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Cinema Seat Reservation System

A graduation project dissertation by:

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GitHub link :
https://github.com/ShinobiBoi/pl3

1-Project Overview

1.1. Objective: To develop a functional and safe console application for cinema seat booking.

1.2. Goal: Implement robust logic to manage seating inventory, prevent double-booking, and generate persistent, unique reservation tickets.

1.3. Technology: F# , which ensures data safety through immutability and simplifies state management using Discriminated Unions for clear seat status representation.

2- System Architecture and Data Model

2.1. Data Representation

We define custom types for clarity and domain safety:

A. **Seat Status :** This union explicitly defines the possible states for any single seat, ensuring impossible states are not represented.

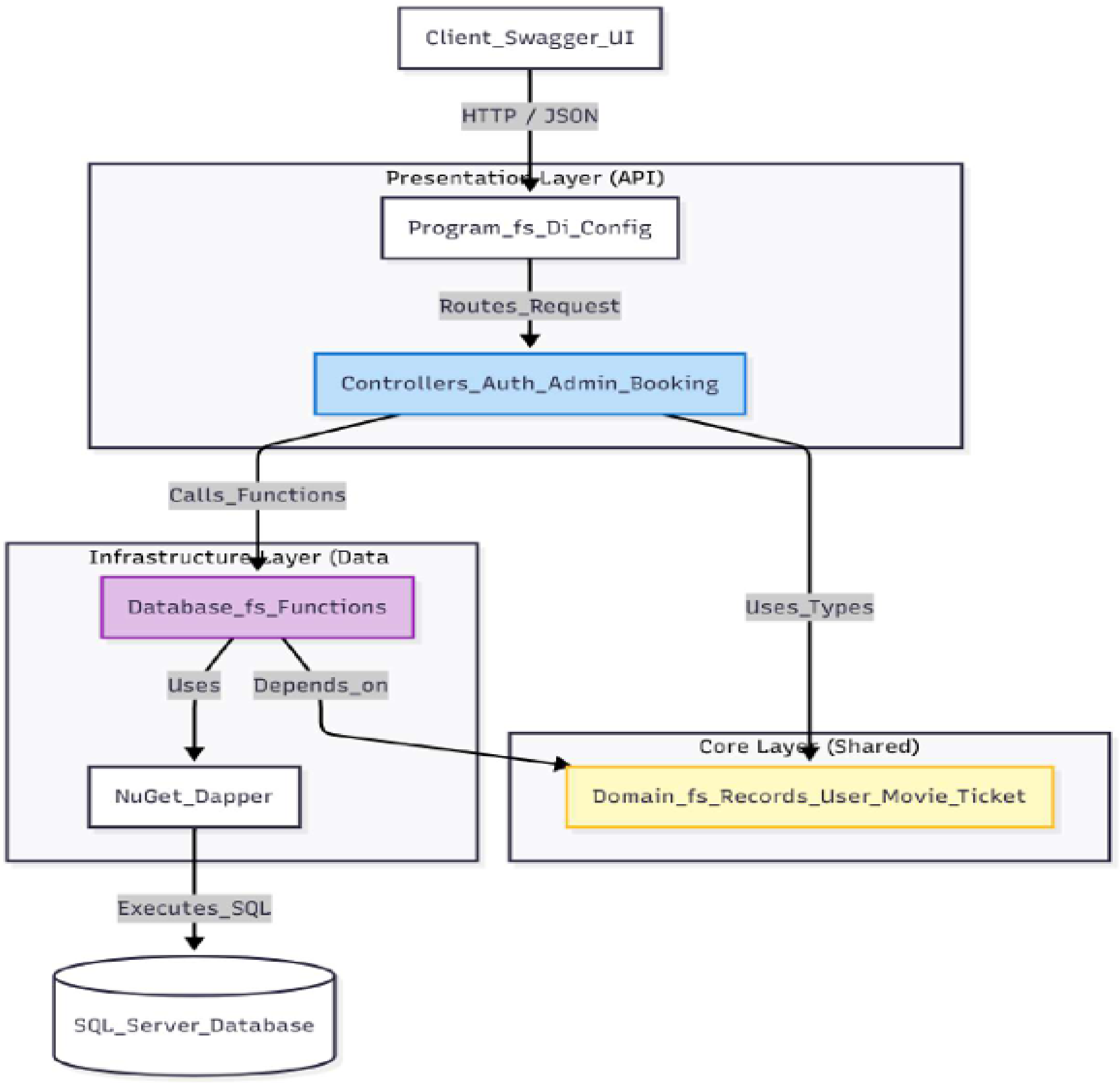
B. **Ticket Record:** A record type is used to store all essential information about a successful reservation.

2.2. Seating Layout

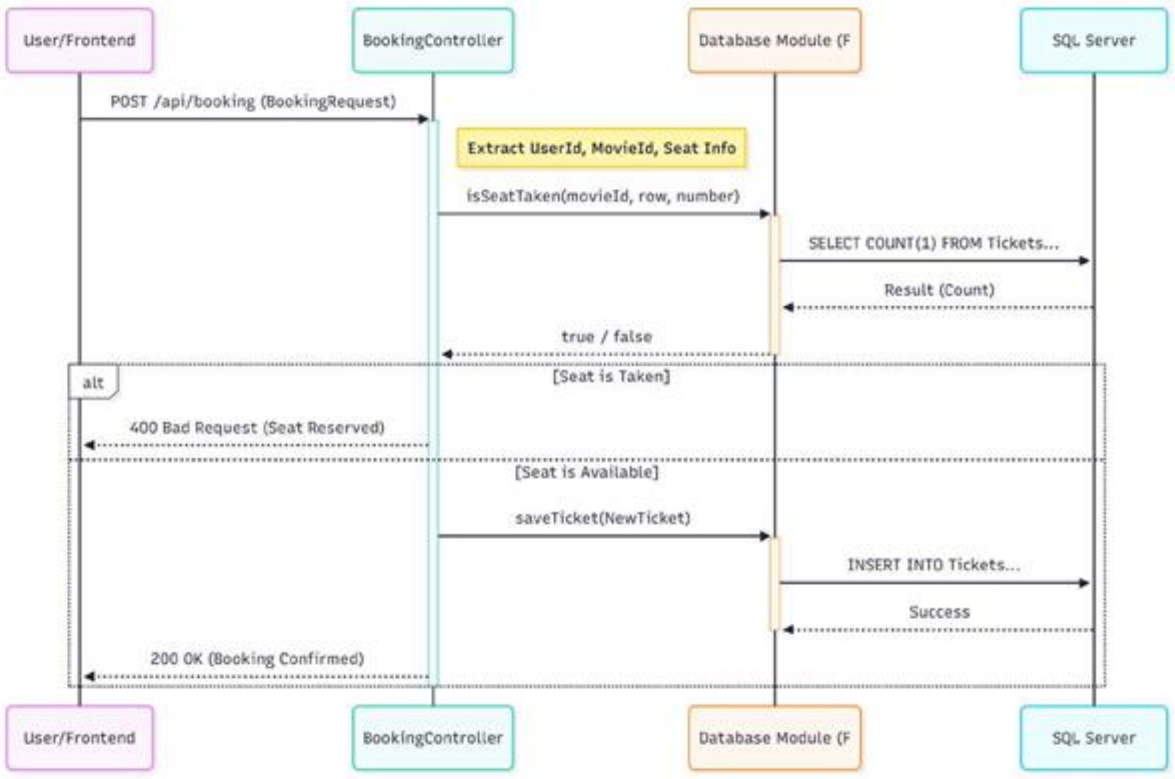
The cinema will be modeled as an immutable 2D Array where each element holds a Seat Status value.

3. System Modeling and Design Diagrams

3.1. System Architecture Diagram



3.2. Sequence Diagram



4. Testing Framework Choice: xUnit.net

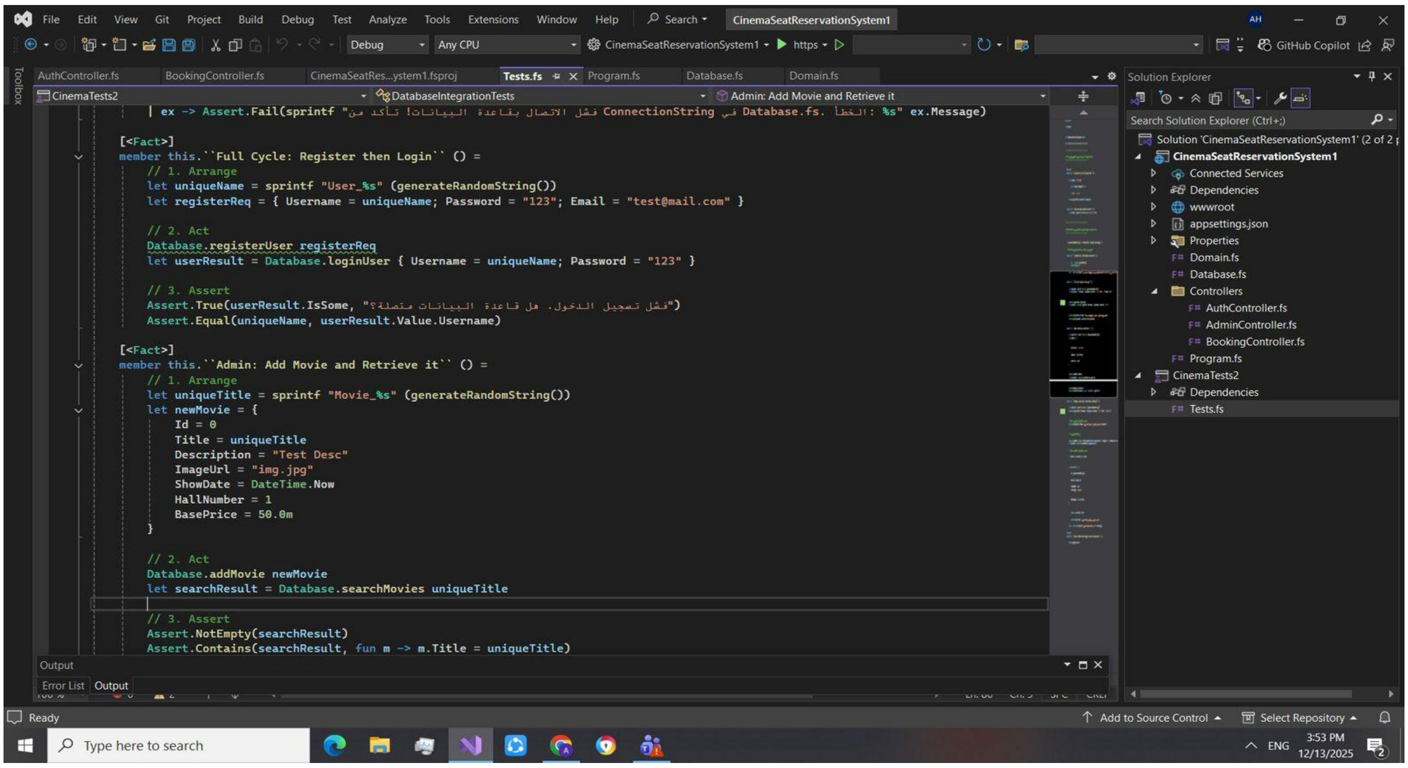
.NET Ecosystem Integration: xUnit is the industry-standard framework for .NET projects (C# and F#), ensuring seamless integration with the build environment.

Functional Focus: xUnit’s design, emphasizing Fact and Theory, perfectly aligns with the F# functional paradigm, allowing easy testing of pure functions with predictable outputs.

Immutability Testing: It facilitates the verification of functions that return new immutable data structures, which is core to the F# design philosophy.

Extensibility: It supports powerful F# testing extensions like FsCheck for advanced property-based testing.

Code Snippet:



```
            | ex -> Assert.Fail(sprintf "فشل الاتصال بقاعدة البيانات! تأكد من ConnectionString في Database.fs. الخطأ: %s" ex.Message)

    [<Fact>]
    member this.``Full Cycle: Register then Login`` () =
        // 1. Arrange
        let uniqueName = sprintf "User_%s" (generateRandomString())
        let registerReq = { Username = uniqueName; Password = "123"; Email = "test@mail.com" }

        // 2. Act
        Database.registerUser registerReq
        let userResult = Database.loginUser { Username = uniqueName; Password = "123" }

        // 3. Assert
        Assert.True(userResult.IsSome, "فشل تسجيل الدخول. هل قاعدة البيانات متصلة؟")
        Assert.Equal(uniqueName, userResult.Value.Username)

    [<Fact>]
    member this.``Admin: Add Movie and Retrieve it`` () =
        // 1. Arrange
        let uniqueTitle = sprintf "Movie_%s" (generateRandomString())
        let newMovie = {
            Id = 0
            Title = uniqueTitle
            Description = "Test Desc"
            ImageUrl = "img.jpg"
            ShowDate = DateTime.Now
            HallNumber = 1
            BasePrice = 50.0m
        }

        // 2. Act
        Database.addMovie newMovie
        let searchResult = Database.searchMovies uniqueTitle

        // 3. Assert
        Assert.NotEmpty(searchResult)
        Assert.Contains(searchResult, fun m -> m.Title = uniqueTitle)
```

Test Cases(8) :-

First of all, Our Core Strategy : The Test Pyramid

1. Business Logic Tests (Unit Tests)

- Calculate Price for Platinum Ticket: Verifies that the ticket pricing function applies the correct multiplier (2.0x) for the 'Platinum' category, ensuring accurate financial calculations within the Core Layer.

- Ticket ID Format Should Be Correct: Confirms that the resulting ticket identifier string adheres to the defined structure (e.g., starts with MOVXX-RXX-SXX-), validating the data formatting rules.

- Seat Layout: Should Generate 8x8 Matrix Logic: Checks the integrity of the in-memory seat map creation, ensuring it initializes with the correct 8x8 dimensions and allows for the successful simulation of a seat status update (e.g., from "Free" to "Booked").

2. Database Integration Tests (Infrastructure Layer Tests)

- A_Connectivity: Check Database Connection: A critical test to confirm the application can successfully establish a connection to the underlying SQL Server database, ensuring the entire Infrastructure Layer is operational.

- Full Cycle: Register then Login: Validates the core Authentication Service by testing the end-to-end user registration and subsequent login using the newly created credentials, confirming data persistence and validation work correctly.

- Admin: Add Movie and Retrieve it: Tests the administrative data management workflow: adding a new movie record and then querying the database to confirm its persistent storage and correct retrieval.

- Booking: Create User, Create Movie, then Book: This is the flagship integration test. It executes the full transaction: creating all necessary entities (user, movie), saving a ticket, and finally querying the database to assert that the specific seat is correctly marked as 'taken', validating the entire booking flow.

- Search: Should Return Empty for Non-Existent Movie: A robust test to ensure the search functionality handles missing data gracefully, returning an empty collection when querying for a non-existent movie title.

5. Core Feature Implementation Details

User Authentication:
Goal: Restrict access to the booking and management functionalities.
Implementation: The AuthController module contains functions to validate user credentials against a hardcoded list (or a simple file store) and return a status (e.g., Authenticated or AccessDenied).

Display Seating Map: A function iterates over the 2D array and uses pattern matching on seatMatrix to render the grid.

Select Seats: User inputs (SeatRow, SeatNumber) are parsed and validated against array bounds to prevent exceptions.

Prevent Double Booking: The BookTicket function explicitly checks

6. Team Roles and Module Mapping

1. **Seat Layout Architect:** Defines the initial dimensions and state of the cinema grid

2. **Display Developer:** Translates the seatMatrix[,] array into a user-friendly console visualization.

2. **Booking Logic Developer:** Implements the core business rules for reservation (BookTicket) and manages the immutable state change.

4. **Ticket System Developer:** Handles the generation of unique IDs and formatting of the ticket data.

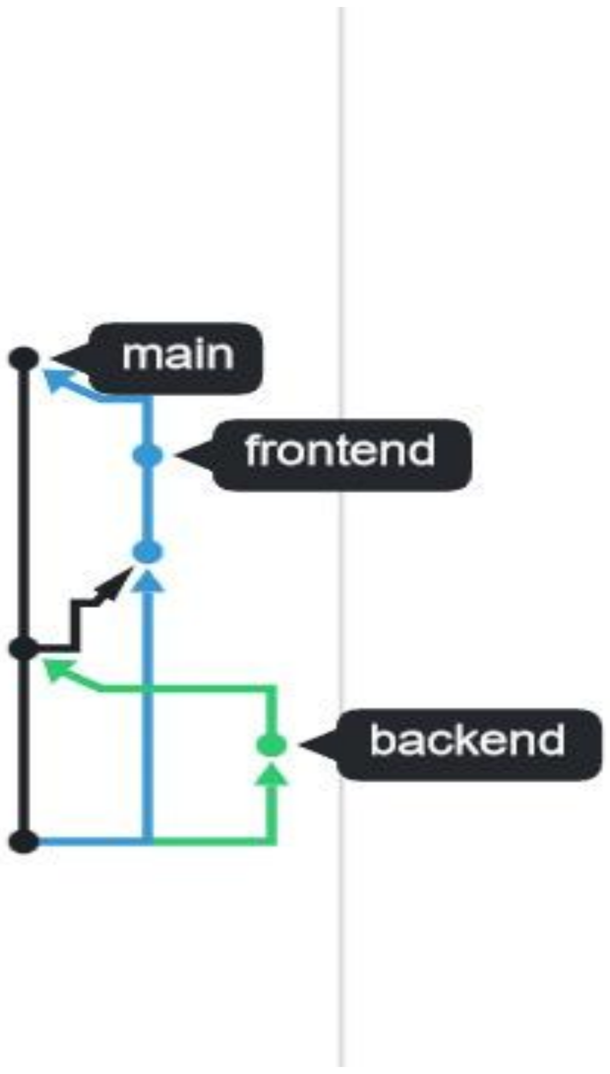
5. **File Storage Developer:** Manages the persistence of booked tickets to disk.

6. **UI Developer:** Implements the main menu, user input handling, and coordinates calls between the Auth and Booking modules.

7. **Tester:** Develops unit and integration tests using xUnit for all core functional units.

8. **Documentation Lead:** Compiles and maintains all project documentation and technical specifications.

GitHub Map


main
frontend
backend