Konobi

Software Development Methods project

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Introduction

Our project

The goal of our project was to develop a command line version of **Konobi**, a board game for two players. The project also contains a client-server version of the game, which allows the two players to play remotely.

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What tools did we use?

- Java 15
- Gradle
- TravisCI
- Git & GitHub

Konobi

Konobi is a drawless game and it can be played either on a go board or a chess board.

Two players, black and white, take turns at placing stones of their color on the board, starting with black. The aim of the players is to build chains of connected stones of their color.

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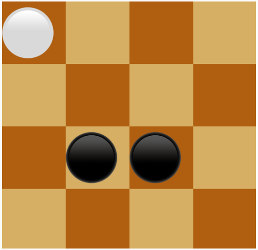
The game is won by the first player who connects the two opposite edges of the board.

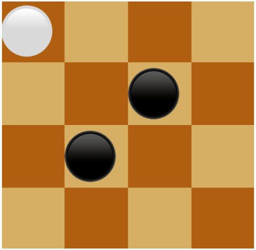
- Black: top $\leftrightarrow$ bottom
- White: left $\leftrightarrow$ right

Connections

Two like-colored stones can be:



Strongly connected



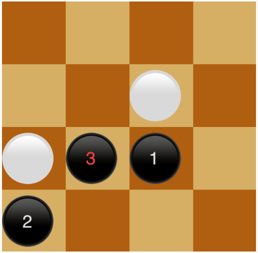
Weakly connected

A chain is a set of connected stones

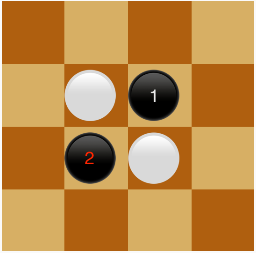
Placement rules

Not all moves are allowed:

- **Weak connections** to a certain stone are illegal unless it is impossible to make a placement that is both strongly connected to that stone and not weakly connected to another
- **Crosscut** placements are always illegal



Legal weak connection



Crosscut placement

Additional rules

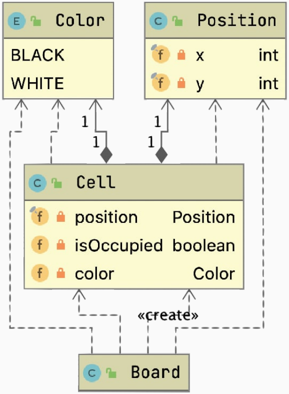
- **Pie rule**: at his first move, white can decide to switch colors with black instead of making a move.
- **Mandatory pass**: if a player cannot make a move (because of placement restrictions), he has to pass. It is guaranteed that at least one player can make a move.

Basic entities

Cell

`Cell` represents the basic building block of the board

- `Position position`
- `Color color`
- `boolean isOccupied`



Cell class

Cell

When a cell is constructed it is empty: no color is associated to it and `isOccupied=False`, when a stone is placed in the cell a color is set and `isOccupied=True`.

Development history:

- From value `NONE` in enum `Color` to field `isOccupied` in class `Cell`
- Removed `Stone` data class

Board

A `Board` is represented by a set of Cells and extends `HashSet<Cell>` by overriding the `dimension()` method

Reasons for this choice of data structure:

- Usage of streams
- `Position` as field of `Cell`

The constructor of Board creates a set of empty cells

Connections

Strong connections

- We implemented a concept of orthogonal adjacency which only depends on the relative positions of two cells: their euclidean distance must be 1
- Given the set of stones that are orthogonally adjacent to a given stone, by filtering only those with the same color we obtain the set of strongly connected neighbors

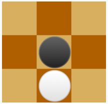
Weak connections

- Same concept applies for weak connections: two cells are diagonally adjacent if their squared euclidean distance is 2
- To obtain the set of weak neighbors, in this case it is also necessary to filter out diagonally adjacent stones with common strong neighbors

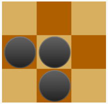
Tests

Different test cases for orthogonal and diagonal adjacency: inner cell, cell on edge, cell on corner

Example of tests for strong and weak connection:



the two stones are
not strongly connected



the two stones are
not weakly connected

Rules

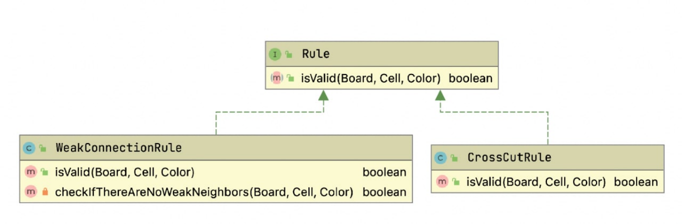
Rule

Initially, a `Rules` class was implemented to provide a way to check whether a move is valid or not and to announce whether there is a chain.

```
public class Rules {
    Board board;

    public Rules(Board board) {
        this.board = board;
    }

    private boolean isLegalWeakConnectionPlacement(Cell cell) {
        Set<Cell> weakNeighbors = board.weakConnectionsOf(cell);
        Color stoneColor = cell.getColor();
        cell.reset();
        boolean condition = weakNeighbors.stream()
                                    .map(c->c.orthogonalNeighborsIn(board.cells))
                                    .anyMatch(s->s.stream()
                                                  .filter(c->!c.isOccupied())
                                                  .anyMatch(c->checkIfThereAreNoWeakNeighbors(c, stoneColor)));
        board.placeStone(cell.getPosition(), stoneColor);
        return !condition;
    }

    private boolean checkIfThereAreNoWeakNeighbors(Cell cell, Color stoneColor){
        board.placeStone(cell.getPosition(), stoneColor);
        Set<Cell> weakConnectionsOfCell = board.weakConnectionsOf(cell);
        cell.reset();
        return weakConnectionsOfCell.isEmpty();
    }

    private boolean isCrosscutPlacement(Cell cell) {
        Set<Cell> weakNeighbors = board.weakConnectionsOf(cell);
        Color stoneColor = cell.getColor();
        return weakNeighbors.stream()
                            .map(c->c.commonOrthogonalNeighborsWith(cell, board.cells))
                            .anyMatch(s->s.stream()
                                          .allMatch(c->c.isOccupied() && c.getColor()==stoneColor.oppositeColor()));
    }
```

Rule

Later we realized that there would be the possibility to abstract...



For a given `Board`, the `isValid` method will check if it is legal to place a stone of a given `Color` in the `Cell`.

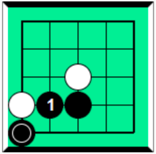
A `Rule` interface will allow the possibility to add new rules on the game.

How were implemented

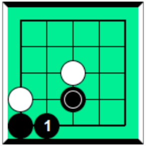
We implemented `WeakConnectionRule` and `CrossCutRule` by following TDD principles based on some examples...

Legal moves

```java
@Test
public void blackStoneMakesLegalWeakConnectionPlacement() {
    Board board = new Board( dimension: 5);
    WeakConnectionRule rule = new WeakConnectionRule();
    board.placeStone(at( x: 1, y: 1), Color.BLACK);
    board.placeStone(at( x: 1, y: 2), Color.WHITE);
    board.placeStone(at( x: 3, y: 2), Color.BLACK);
    board.placeStone(at( x: 3, y: 3), Color.WHITE);
    Cell cellToVerify = board.getCell(at( x: 2, y: 2));
    assertTrue(rule.isValid(board, cellToVerify, Color.BLACK));
}
```



Illegal moves

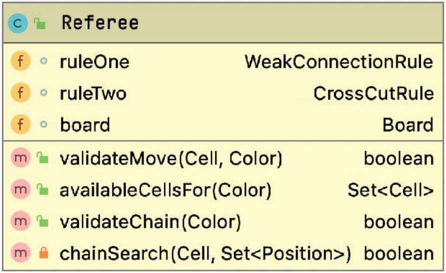



```java
@Test
public void blackStoneMakesIllegalWeakConnectionPlacement() {
    Board board = new Board( dimension: 5);
    WeakConnectionRule rule = new WeakConnectionRule();
    board.placeStone(at( x: 1, y: 1), Color.BLACK);
    board.placeStone(at( x: 1, y: 2), Color.WHITE);
    board.placeStone(at( x: 3, y: 2), Color.BLACK);
    board.placeStone(at( x: 3, y: 3), Color.WHITE);
    Cell cellToVerify = board.getCell(at( x: 2, y: 1));
    assertFalse(rule.isValid(board, cellToVerify, Color.BLACK));
}
```

Referee

Given the logic of a valid move in `Rules` package, our aim was to group together all the methods needed to check if:

- a given move is legal w.r.t. `WeakConnectionRule` and `CrossCutRule`
- a winning chain is present
- the current player has to pass



InputOutput

InputHandler and Display

Classes `InputHandler` and `Display` take care of game I/O.

- `Display`: interaction with players
- `InputHandler`: management of player inputs

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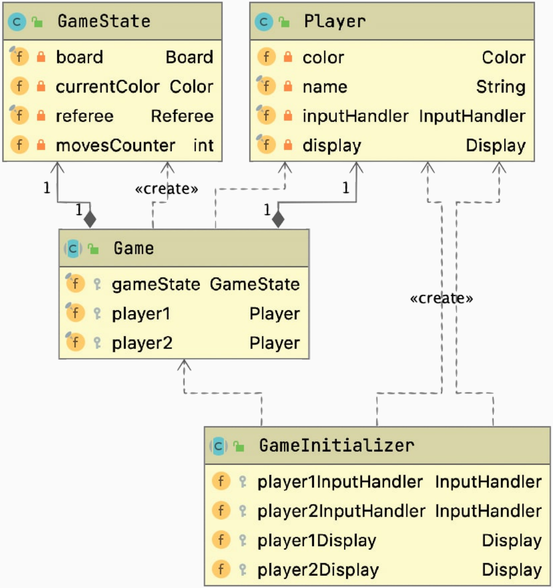
Game dynamics

Overview



GameState
board Board
currentColor Color
referee Referee
movesCounter int
Player
color Color
name String
inputHandler InputHandler
display Display
1
«create»
1
1
1
Game
gameState GameState
player1 Player
player2 Player
«create»
GameInitializer
player1InputHandler InputHandler
player2InputHandler InputHandler
player1Display Display
player2Display Display

GameState

GameState class keeps track of current state of the game.

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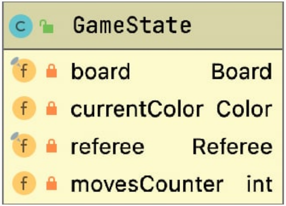

GameState acts as an intermediary between Referee and Board on one side and the higher-level class Game on the other side.

Game

Based on the directives of `GameState`, `Game` manages the interactions with players.

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public void play() {
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public void play() {
    do {
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}

public void singleTurn() {
    currentDisplay().currentPlayerTurnMessage(getCurrentPlayer());
    if(gameState.pieRuleCanBeApplied() && currentInputHandler().playerWantsToApplyPieRule(getCurrentPlayer())) {
        applyAndNotifyPieRule();
    } else {
        regularMove();
        printBoard(gameState.getBoard());
    }
    gameState.changeTurn();
}
```

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        applyAndNotifyPieRule();
    } else {
        regularMove();
        printBoard(gameState.getBoard());
    }
    gameState.changeTurn();
}
```

```java
private void regularMove() {
    if(gameState.passIsMandatory()) {
        currentDisplay().passMessage(getOtherPlayer());
    }
    else {
        Position inputPosition = chooseNextMove();
        gameState.updateBoard(inputPosition);
    }
}
```

GameInitializer

`GameInitializer` abstracts the initialization of the `Game`.

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Running the game

Versions of Konobi

INSERT UML HERE Konobi can be played by the two players on the same terminal or in a Client-Server version, with the two players connecting through `telnet` to a Server running the game.

Comparison between Console and C/S

```java
public class MainConsole {

    public static void main(String[] args){
        GameInitializerConsole gameInitializer = new GameInitializerConsole();
        Game game = gameInitializer.init();
        game.play();

    }


}
```

Console version: a `Game` is initialized and its `play` method is called.

```java
public class MainClientServer {
    public static void main(String[] args) {
        int portNumber = 4444;

        if (args.length > 1) {
            System.err.println("error: too many arguments");
            System.exit( status: 1);
        }
        if (args.length == 1) {
            portNumber = Integer.parseInt(args[0]);
        }

        try {
            GameInitializerClientServer gameInitializer = new GameInitializerClientServer(portNumber);
            Game game = gameInitializer.init();
            game.play();
        } catch (IOException e) {
            System.err.println("I/O error: not able to establish client-server connection");
            System.exit( status: 1);
        }
    }


}
```

Client-Server version: The server creates the socket and waits for two clients to connect to it. The port number can be decided using command-line arguments.

Inheritance in GameInitializer