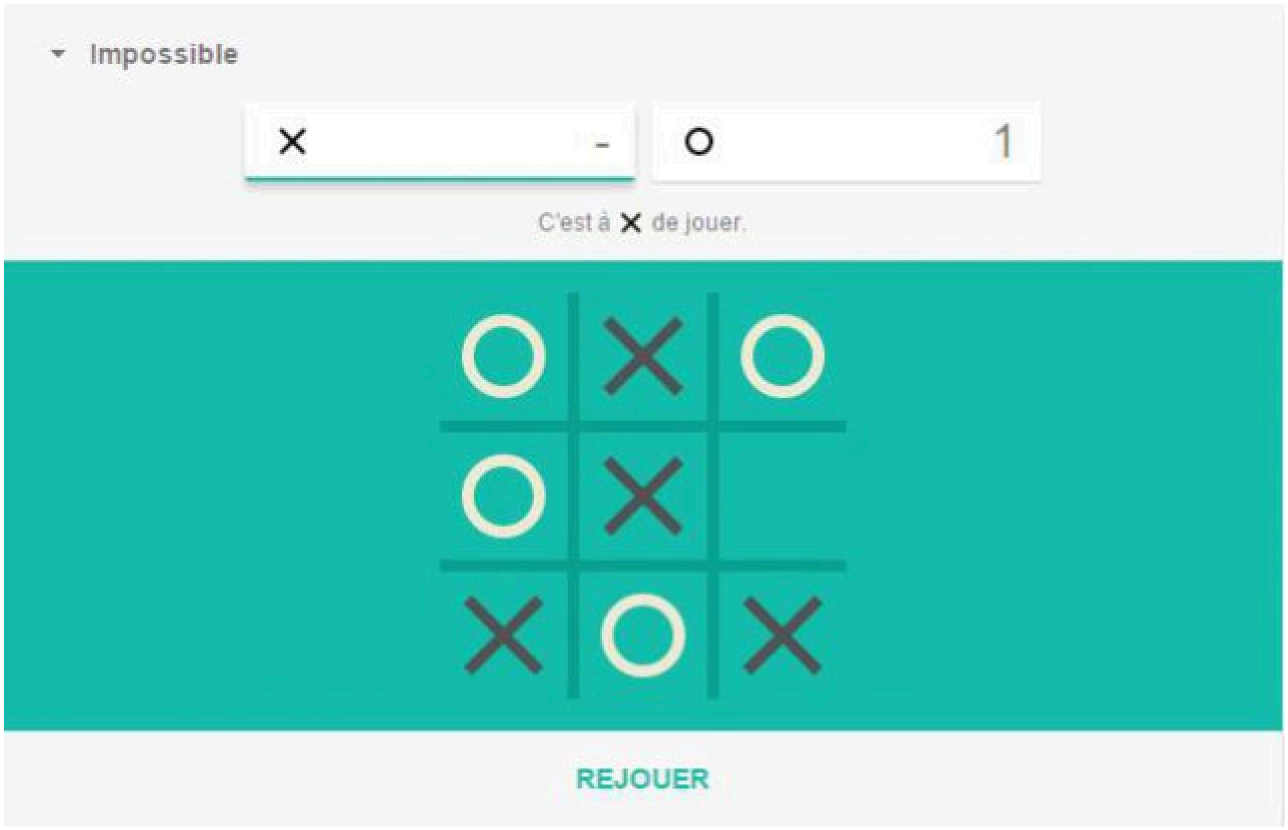
Design Tic-Tac-Toe

What is Tic-Tac-Toe?

TicTacToe is a 2 player game played on a 3 x 3 board. Each player is allotted a symbol (one X and one O). Initially, the board is empty. Alternatively, each player takes a turn and puts their symbol at any empty slot. The first player to get their symbol over a complete row OR a complete column OR a diagonal wins.

You can play the game within Google Search by just searching for “tictactoe”!



Questions to Ask

- Will the game be played amongst only 2 players or can there be any number of players in future?
- Is the board size restricted to 3x3 or can it be any NxN?
- Can there be different ways to win?
- Can one of the players be a bot?
- Feature Suggestions:

    - Do we want to time a move? Skip/ Declare the other person as winner if the move doesn’t happen within x seconds.
    - Do we want to support undo operation?
    - Can there be some players who are just watching? Not playing.
    - Do we want to store analytics? Basically previous games, who played what move etc.
    - Support for tournaments? Basically a set of matches, each match between 2 players of the tournament.

Expectations

- The code should be working and functionally correct
- Good software design practices should be followed:
- Code should be modular, readable, extensible
- Separation of concern should be addressed
- Project structured well across multiple files/ packages
- Write unit tests
- No need of GUI

Problem Requirements

- Board can be of any NxN size.
- There can be two players.
- Each player will be allotted a symbol.
- The symbol can be one of O and X.
- The players can be either humans or bots.
- Each human player will have a name, email and profile image.
- Each bot player will have a difficulty level.
- Any random player can start the game.
- Then the players will take turns alternatively.
- The player with any consecutive N symbols in a row, column or diagonal wins.
- If the board is full and no player has won, the game is a draw.

Entities and their attributes

- Game
    - Board
    - Players

- Board
  - Cells
- Cell
  - Row
  - Column
  - Symbol
- Human Player
  - Name
  - Email
  - Profile Image
- Bot Player
  - Difficulty Level

Design

Use Case Diagram

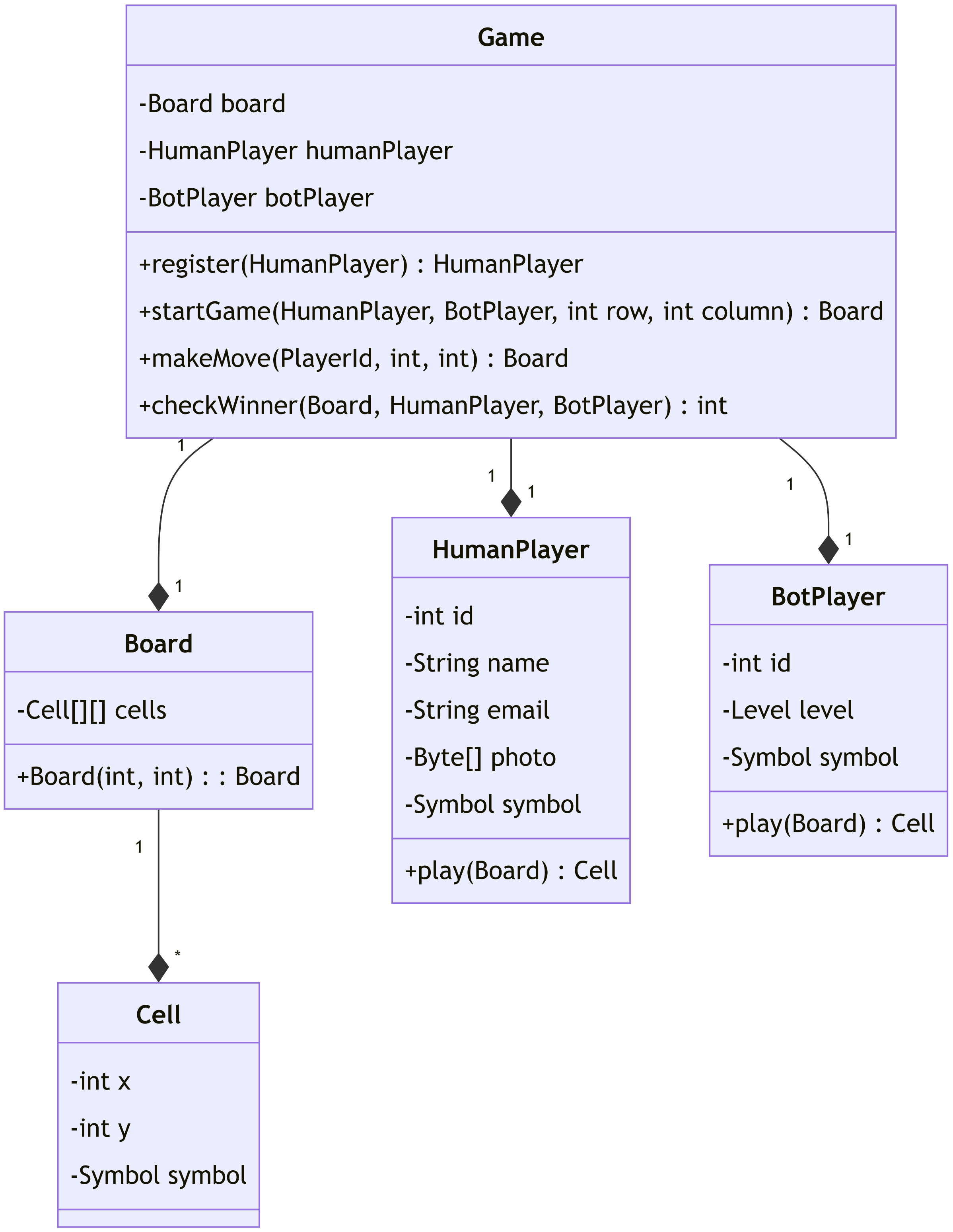
```
Error: plantuml.jar file not found: ""

Please download plantuml.jar from https://plantuml.com/download.


If you are using VSCode or coc.nvim, then please set the setting "markdown

If you don't want to use plantuml.jar, then you can use the online plantum
by setting the setting "markdown-preview-enhanced.plantumlServer" to the U
```

Initial Design

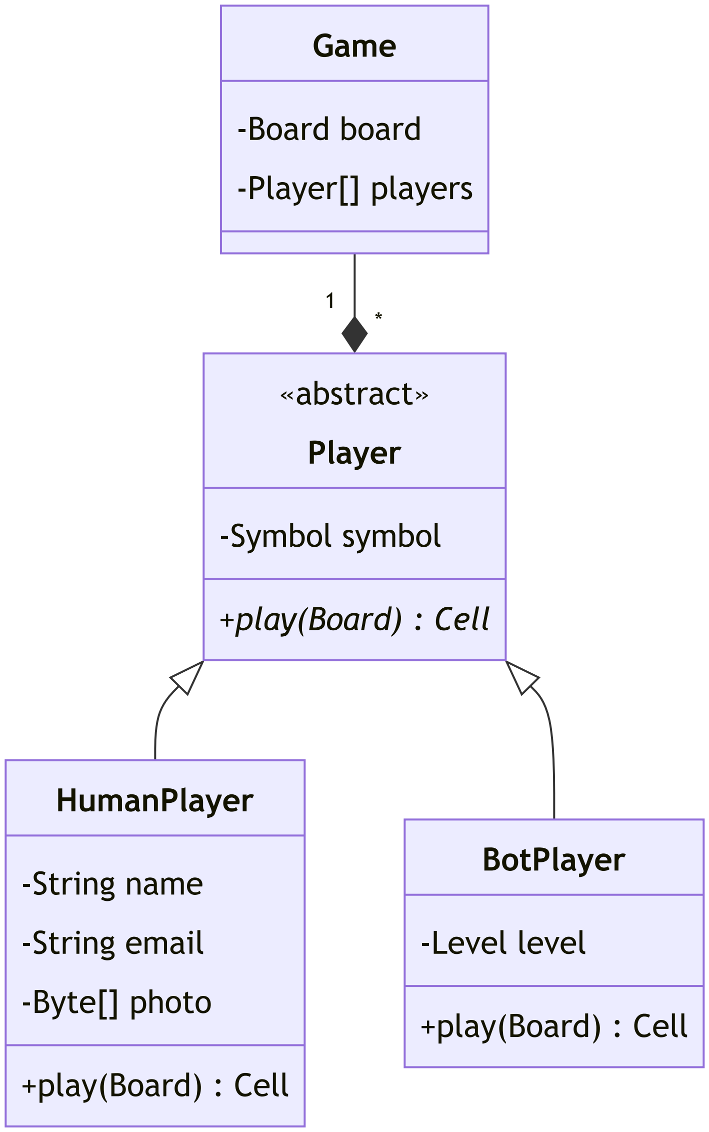


- There is no common contract for players. Parent class to represent all different types of players.
- There is tight coupling between Game and different types of players. It is not extensible to support multiple players
- OCP and SRP violation in play method.

- Huge memory consumption - multiple instances of the player will be created for multiple games. Each instance has a new photo.

Common contract - Player abstract class

- Common behaviour - `play`
- Common attributes - `Symbol`



- ~~There is no common contract for players. Parent class to represent all different types of players.~~
- ~~There is tight coupling between Game and different types of players. It is not extensible to support multiple players~~
- OCP and SRP violation in play method.
- Huge memory consumption - multiple instances of the player will be created for multiple games. Each instance has a new photo.

Tight coupling

-HumanPlayer

-BotPlayer

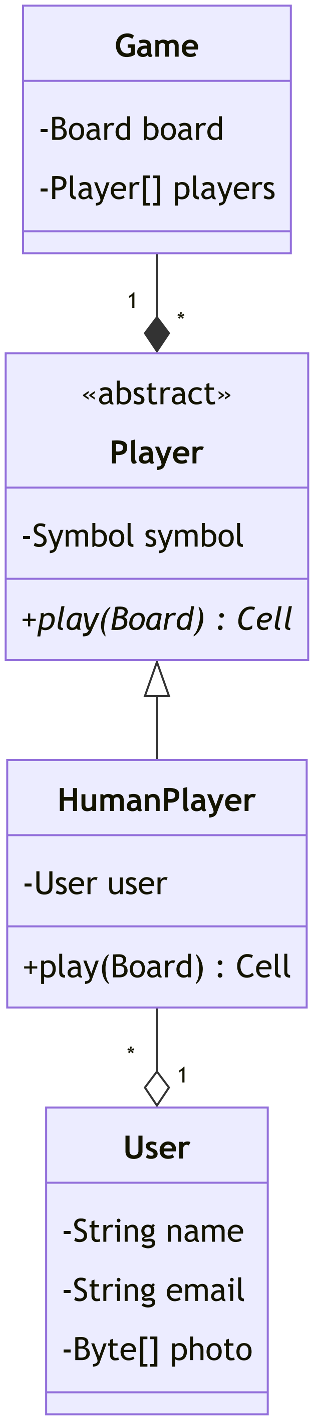
-Player[] players

```
mermaid
```

OCP and SRP violation in play method - Strategy

Huge memory consumption - Flyweight

- Paul Morphy
- Instance 1 -
  - name - Paul Morphy
  - email - paul@blind.in
  - photo - 5MB
  - symbol - O
- Instance 2 -
  - name - Paul Morphy
  - email - paul@blind.in
  - photo - 5MB
  - symbol - X
- Store fields that do not change in a class - Intrinsic state
- Store field that change in a class - Extrinsic state



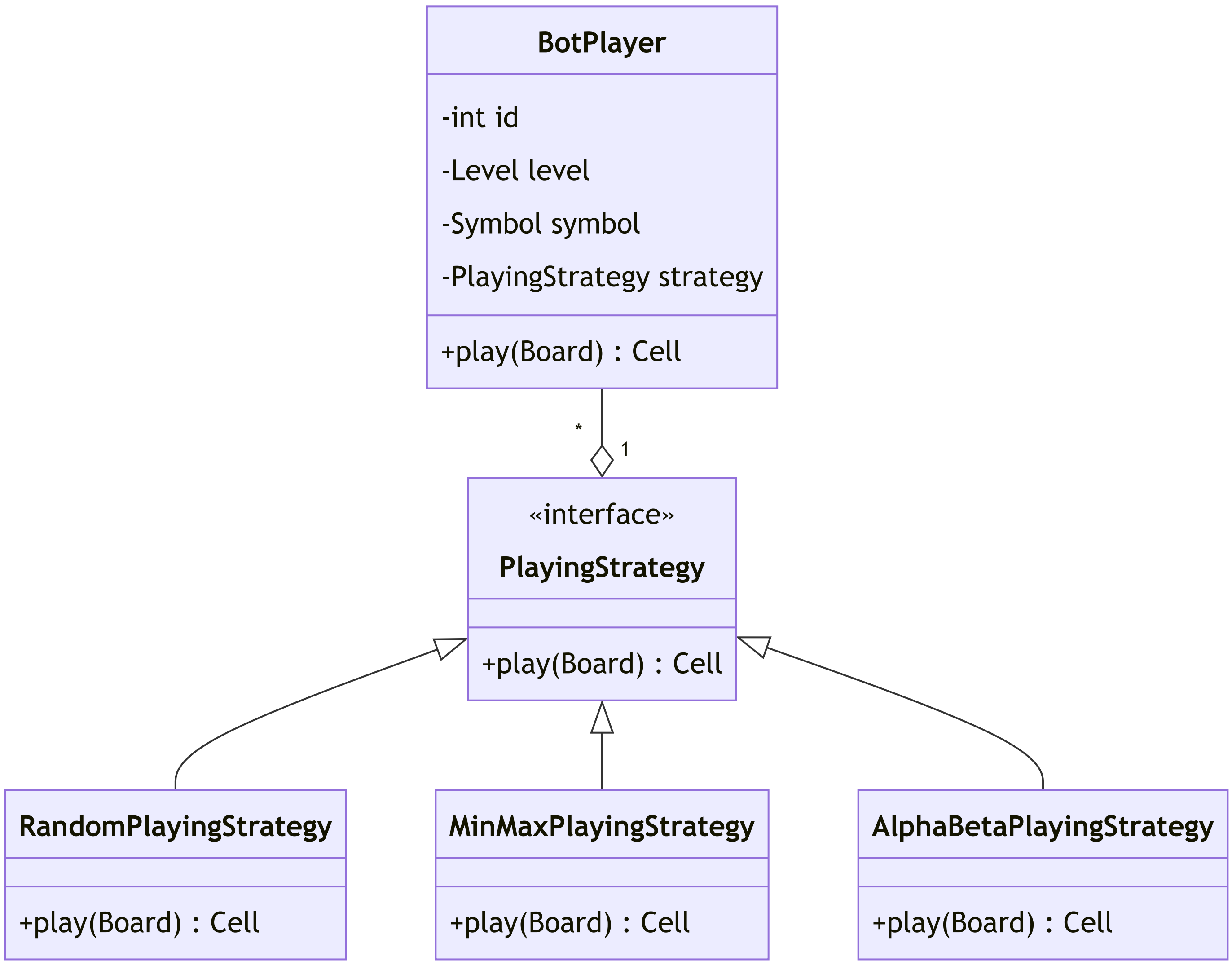
- Problems so far
- OCP and SRP violation in play method.

Implement different levels in a bot

```
class BotPlayer {

  private Level level;

  private Cell play(Board board) {
    switch (level) {
      case EASY:
        // Really easy move
      case MEDIUM:
        // Medium level moves
    }
  }
}
```



- Inject different behaviours

- Such that they can be reused
    - Strategy Design pattern
- There is no common contract for players. Parent class to represent all different types of players. - Abstract classes
- There is tight coupling between Game and different types of players. It is not extensible to support multiple players - `List<Player>`
- OCP and SRP violation in play method.
    - Strategy pattern
- Huge memory consumption - multiple instances of the player will be created for multiple games. Each instance has a new photo. - Flyweight