Software Engineering Coursework 1 - Othello

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1 Introduction

The game of Othello (Reversi), is a two player strategy game involving a square board and playing pieces that take the form of counters which are white on one side and black on the other. Players take turns to place pieces on the board, attempting to surround their opponent's pieces. Any opposing pieces that are surrounded are flipped over and converted from white to black, or vice versa. At the end of the game, the winner is the player with more pieces of their colour on the board (Summarized from specification).

2 Design

2.1 Description

There are five major packages:

2.1.1 Display:

- Display interface: enables us to implement different visual representations.
- Includes a CommandLineDisplay class and a GUIDisplay class which both implement the Display interface.

2.1.2 Game:

- Board class: Creates a board, which is a 2 dimensional array of Pieces. At the start of the game, each array element of the board is a null instance of Piece.
- Colour enum: This enum contains the possible colours of the pieces. Since it is a two player game, the elements of the enum Colour are Black & White, but this can easily be extended by adding additional colours.
- Game abstract class & ReversiGame class: The ReversiGame class extends the Game abstract class. Although the project's focus is creating a Reversi game, the Game abstract class outlines methods that can be used in a general game. Thus, if a Chess game was to be created, it would be possible to extend the Game abstract class and reuse some of the methods.

2.1.3 Piece:

- Piece abstract class and ReversiPiece class: The ReversiPiece class extends the Piece abstract class. The relationship between these two classes is very similar to the relationship between the Game and ReversiGame classes. The ReversiPiece represents each piece on the board. The colour of the piece is stored, while there is a flip method which changes the colour of the piece.

2.1.4 Player:

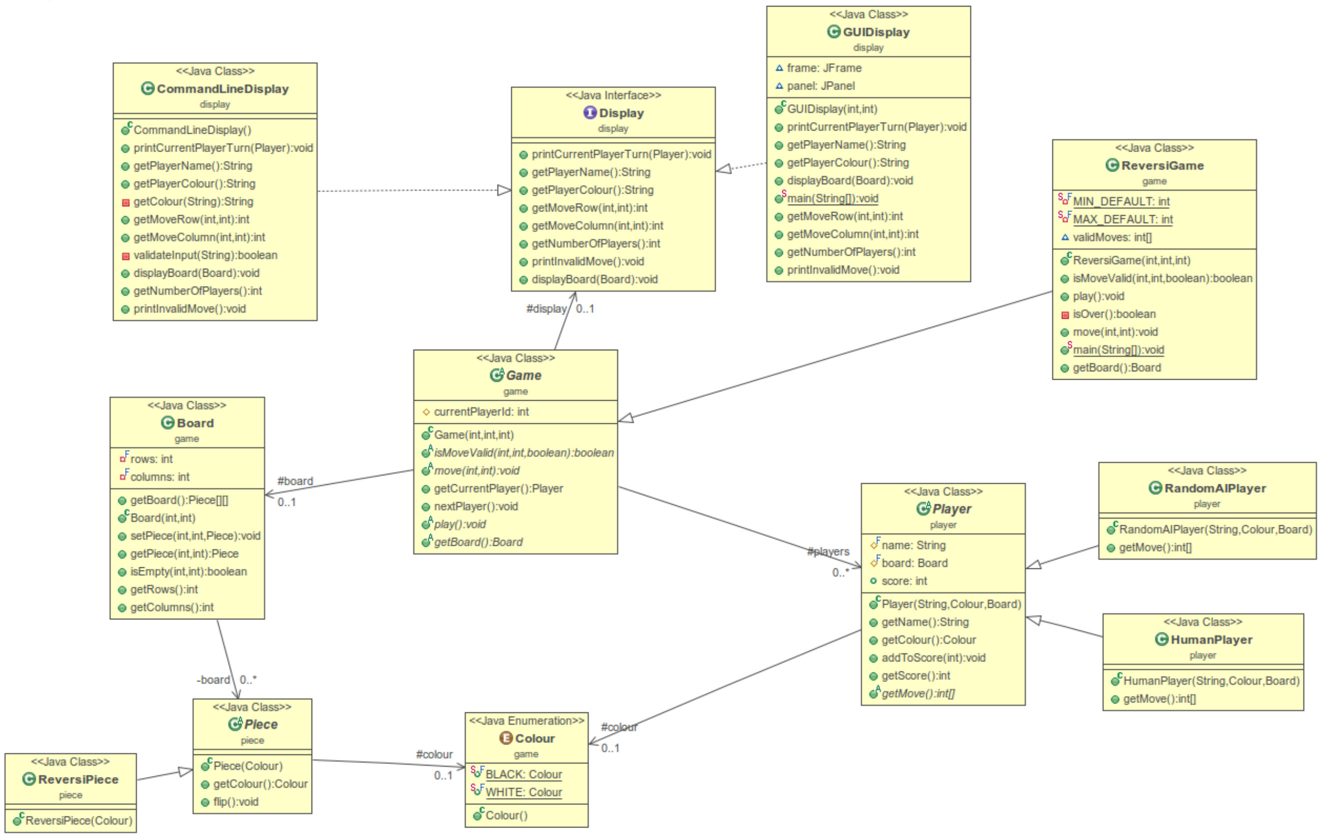
- Player abstract class, RandomAIPlayer, and HumanPlayer class: The HumanPlayer and RandomAIPlayer classes extend the Player abstract class. This follows the same style as the Game & Piece classes. The Player's attributes are its name and its piece's colour. Both subclasses have different implementations for the getMove method. The HumanPlayer class gets a move by reading the user's input through a Scanner, while the AI Player generates a move.

2.1.5 Tests

- There are four JUnit test classes, which test individual components of the game. The following components are tested: Board, Human Player, Reversi Game, and Piece.

2.2 UML

The UML (shown below) describes the overall implementation of the game.



2.3 Design Decisions

2.3.1 Interfaces:

- Used in: Display interface - GUI and Command Line displays implement the display interface
- The displays can be easily switched between a command line or a GUI display, depending on what the user prefers, without changing the actual implementation of the game. This also enables

the use of polymorphism. The advantages of polymorphism in relation to the Reversi code are listed and explained in the section 2.3.4.

2.3.2 Abstract classes

- Used in : Game, Player, Piece class
- An example of this design decision is the Game abstract class and a ReversiGame class which extends the Game. The Game class has methods that deal with the current player and the player's turn and the ReversiGame class inherits these methods. This allows us to implement multiple two player games and reuse the same Game class, minimizing duplication. The ReversiGame class further implements methods like checking if a move is valid, which varies from game to game.
- Player is an abstract class, and the reason for this implementation is so that different types of players can be added easily. One example is the simple AI Player, where the only method that needs to be changed is the getMove method, which decides how a move would be selected. For the Human Player class, the getMove method consists of getting the user's input. An extension that we could implement and easily integrate into our design is adding different difficulty levels for the Computer Player - again, only the getMove method must be changed, and different algorithms can be used in each getMove method.
- Piece is an abstract class as well. If different games were to be implemented with the same design, different types of pieces may be needed. The abstract class allows a much easier implementation of this.

2.3.3 Model-View-Controller

The design follows the Model-View-Controller architecture (See Figure 1).

- Model: The ReversiGame class, including its dependencies (e.g. Piece, Player), acts as the model. It performs the moves done by the players on the board. This allows the view (display) to produce the updated representation of the board.
- View: In the design, the displays act as the views in the MVC architecture. The CommandLineDisplay & the GUIDisplay do not interact with the actual implementation of the game. As shown in Figure 1, the view deals with the user interaction. For example, the display provides the functionality to obtain the user's name. The Controller updates the View and the View displays the current representation of the game.
- Controller: The controller is primarily the 'play' method in the ReversiGame class. It sends commands to the view to update the display, using the displayBoard method. It obtains the input from the view and passes it to the Model to update the game, as can be seen in Figure 1.

2.3.4 Polymorphism

- Code reuseability: As mentioned before, the abstract classes have allowed us to reuse the code and avoid duplication.
- Extendability: Polymorphism allows us to add classes that have a generic type but its actual type would be different. For example we can have an AI Player and a Human player but they both have a generic type Player. This allows us to still use the same code and extend it with different types of players which would allow similar functionality.

- Maintainability: Characteristics can be modified without any significant changes in the code. For example, in the CommandLineDisplay, black and white pieces are represented as b and w, respectively, which can be changed easily. Furthermore, the enum Colour can be modified to change colours of pieces, if required.

2.3.5 Test-Driven Development

Test driven development was used for the classes Player and Piece. An abstract class for Player was implemented with dummy methods for the functionality which would be required by a Player object. The test suite was implemented with different tests for the various different functionalities which would be required by any Player object. Each method was implemented while the tests were run, to make sure that only one behaviour of the object Player was implemented at any time. A similar approach was used to implement the Piece class. The tests were run by using objects which had the abstract type as their generic type and their actual type was concrete. This ensured dependency inversion, i.e the objects that use these objects can depend on the abstractions (Player and Piece) and not concretions (HumanPlayer and ReversiPiece). An example of a test is shown below:

```
@Test
public void testFlip()
{
    Piece piece = new ReversiPiece(Colour.BLACK);
    assertEquals(Colour.BLACK, piece.getColour());
    piece.flip();
}
```

2.3.6 Refactoring

This was a major chunk of our design. For example, this was used when loading inputs from the user in the game. Since we can have either a command line or GUI output, we isolated the loading of input and just used methods such as getPlayerName() which are defined in the displays. This not only aids readability, but also allows us to easily maintain the code, without having to deal with the actual displays.

2.3.7 Visibility choices

- Especially in the Game and Piece abstract classes, we decided to keep the fields protected. This is because these fields had to be accessed by the sub classes which are in the same package. This avoids bad encapsulation, because these fields cannot be accessed outside the package.
- We used private fields where possible. For example, all the fields in the abstract Player class are private. This is because these fields, especially the name and the colour, arent changed throughout the game, and access to these fields have been restricted.

2.3.8 Dependency Inversion

Dependency inversion enforces the Objects to depend on abstractions and not concretions. This makes the code more maintainable because concrete classes can be added wihout modifying the actual implementation of the parent classes. The Game class is dependant on the Piece and Player classes which are abstract. This provides us with the functionality to add different sub-classed types of players without modifying the Game class.

3 Testing

3.1 Component Level Testing

The behaviour for each individual component were tested using the JUnit test environment. Before the components were integrated for the whole game, the behaviour of each component was ensured to be correct.

3.2 Validation Testing

The display class which deals with user interaction includes all the validation checks to ensure that the returned input to the callee method is always valid. This was particularly important in the Command Line Display, where a user could enter any row and column combination which could be off the board. Another key validation method is the isMoveValid function, which is in the Reversi game class. This ensures that a chosen move is valid according to the rules of the game.

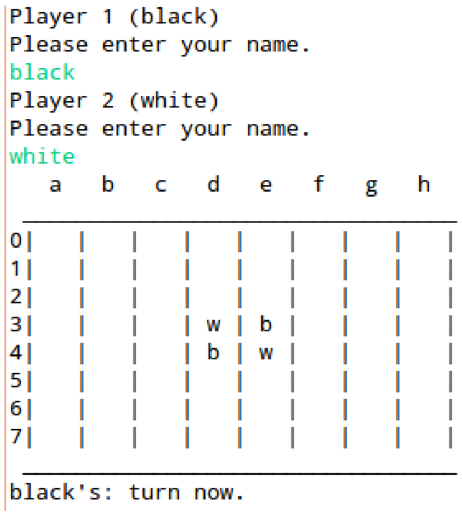
3.3 System Testing

System testing involves testing the system once all the individual components are linked together. Since the game uses a command line dispay to enter the input. This was done by invoking tests games.

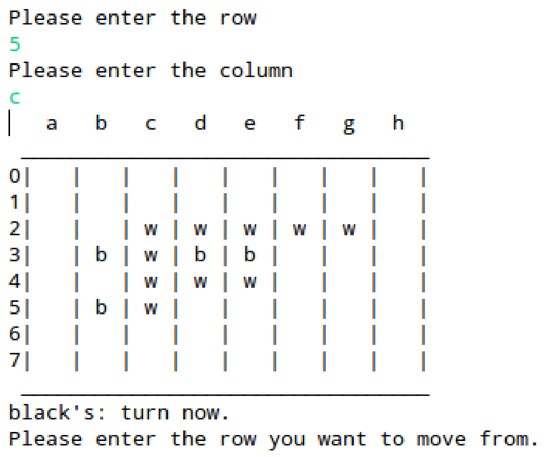
4 Summary

It was attempted to make the Reversi game as simple as possible. A design is simple to the extent that it behaves correctly, minimises duplication, maximises clarity, and has fewer elements. Our testing methods listed in section 3 and test-driven development for certain objects ensures that the program behaves correctly and passes our tests. Duplication was minimised as far as possible by using object oriented design features such as abstract methods and polymorphism. In terms of maximising clarity and reducing the number of elements, we use abstract classes to allow extendability to the code without adding and modifying code.

Running the Game (Command Line Display screenshots)



```
Player 1 (black)
Please enter your name.
black
Player 2 (white)
Please enter your name.
white
    a    b    c    d    e    f    g    h
  ________________________________________
0|    |    |    |    |    |    |    |    |
1|    |    |    |    |    |    |    |    |
2|    |    |    |    |    |    |    |    |
3|    |    |    | w  | b  |    |    |    |
4|    |    |    | b  | w  |    |    |    |
5|    |    |    |    |    |    |    |    |
6|    |    |    |    |    |    |    |    |
7|    |    |    |    |    |    |    |    |
  ________________________________________
black's: turn now.
```



```
Please enter the row
5
Please enter the column
c
|   a    b    c    d    e    f    g    h
  ________________________________________
0|    |    |    |    |    |    |    |    |
1|    |    |    |    |    |    |    |    |
2|    |    | w  | w  | w  | w  | w  |    |
3|    | b  | w  | b  | b  |    |    |    |
4|    |    | w  | w  | w  |    |    |    |
5|    | b  | w  |    |    |    |    |    |
6|    |    |    |    |    |    |    |    |
7|    |    |    |    |    |    |    |    |
  ________________________________________
black's: turn now.
Please enter the row you want to move from.
```