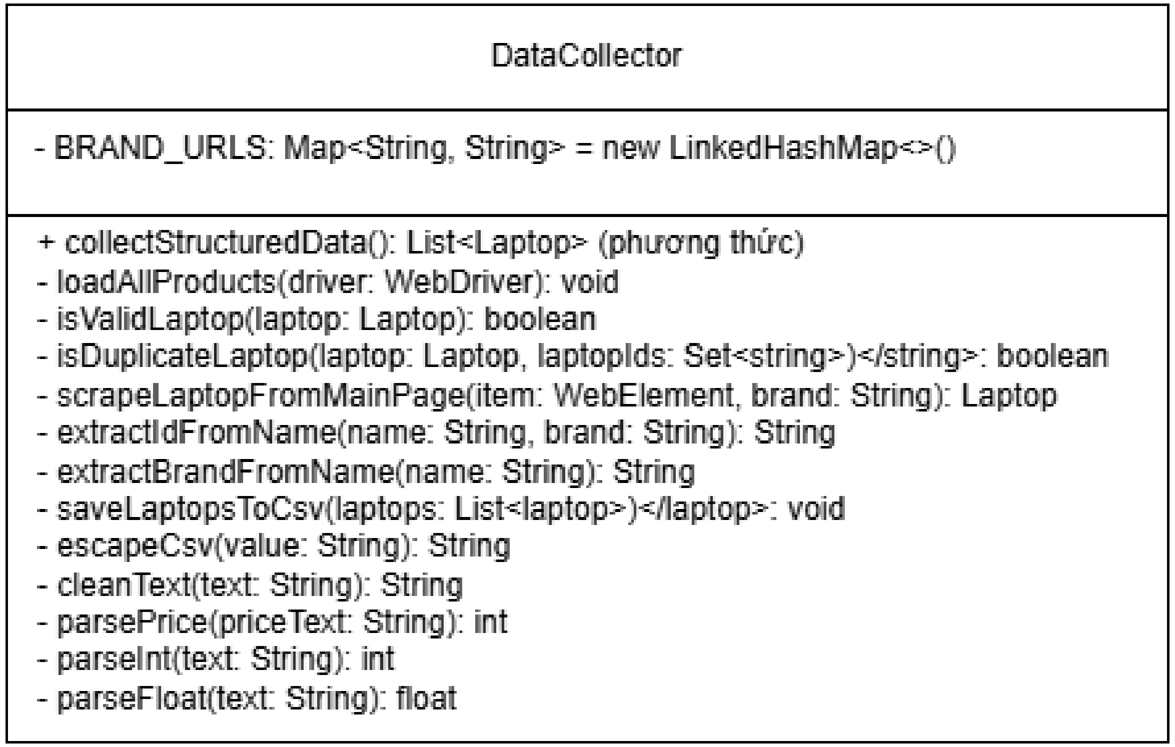
II. System architecture overview

Package: **`group7.config`**



II. System architecture overview

Package: `group7.data.collector`



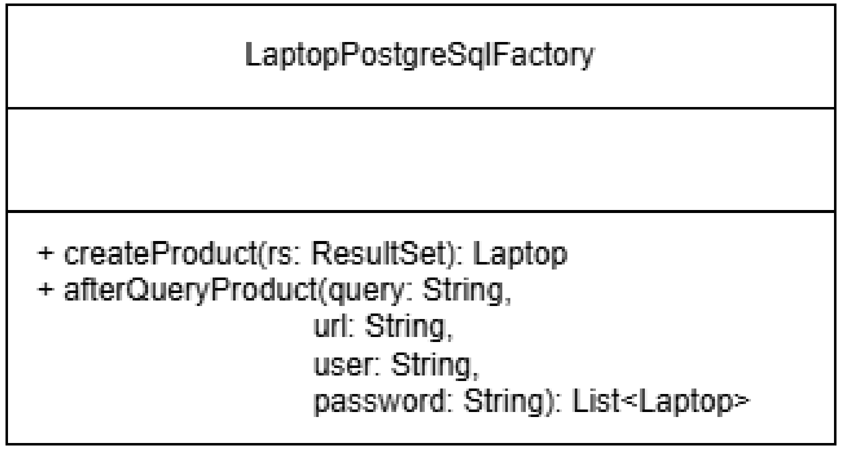
DataCollector

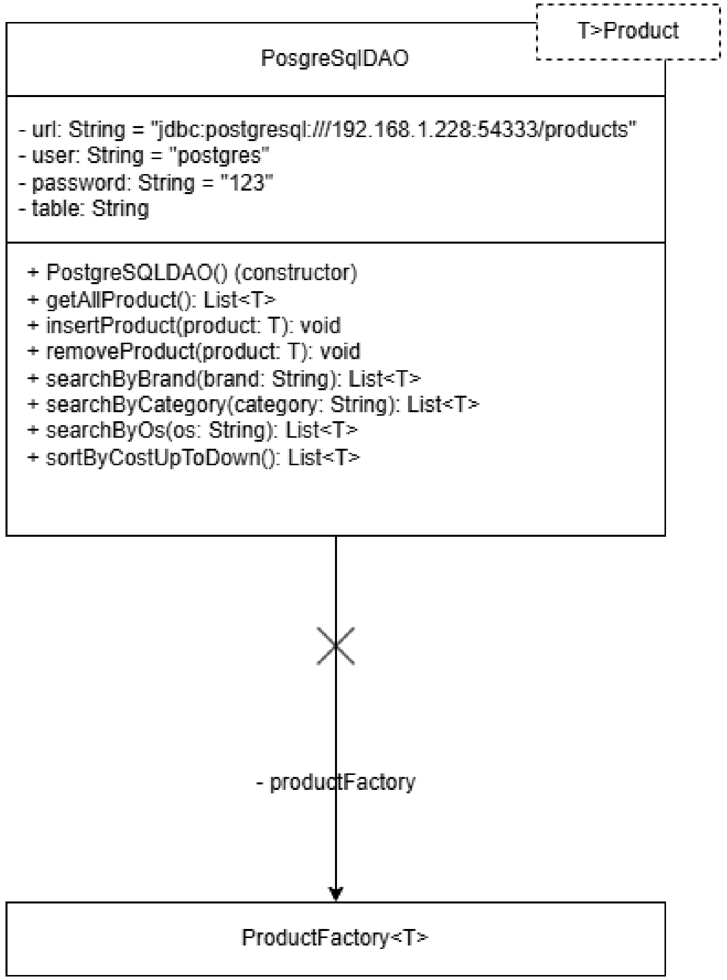
- BRAND_URLS: Map<String, String> = new LinkedHashMap<>()

+ collectStructuredData(): List<Laptop> (phương thức)
- loadAllProducts(driver: WebDriver): void
- isValidLaptop(laptop: Laptop): boolean
- isDuplicateLaptop(laptop: Laptop, laptopIds: Set<string>)</string>: boolean
- scrapeLaptopFromMainPage(item: WebElement, brand: String): Laptop
- extractIdFromName(name: String, brand: String): String
- extractBrandFromName(name: String): String
- saveLaptopsToCsv(laptops: List<laptop>)</laptop>: void
- escapeCsv(value: String): String
- cleanText(text: String): String
- parsePrice(priceText: String): int
- parseInt(text: String): int
- parseFloat(text: String): float

II. System architecture overview

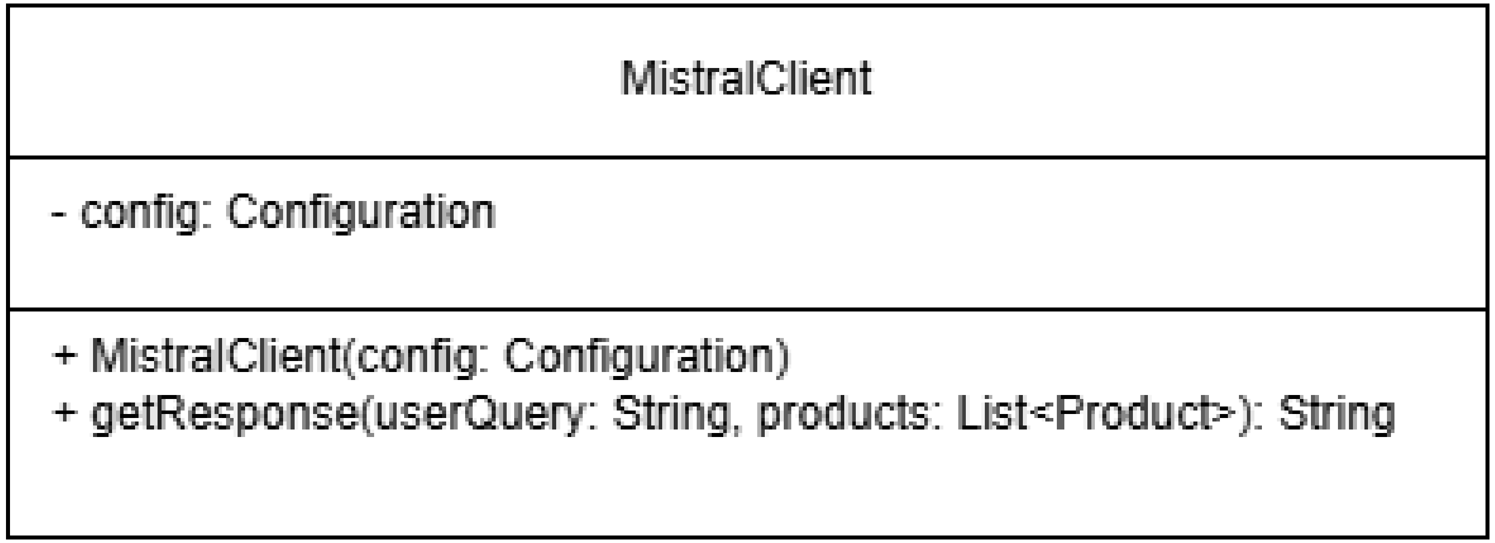
Package: `group7.data.storage`


LaptopPostgreSqlFactory
+ createProduct(rs: ResultSet): Laptop
+ afterQueryProduct(query: String,
url: String,
user: String,
password: String): List<Laptop>


T>Product
PosgreSqlDAO
- url: String = "jdbc:postgresql:///192.168.1.228:54333/products"
- user: String = "postgres"
- password: String = "123"
- table: String
+ PostgreSQLDAO() (constructor)
+ getAllProduct(): List<T>
+ insertProduct(product: T): void
+ removeProduct(product: T): void
+ searchByBrand(brand: String): List<T>
+ searchByCategory(category: String): List<T>
+ searchByOs(os: String): List<T>
+ sortByCostUpToDown(): List<T>
- productFactory
ProductFactory<T>

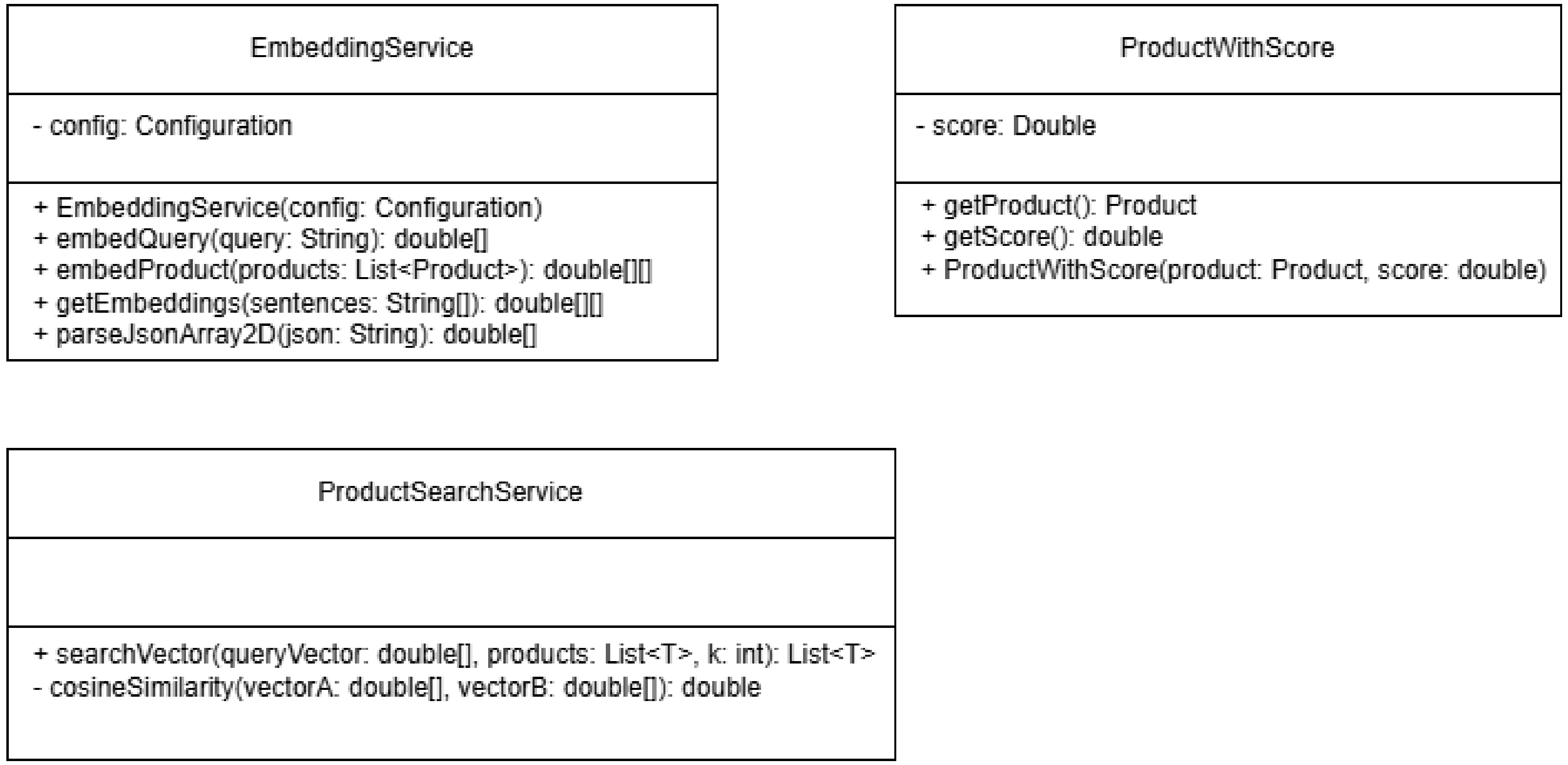
II. System architecture overview

Package: **`group7.llm`**


MistralClient
- config: Configuration
+ MistralClient(config: Configuration)
+ getResponse(userQuery: String, products: List<Product>): String

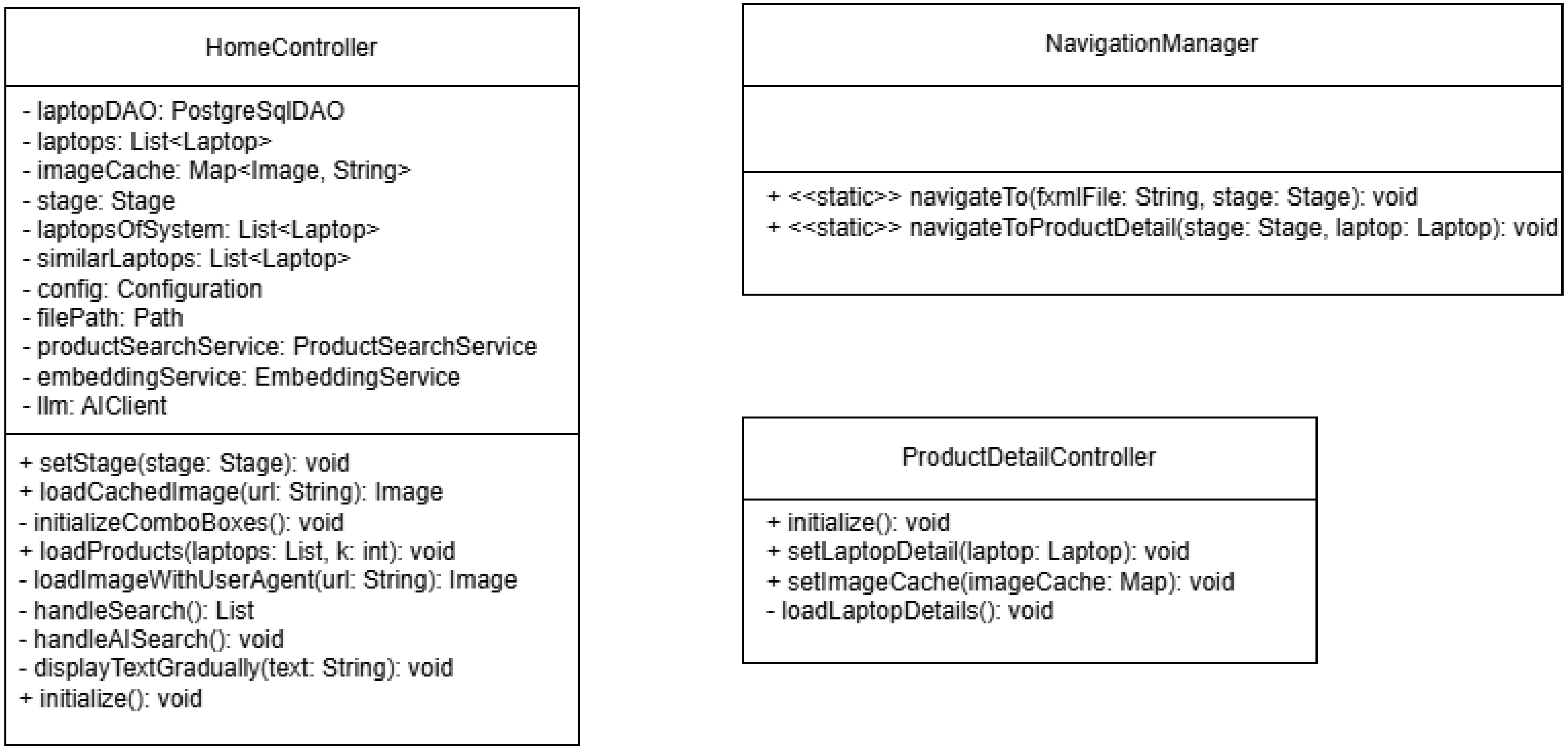
II. System architecture overview

Package: `group7.retrieval`


EmbeddingService
- config: Configuration
+ EmbeddingService(config: Configuration)
+ embedQuery(query: String): double[]
+ embedProduct(products: List<Product>): double[][]
+ getEmbeddings(sentences: String[]): double[][]
+ parseJsonArray2D(json: String): double[]
ProductWithScore
- score: Double
+ getProduct(): Product
+ getScore(): double
+ ProductWithScore(product: Product, score: double)
ProductSearchService
+ searchVector(queryVector: double[], products: List<T>, k: int): List<T>
- cosineSimilarity(vectorA: double[], vectorB: double[]): double

II. System architecture overview

Package: **`group7.ui.controller`**



HomeController

- laptopDAO: PostgreSqlDAO
- laptops: List<Laptop>
- imageCache: Map<Image, String>
- stage: Stage
- laptopsOfSystem: List<Laptop>
- similarLaptops: List<Laptop>
- config: Configuration
- filePath: Path
- productSearchService: ProductSearchService
- embeddingService: EmbeddingService
- llm: AIClient

+ setStage(stage: Stage): void
+ loadCachedImage(url: String): Image
- initializeComboBoxes(): void
+ loadProducts(laptops: List, k: int): void
- loadImageWithUserAgent(url: String): Image
- handleSearch(): List
- handleAISearch(): void
- displayTextGradually(text: String): void
+ initialize(): void

NavigationManager

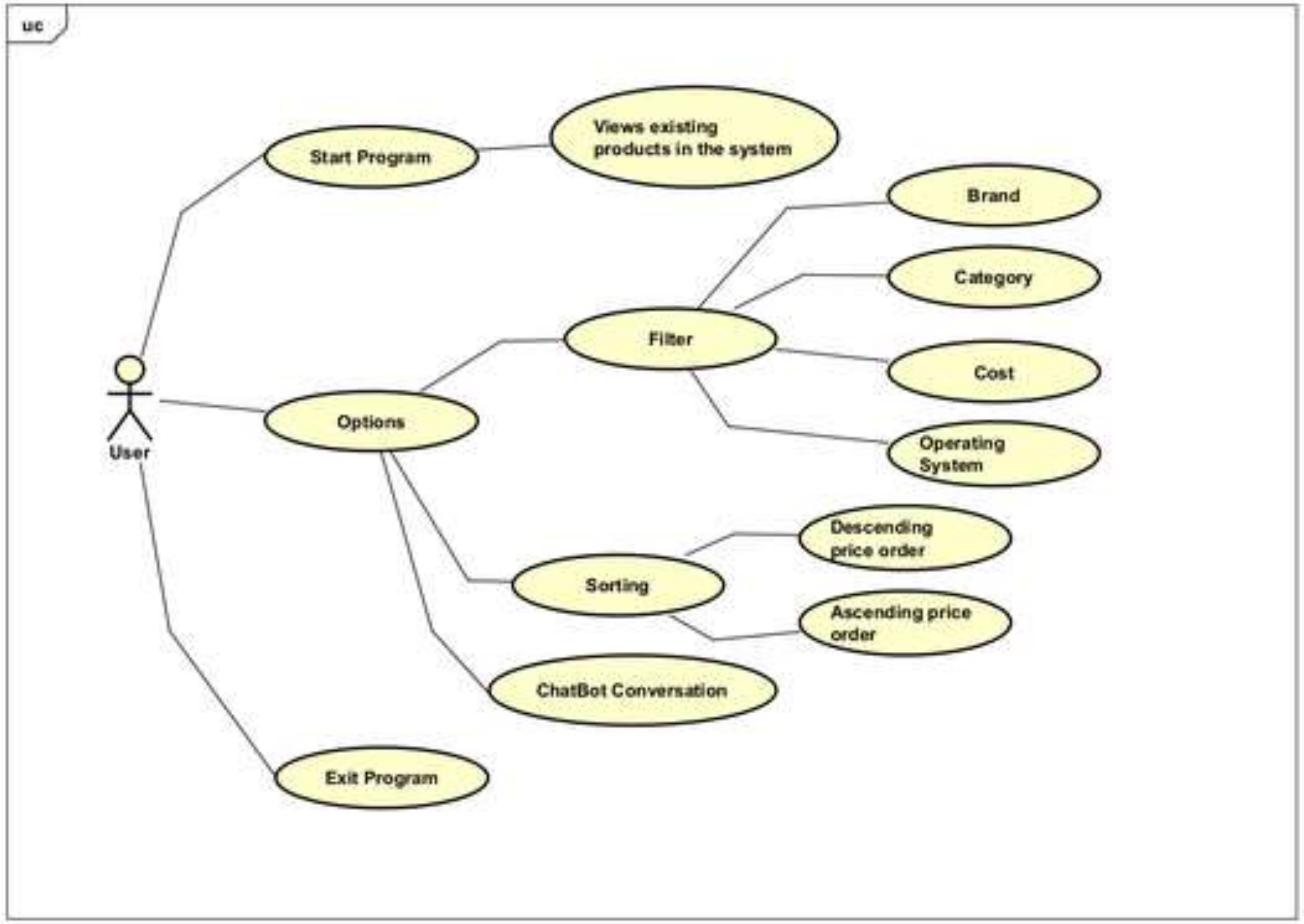
+ <<static>> navigateTo(fxmlFile: String, stage: Stage): void
+ <<static>> navigateToProductDetail(stage: Stage, laptop: Laptop): void

ProductDetailController

+ initialize(): void
+ setLaptopDetail(laptop: Laptop): void
+ setImageCache(imageCache: Map): void
- loadLaptopDetails(): void

II. System architecture overview

User case diagram:



III. Main components of the system

1. Product Class and Laptop Class

The abstract class **`Product`** serves as the foundation for all products in the system.
Basis attributes: `id, name, brand, price, rating and url.`
Abstract methods: `mapToDataBase()` and `getVector()` to support storage and search functionalities.

Characteristic:

- **Abstraction:** Allows easy extension to other product types (e.g., phones, tablets).
- **Reusability:** Common attributes are defined once, reducing code duplication.
- **Easy integration:** Supports data mapping for database storage.

III. Main components of the system

1. Product Class and Laptop Class

The **`Laptop`** class inherits from the **`Product`** class and extends it with laptop-specific attributes.

It implements the `mapToDatabase()` method to map laptop information into the database.

Additionally, it provides the `getSpecification()` method to return technical specifications in the form of a map.

III. Main components of the system

2. DataCollector Class

Uses Selenium WebDriver to scrape data from websites

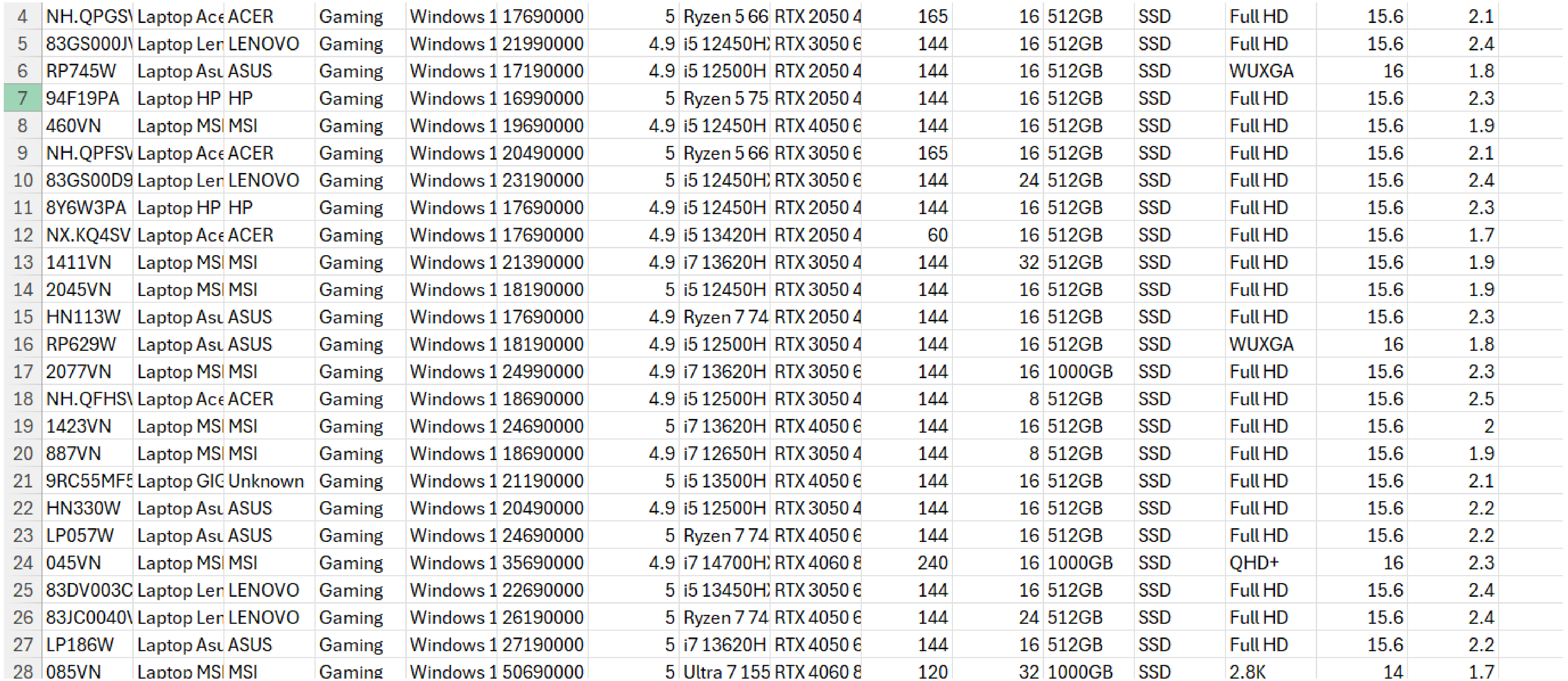
1. Access brand URLs from BRAND_URLS.
2. Auto-scroll and click "Load More" to load all products (`loadAllProducts`).
3. Extract product data from HTML (`scrapeLaptopFromMainPage`).
4. Validate and check for duplicates (`isValidLaptop, isDuplicateLaptop`).
5. Save to CSV and return Laptop objects (`saveLaptopsToCsv`).

Characteristic:

- High automation
- Robust exception handling (e.g., network errors, HTML changes)
- High performance (with processing time measurement).
- Flexible and adaptable design

III. Main components of the system

2. DataCollector Class



4	NH.QPGS\	Laptop Ace	ACER	Gaming	Windows 1	17690000	5	Ryzen 5 66	RTX 2050 4	165	16	512GB	SSD	Full HD	15.6	2.1
5	83GS000J\	Laptop Len	LENOVO	Gaming	Windows 1	21990000	4.9	i5 12450H)	RTX 3050 6	144	16	512GB	SSD	Full HD	15.6	2.4
6	RP745W	Laptop Asu	ASUS	Gaming	Windows 1	17190000	4.9	i5 12500H	RTX 2050 4	144	16	512GB	SSD	WUXGA	16	1.8
7	94F19PA	Laptop HP	HP	Gaming	Windows 1	16990000	5	Ryzen 5 75	RTX 2050 4	144	16	512GB	SSD	Full HD	15.6	2.3
8	460VN	Laptop MSI	MSI	Gaming	Windows 1	19690000	4.9	i5 12450H	RTX 4050 6	144	16	512GB	SSD	Full HD	15.6	1.9
9	NH.QPFS\	Laptop Ace	ACER	Gaming	Windows 1	20490000	5	Ryzen 5 66	RTX 3050 6	165	16	512GB	SSD	Full HD	15.6	2.1
10	83GS00D9	Laptop Len	LENOVO	Gaming	Windows 1	23190000	5	i5 12450H)	RTX 3050 6	144	24	512GB	SSD	Full HD	15.6	2.4
11	8Y6W3PA	Laptop HP	HP	Gaming	Windows 1	17690000	4.9	i5 12450H	RTX 2050 4	144	16	512GB	SSD	Full HD	15.6	2.3
12	NX.KQ4SV	Laptop Ace	ACER	Gaming	Windows 1	17690000	4.9	i5 13420H	RTX 2050 4	60	16	512GB	SSD	Full HD	15.6	1.7
13	1411VN	Laptop MSI	MSI	Gaming	Windows 1	21390000	4.9	i7 13620H	RTX 3050 4	144	32	512GB	SSD	Full HD	15.6	1.9
14	2045VN	Laptop MSI	MSI	Gaming	Windows 1	18190000	5	i5 12450H	RTX 3050 4	144	16	512GB	SSD	Full HD	15.6	1.9
15	HN113W	Laptop Asu	ASUS	Gaming	Windows 1	17690000	4.9	Ryzen 7 74	RTX 2050 4	144	16	512GB	SSD	Full HD	15.6	2.3
16	RP629W	Laptop Asu	ASUS	Gaming	Windows 1	18190000	4.9	i5 12500H	RTX 3050 4	144	16	512GB	SSD	WUXGA	16	1.8
17	2077VN	Laptop MSI	MSI	Gaming	Windows 1	24990000	4.9	i7 13620H	RTX 3050 6	144	16	1000GB	SSD	Full HD	15.6	2.3
18	NH.QFHS\	Laptop Ace	ACER	Gaming	Windows 1	18690000	4.9	i5 12500H	RTX 3050 4	144	8	512GB	SSD	Full HD	15.6	2.5
19	1423VN	Laptop MSI	MSI	Gaming	Windows 1	24690000	5	i7 13620H	RTX 4050 6	144	16	512GB	SSD	Full HD	15.6	2
20	887VN	Laptop MSI	MSI	Gaming	Windows 1	18690000	4.9	i7 12650H	RTX 3050 4	144	8	512GB	SSD	Full HD	15.6	1.9
21	9RC55MF5	Laptop GIC	Unknown	Gaming	Windows 1	21190000	5	i5 13500H	RTX 4050 6	144	16	512GB	SSD	Full HD	15.6	2.1
22	HN330W	Laptop Asu	ASUS	Gaming	Windows 1	20490000	4.9	i5 12500H	RTX 3050 4	144	16	512GB	SSD	Full HD	15.6	2.2
23	LP057W	Laptop Asu	ASUS	Gaming	Windows 1	24690000	5	Ryzen 7 74	RTX 4050 6	144	16	512GB	SSD	Full HD	15.6	2.2
24	045VN	Laptop MSI	MSI	Gaming	Windows 1	35690000	4.9	i7 14700H)	RTX 4060 8	240	16	1000GB	SSD	QHD+	16	2.3
25	83DV003C	Laptop Len	LENOVO	Gaming	Windows 1	22690000	5	i5 13450H)	RTX 3050 6	144	16	512GB	SSD	Full HD	15.6	2.4
26	83JC0040\	Laptop Len	LENOVO	Gaming	Windows 1	26190000	5	Ryzen 7 74	RTX 4050 6	144	24	512GB	SSD	Full HD	15.6	2.4
27	LP186W	Laptop Asu	ASUS	Gaming	Windows 1	27190000	5	i7 13620H	RTX 4050 6	144	16	512GB	SSD	Full HD	15.6	2.2
28	085VN	Laptop MSI	MSI	Gaming	Windows 1	50690000	5	Ultra 7 155	RTX 4060 8	120	32	1000GB	SSD	2.8K	14	1.7

III. Main components of the system

3. Data Storage & Search

Interface: `ProductDAO<T extends Product>`

- Defines essential functionalities that any database should support for handling product data.
- Utilizes **generics** for flexibility when switching product types.
- Implemented by specific DAO classes for different database, e.g., `PostgreSqlDAO` in this project.

III. Main components of the system

3. Data Storage & Search

Interface: `ProductFactory<T>`

Provides two main functionalities:

- Convert a database query result into a product of type T.
- Return a list of `T` products by executing a query with a given database URL, username, and password. Implemented by the abstract class `SqlFactory`.

III. Main components of the system

3. Data Storage & Search

Abstract Class: `SqlFactory`

- Extended by product-specific factory classes for different databases
  e.g., `LaptopPostgreSqlFactory`.
- Eliminate code duplication.
  Without it, adding a new product (e.g., Phone) would require writing a separate factory class (e.g., PhonePostgreSqlFactory) and duplicating common logic.
- The `createProduct()` method must still be implemented individually in each factory, as each product type has distinct attributes.

III. Main components of the system

3. Data Storage & Search

Class: `LaptopPostgreSqlFactory` **`implements`** `ProductFactory<Laptop>`

• Generates Laptop objects from database queries.

• To support additional product types or databases, similar factory classes should be created by extending `SqlFactory` — e.g., `PhoneMySqlFactory`.

III. Main components of the system

3. Data Storage & Search

Class: `PostgreSqlDAO<T extends Product>`

- Implements the `ProductDAO<T>` interface to handle database operations.
- Uses Java generics to easily switch between different product types in the PostgreSQL database.
- Contains a `ProductFactory<T>` attribute to separate responsibilities:
  PostgreSqlDAO handles connection and query logic.
  The factory handles converting query results into product objects.
- Enhances reusability:

```
ProductDAO<Laptop> admin
           = new PostgreSqlDAO<>("laptop", new LaptopPostgreSqlFactory());
ProductDAO<Phone> admin
           = new PostgreSqlDAO<>("phone", new PhonePostgreSqlFactory());
```

III. Main components of the system

4. Query & Response Generation

4.1. Package retrieval

Function: Handle information retrieval tasks - product search based on vector embeddings and similarity computation.

III. Main components of the system

4. Query & Response Generation

4.1. Package retrieval

Class: `ProductWithScore`

- Attributes:

```
private final Product product;
private double score;
```

- Encapsulate a Product object along with its associated relevance score.
- The **`Product`** attribute is marked as `final`, ensuring that the associated **`Product`** object cannot be changed after initialization.
- **`ProductWithScore`** can hold any object of type **`Product`** or its subclasses, allowing the class to be reused in the future when the system expands to include other product types.

III. Main components of the system

4. Query & Response Generation

4.1. Package retrieval

Class: **`ProductSearchService`**

Method:

```
    public <T extends Product> List<T>
        searchVector(double[] queryVector, List<T> products, int k)
```

returns the k products with the highest similarity scores to the query vector.

This method uses a generic type parameter `<T extends Product>`, meaning T must be a subclass of `Product` ⇒ Flexibility & Code reuse

Method:

```
    private double
        cosineSimilarity(double[] vectorA, double[] vectorB)
```

calculate the cosine similarity between two vectors using the **cosineSimilarity**.

III. Main components of the system

4. Query & Response Generation

4.1. Package retrieval

Class: **`EmbeddingService (1)`**

Function: Converts user queries and product descriptions (via toString()) into numerical vector embeddings using an external API.

Key Components:

- `private final Configuration config`: Stores the API URL (via `config.getApiUrl()),` ensures immutability and safety.
- `public double[] embedQuery(String query):` Returns the embedding vector of a text query.
- `public double[][] embedProducts(List<? extends Product> products)`: Returns embedding vectors for a list of products.

III. Main components of the system

4. Query & Response Generation

4.1. Package `retrieval`

Class: **`EmbeddingService (2)`**

This class is highly generalized, offering flexibility and abstraction because:

- Supports Multiple Product Types

  The embedProducts method uses `List<? extends Product>,` allowing it to handle any subclass of `Product` (e.g., Laptop, Smartphone).

- Decoupled Configuration

  Uses the Configuration class to fetch API URLs (via `getApiUrl()),` making it easy to change endpoints or settings without modifying the code.

- Batch Processing Support

  The getEmbeddings method accepts a String[] array, enabling batch requests for multiple queries/products in a single API call to optimize performance.

III. Main components of the system

4. Query & Response Generation

4.2. Package `llm`

Function: Integrate Large Language Models (LLMs) to generate intelligent, context-aware responses for product consultation tasks.

Interface: `AIClient`

Defines a contract for AI integration, requiring implementing classes to provide a `getResponse(String userQuery, List<? extends Product> products)` method that returns a string-based response based on a user query and a list of products.

Class: `MistralClient implements AIClient`

+ Implements the AIClient interface and interacts with the Mistral AI API.
+ Constructor accepts a Configuration object to retrieve API URL and API key, ensuring flexibility and avoiding hard-coded values.
+ Encapsulates API logic, making it easy to switch to or support other AI providers in the future.

IV. Demo

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