

## Introduction

The Binary Calculator Web Application was developed to perform basic binary arithmetic operations (addition, multiplication, bitwise AND, and bitwise OR) using a web-based interface. The system includes controllers for handling both standard web requests and API-based interactions. This report outlines the design and implementation of the system, including the Binary, BinaryController, and BinaryAPIController classes, along with the testing strategy to ensure correctness and reliability.

## Key Features

1. Binary Class:
  - Represents unsigned binary numbers.
  - Supports bitwise operations (AND, OR) and multiplication.
  - Provides helper methods for addition and normalization of binary numbers.
2. BinaryController Class:
  - Handles user input and processes arithmetic operations.
  - Implements a web interface for interactive binary calculations.
  - Ensures valid user input and provides appropriate feedback.
3. BinaryAPIController Class:
  - Provides REST API endpoints for binary arithmetic operations.
  - Implements JSON-based responses for API users.
  - Supports GET requests for arithmetic computations.

## Implementation Details

### Binary Class

- Encapsulates binary number representations and arithmetic logic.
- Implements bitwise AND, OR, and multiplication operations.
- Handles input validation and normalization to ensure consistency.

### BinaryController Class

- Provides an interactive web interface for users to input binary numbers and perform calculations.
- Uses Spring Boot and Thymeleaf to render results dynamically.
- Handles HTTP GET and POST requests for arithmetic operations.

### BinaryAPIController Class

- Implements a RESTful API to expose binary arithmetic operations.
- Returns structured JSON responses with operands, operators, and results.
- Provides endpoints for addition, multiplication, AND, and OR operations.

#### Enhancements

- Input validation ensures only valid binary numbers are processed.
- API responses provide detailed JSON objects for structured data access.
- User-friendly error messages enhance usability.
- Modular design allows for easy expansion and additional features.

#### Conclusion

The Binary Calculator Web Application successfully implements interactive and API-based binary arithmetic. The combination of thorough unit and integration testing ensures correctness, reliability, and maintainability. Future improvements may include additional arithmetic operations, improved UI/UX, and database integration for storing calculation history.