# DESIGN DOCUMENT – RECIPE FINDER

COMP.SE.110 Software Design

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## Introduction and high-level description

The designed solution is a Java desktop application with a Web frontend. The app is to function as a recipe finder which provides price details of groceries from the Statistics Finland API and gives recipe suggestions from Spoonacular API based on the ingredients chosen from the first one. Users can filter recipes further by dietary preferences, cuisines and nutritional information. Key functionalities include displaying grocery price trends, recipe filtering, and user profile management for saving preferences and favorite recipes. Our chosen architecture pattern is Model-View-Controller, making it easy to split the web-based part from backend, distribute tasks, and create both vertical and horizontal workstreams internally. Scalability, modularity and flexibility are additional benefits, which in this small-scale application are only partially noticeable.

The frontend is built with vite.js due to previous familiarity and being simple to combine with Java, providing a lightweight framework for UI design. Our web interface allows selecting ingredients and displays the price data graph based on data from Statistics Finland API, enabling users to filter food item categories. The frontend also facilitates recipe browsing and saving selected ones within the user's profile. It does not do anything else besides managing requests from the backend and formatting the View parts of the app.

The backend is built with Java Spring Boot, as it takes care of most of our initialization and is simple to set up. It also offers a variety of libraries that offer additional help with integration. The backend requests data from Statistics Finland API and retrieves recipes based on user-defined ingredients and filters, which are relayed to the frontend. It also manages business logic, data transformation, validation, and recipe filtering based on cuisine, diet and nutritional information. User profile data is stored in CSV format, which includes preferences and saved recipes. The backend is separated into services, controllers, models and repositories to create modular structure, enhancing maintainability and scalability.

The main functionality the Statistics Finland API provides is up-to-date price data of selected groceries and ingredients. After data is retrieved, it is then delivered by the backend to the Spoonacular API, which recommends recipes based on the chosen ingredients and other user-selected parameters.

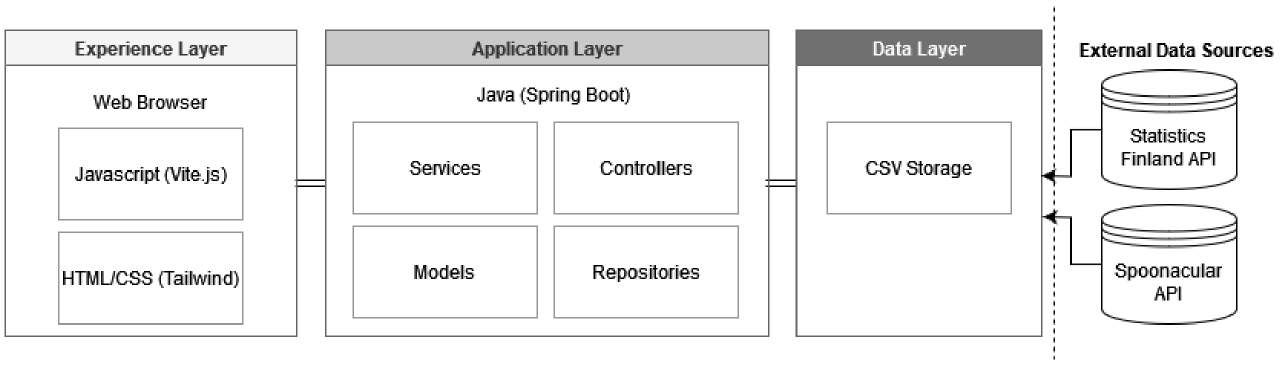


**Figure 1**. High-level system architecture diagram

Experience layer in Figure 1 corresponds to "View" in MVC, with Controllers taking care front-to-back integration and "Models" constituting for almost everything else.

## Internal boundaries and interfaces

Our application relies on three different sources of data: (1) Spoonacular REST API, (2) Statistics Finland REST API, and (3) local CSV files that serve as a lightweight database. These data sources are controlled by different repositories which have methods to interact with the data. Controllers, which receive HTTP requests from frontend users, use repositories through services which handle processing of the data if needed. Repositories convert the data from external API or CSV files into models our application can more easily interact with.

We didn't want to include a proper SQL or NoSQL database in this project to keep it as simple as possible and to focus on the main topic of the course. It also makes it easier to test the application by fellow students.

The basic flow of our Recipe Finder application works as follows:

1. Controller receives HTTP request from Client/User.
2. Controller asks relevant Service to get the requested data.
3. Service layer gets the data from Repository and processes data if needed.
4. Controller responses to the Client with the data as HTTP response.
5. Frontend handles updating the user interface accordingly.

Example flow for getUserById method:

1. Client sends HTTP GET request to /api/profile/{id}.
2. UserController's method getUserById handles the request.
3. UserService's method getUserById is called by the controller.
4. UserRepository's method findById is called by the service.
5. In repository, relevant data is pulled from the CSV file.
6. Repository returns the user data to the service.
7. The service returns the user data to the controller.
8. The controller returns the user data in a JSON format and as HTTP response to the frontend.
9. Frontend updates the view based on the received data.

For the graph (food price dashboard), we use filtered data from Statistic Finland API, reconstruct the data elements as our custom internal objects with simplified structure in the backend. Then we send the Price Data objects to the frontend using our endpoints. The price dashboard graph in the frontend page utilizes **asynchronous loading design** to make sure other parts of the homepage are rendered properly.

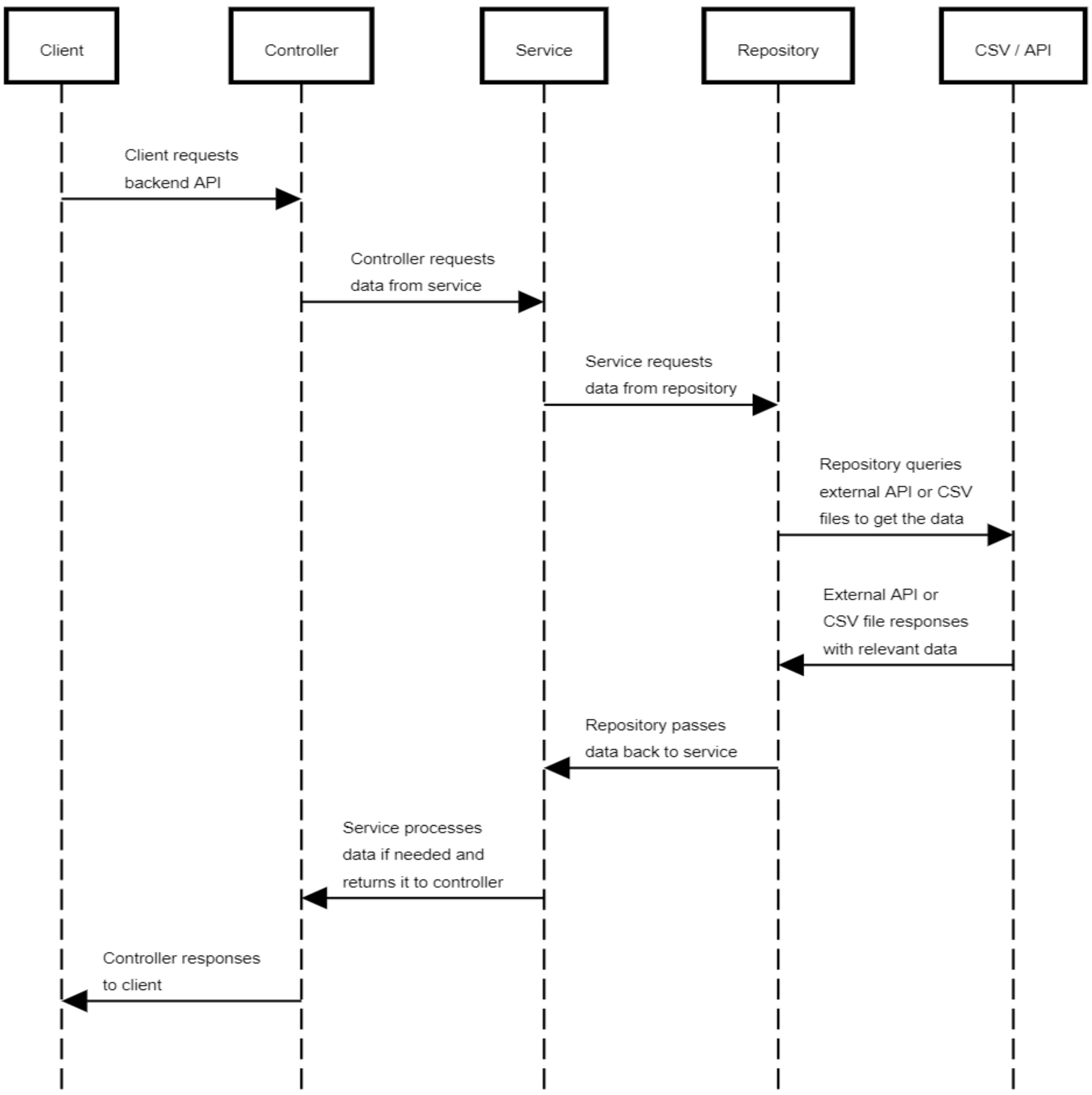

Client
Controller
Service
Repository
CSV / API
Client requests backend API
Controller requests data from service
Service requests data from repository
Repository queries external API or CSV files to get the data
External API or CSV file responses with relevant data
Repository passes data back to service
Service processes data if needed and returns it to controller
Controller responses to client

**Figure 2.** Data flow through different parts of application

## Components and responsibilities

In this chapter we'll discuss each component of the application and what they do on a general level. In addition, we'll show the internal structure on a detailed level, as well as demonstrate our thinking and decision-making on the use of lower-level design patterns.

**Backend**:

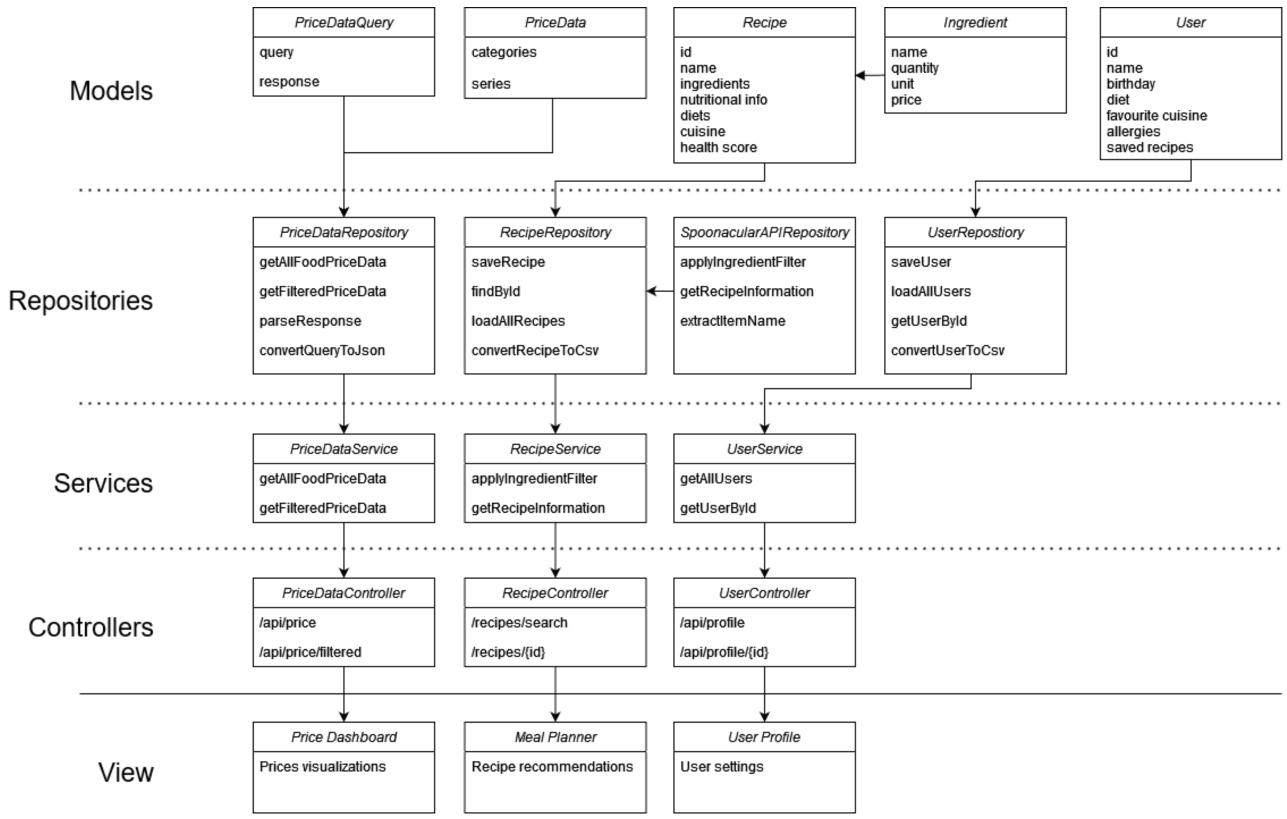
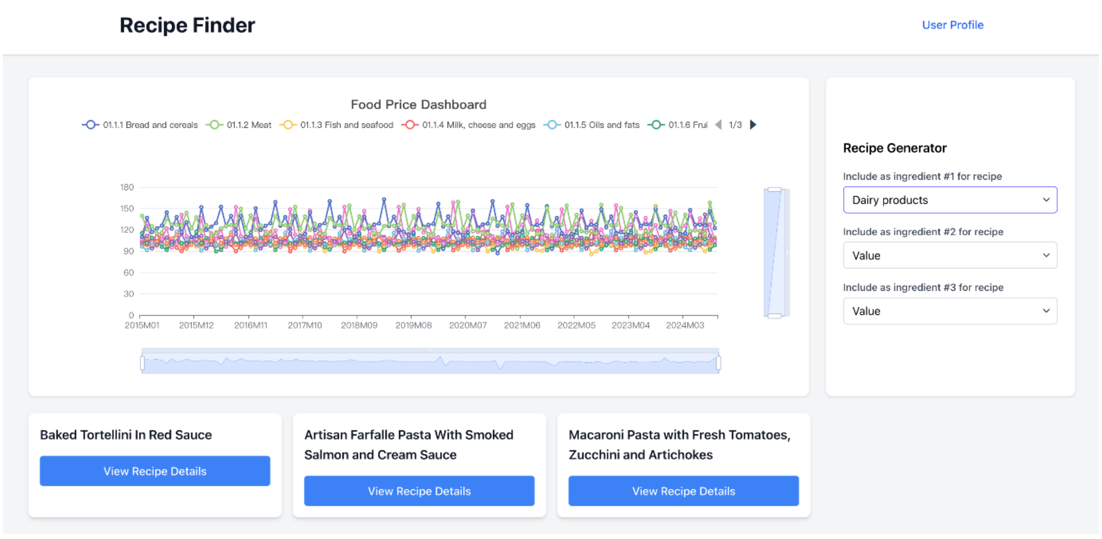


**Figure 3.** All classes, layers and methods visualized

Our Java backend implements the Model and Controller parts of the MVC pattern. As such, there are four key items developed using Java: controllers, services, repositories, and models. The full scope with all planned and implemented methods for each class can be seen above on Figure 2. Vertically there are three functional groups to consider: price data, recipes and user data.

### Controllers

The three controllers manage the flow of data between the frontend and backend. There are one for the price data from Statistics Finland API, recipe data from Spoonacular API and one for managing user related data. They focus on managing incoming requests from the frontend, directing them to the appropriate services. The purpose of the controllers is to handle user interactions and route them to the necessary functions.


Recipe Finder

User Profile

Food Price Dashboard

Recipe Generator

Include as ingredient #1 for recipe: Dairy products

Include as ingredient #2 for recipe: Value

Include as ingredient #3 for recipe: Value

Baked Tortellini In Red Sauce — View Recipe Details

Artisan Farfalle Pasta With Smoked Salmon and Cream Sauce — View Recipe Details

Macaroni Pasta with Fresh Tomatoes, Zucchini and Artichokes — View Recipe Details

**Figure 4.** The Price Data dashboard view on our front page

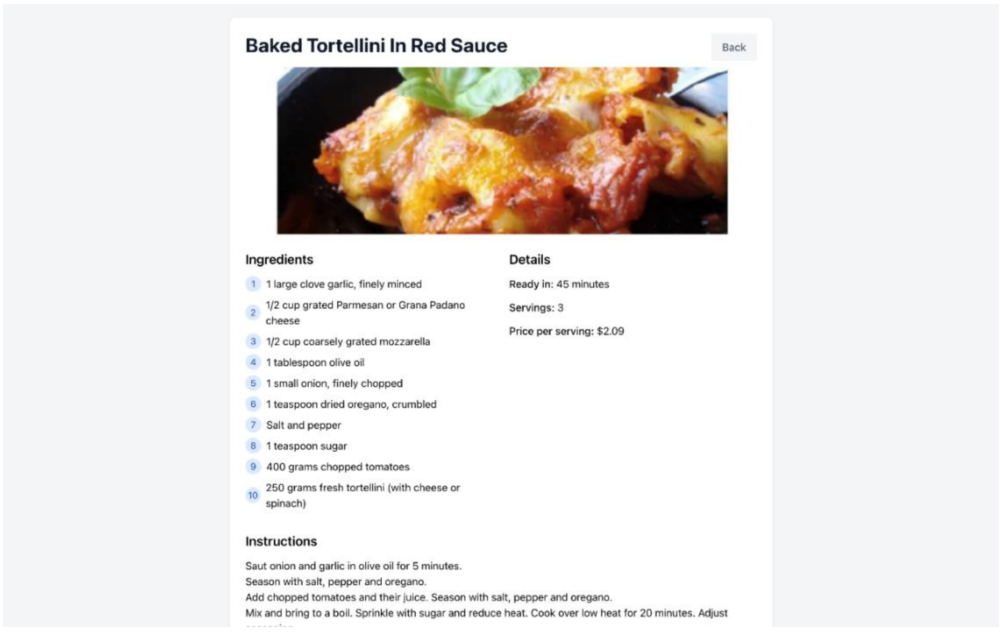
**PriceDataController**.java has one method to gather all recent price data on a high level, and another to apply specific filters. Example use cases of both below.

GET /api/price

GET /api/price/filtered?startMonth=2023M01&endMonth=2023M06&commodities=0111,0112

**Description**: This endpoint retrieves food price data filtered by optional parameters: startMonth, endMonth, and a list of commodities. The controller passes these parameters to the PriceDataService for custom query building.

These filters can be combined and expanded as needed, and the backend will take care of forming the JSON queries that it then relays to respective APIs. The same principle applies to both requests made towards Statistics Finland API and Spoonacular.


Baked Tortellini In Red Sauce

Back

Ingredients

1. 1 large clove garlic, finely minced
2. 1/2 cup grated Parmesan or Grana Padano cheese
3. 1/2 cup coarsely grated mozzarella
4. 1 tablespoon olive oil
5. 1 small onion, finely chopped
6. 1 teaspoon dried oregano, crumbled
7. Salt and pepper
8. 1 teaspoon sugar
9. 400 grams chopped tomatoes
10. 250 grams fresh tortellini (with cheese or spinach)

Details

Ready in: 45 minutes

Servings: 3

Price per serving: $2.09

Instructions

Saut onion and garlic in olive oil for 5 minutes.
Season with salt, pepper and oregano.
Add chopped tomatoes and their juice. Season with salt, pepper and oregano.
Mix and bring to a boil. Sprinkle with sugar and reduce heat. Cook over low heat for 20 minutes. Adjust

**Figure 5.** Recipe details shown on the web interface

**RecipeController**.java can be used in a similar way:

GET /recipes/search?ingredients=chicken,garlic,tomato

In addition there is a specific call for search details of individual recipes:

/recipes/{id}

**Description**: This endpoint retrieves detailed information about a specific recipe identified by its unique id. The recipe information includes details like ingredients, description, nutrition value, etc. The controller calls getRecipeInformation(id) in the RecipeService to retrieve the data.

**UserController**.java manages user profiles, handling requests to retrieve all user profiles or a specific user profile by ID. The controller interacts with the UserService, which contains the business logic to retrieve user data.

GET /api/profile

Allows displaying full set of users in the system for admin purposes, whereas

GET /api/profile/{id}

**Description**: The endpoint retrieves a specific user profile based on the user's unique ID, which will always be 1 in our MVP implementation. The id is passed as a path variable, and the controller uses the UserService to fetch the corresponding user. If the user is found, their profile is returned. Otherwise, a 404 Not Found response is returned.

## Services

There are three in total, one mapping to each respective controller and only holding the available method initialization. Each of these methods has already been introduced in the chapter discussing controllers. They focus on encapsulating the business logic and coordinating data processing. This allows logic to be reusable and independent of the way data is stored or retrieved.

## Repositories and design patterns

Repositories handle the interactions with data storage and providing a layer dedicated to data access. This ensures that data management is organized and can be easily modified.Repositories use a combination of patterns depending on what best suits each one. Just for instance the Price Data repository uses many patterns by itself:

For example, the PriceDataRepository.java has a method buildQueryWithOptionalMonths, which uses the **Builder Pattern** by building PriceDataQuery objects with nested queryItem and Selection objects. This helps in setting up the logic for complex query parameters based on the startMonth, endMonth and commodities. Thinking behind selecting this pattern was to make the codebase cleaner and to reduce errors as the setup is greatly simplified.

PriceDataRepository also has createQueryItemWithValues method that follows the **Factory Method Pattern** to create and initialize QueryItem instances. We decided to use it here to centralize the setup of

QueryItem objects and to reduce duplication, because it allows simplifying future adjustments to the item creation process.

parseResponse acts like a Template Method for parsing JSON responses from the Statistics Finland API. It provides a consistent parsing flow that could be reused or overridden if needed to handle variations in the response structure. This approach provides a structured way to interpret responses and populate PriceData objects while handling exceptions in a standardized way.

SpoonacularAPIRepository.java and PriceDataRepository classes act as Adapters between the application and external APIs. They translate internal method calls into specific HTTP requests and responses. This is our implementation of the **Adapter Pattern,** allowing us to easily swap APIs if needed, hence leading to enhanced modularity and flexibility. We chose the adapter pattern deliberately to adapt other parts of the design.

Last major pattern in the case of our Recipe Finder repositories are the **Singletons** (Java Spring beans uses them by default). They are not only limited to PriceData, but every class definition using @Service and @Repository annotations e.g. has Singletons running on the background.

## Models

The models represent core data structures used throughout the application. The purpose of models is to format and form the relationships of data, making it easy to manage and use consistently across the application.

**Ingredient.java** model represents individual ingredients that are used in recipes. The key fields are name, quantity, unit and price. It is linked to Recipe as list of ingredients.

**NultrionalInfo.java** stores the nutritional details associated with a recipe. The key fields are calories, protein and carbs. It Is linked to Recipe to provide these details about each recipe.

**PriceData.java** stores data from the Statistics Finland consumer price index API. Each price data object is associated with a list including relevant categories of food products, and another list for time series to draw filterable graphs.

**PriceDataQuery.java** was created to construct the queries themselves and to have a clear distinction between the data objects returned and query objects being sent to the API. The model has list of query items and the response as key fields.

**Recipe.java** represents a recipe, including the ingredients used in the recipe and nutritional information. The key fields are id, name, list of ingredients, nutritional info, diets, cuisines, health score and Boolean attributes fetched from the API is the recipe dairy free, gluten free, sustainable, cheap, popular and/or healthy. These are used for filtering different recipes. It is linked to Ingredient, Nutritional info and the User model as the user can save favorite recipes in a list.

**User.java** stores the user profile information. The key fields are id, name, birthday, diet, favorite cuisine, allergies and the list of saved recipes. It is connected to the Recipe model through the saved recipes.

## Decision-making and Design reasoning

We had weekly design/sprint meetings each Saturday to discuss the tools, architecture and distribute implementation tasks for each respective week. In these meetings we decided to go with the MVC pattern, with the tools previously introduced, and focus on scalability, modularity and prioritize development of Models and Controllers first, focusing on the View later.

**Technology Choices**

Backend: Spring Boot

- Provides robust framework for building RESTful APIs with built-in dependency injection
- Excellent integration capabilities for external APIs (Statistics Finland and Spoonacular)
- Strong support for MVC architecture pattern
- Team members' prior Java experience makes it a practical choice

Frontend: Vite.js (React)

- Modern build tool offering faster development of new features
- Simplified state management mechanisms
- Team's existing web development experience makes it a suitable choice

Data Storage: CSV Format

- The format is simple, lightweight and easy to work
- Easy integration to Java backend through common Java libraries
- Data volume of the application is estimated to be low
- Minimal setup and hosting requirements, enabling rapid testing if needed

**Scalability considerations**

1. **Asynchronous Loading**
   a. Implemented for price dashboard graphs and recipe information
   b. Ensures responsive UI even with large datasets
   c. Prevents blocking of other components during data loading
2. **Modular Component Design**
   a. Separate controllers for price data, recipes, and user management
   b. Makes it easier to add new functionality
3. **Query Parameter Handling**
   a. Flexible filtering system for both price data and recipes
   b. Custom query building for optimal API interactions
   c. Reduces unnecessary data transfer

**Backend design patterns**

As already mentioned, the backend has been organized based on general MVC structure, allowing separation into distinct layers. This decision was made uniformly and has served us well. Individual methods in the model and controllers use e.g., Builder, Factory, Adapter, and Singleton patterns as discussed. We didn’t want to limit ourselves to only a selected few, so they are used where they offer adaptability, maintainability, or some other clear benefit. Each chosen use of a design pattern serves a very specific purpose, addressing some local challenges, such as the builder for price data simplifying complex queries, or adapter pattern allowing modular interaction with APIs.

## Testing

The application testing plan focuses on ensuring that key components of the program are working as they are supposed to within the time limitations of the course.

### Unit testing

We will write tests for individual methods to test core functionalities, for example CSV data handling and recipe filtering. These unit tests will verify that a method produces the correct output, being otherwise limited in their scope. The main reason for implementing them is catching errors in early development process, reducing required effort for debugging.

- **Tool**: JUnit

### Additional tests

- API pinning to ensure the APIs are up and running
- Integration tests to check how the components work together
- Tools: Spring Boot testing support

This testing plan is currently still being refined and will be expanded in the future as needed.

## Self-evaluation

**Design Review**:

Our initial design was reasonably high-level and based on our limited knowledge of software architecture patterns at that time. Considering what we know now, some elements we could have simplified (such as ingredient model) and others expanded upon already in the beginning. It would have also been beneficial to have a list of all possible patterns somewhere, and together map those to our methods/classes/components to discuss the approach more methodically.

However, all things considered, we did manage to follow the initial plan almost step-by-step throughout the implementation process, and it was immensely helpful in structuring work, distributing tasks, and keeping track of overall status. The benefits of thinking about architecture patterns have been very well demonstrated by this exercise, and so far, we are quite happy with the results.

Furthermore, the initial design would have been even more useful with some additional sequence diagrams showcasing in detail what the backend is supposed to do in each step, as well as having a full set of endpoints already decided from the moment the implementation began. The way we progressed was not as structured as it could have been.

**Changes to Original Design**:

Additions:

- New Controller, Service and Repository for user management was implemented to support user creation. This was in the initial plan, but not part of the documentation.
- PriceData model was split into two: PriceData.java and PriceDataQuery.java to manage query parameters and construct PriceData objects separately. This decision was based on the lecture about builders and factories, and was done to test them out, but also simplify the general querying process.
- CSV format for data storage was defined. Previously we thought about using some type of SQL storage, but CSV was deemed sufficient for this assignment. It also reduces the amount of effort required to manage more complex databases, although we are aware that CSV is not the most modern option.

**Future Implementation**:

We have already implemented most of the code required for the backend (Models and Controllers). This means that most development will happen on the frontend and View side, which we expect to be quite quick with the existing structure in place. No major changes to the backend to be expected, although some functionalities perhaps need to be expanded. Adding and expanding the now existing controllers, services and repositories should be rapid, but also simple. A few that we have already planned include new endpoints for UserController to patch user data, methods to save recipes, and a method to PriceDataService to apply additional filters. Otherwise, we have a stable foundation for any continuous implementation built on top of MVC pattern. For example, due to the design decision to split the API repository and our local repository for recipes, we could easily switch to using any other recipe API if the old one would e.g. become depreciated. This is just an example of how the modularity of our design ensures scalability and flexibility.