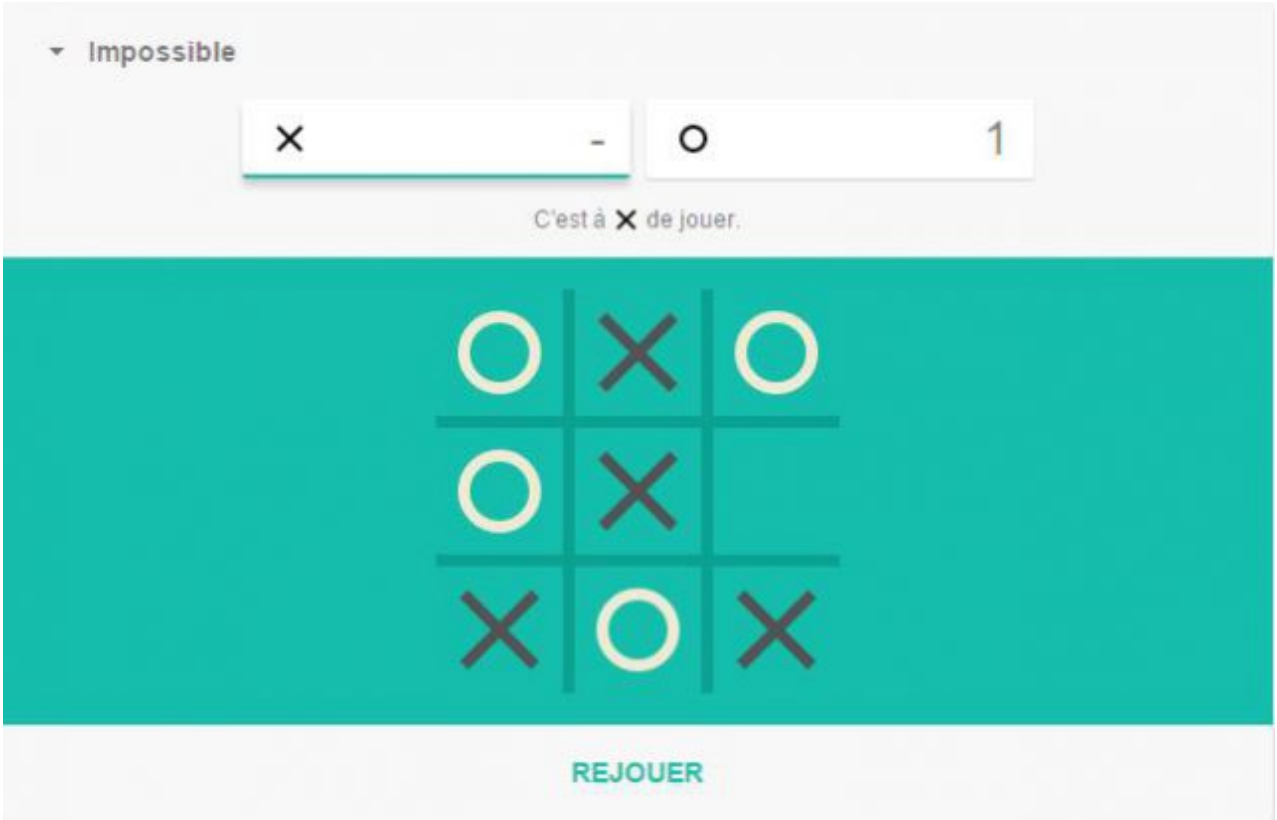
Design Tic-Tac-Toe

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.

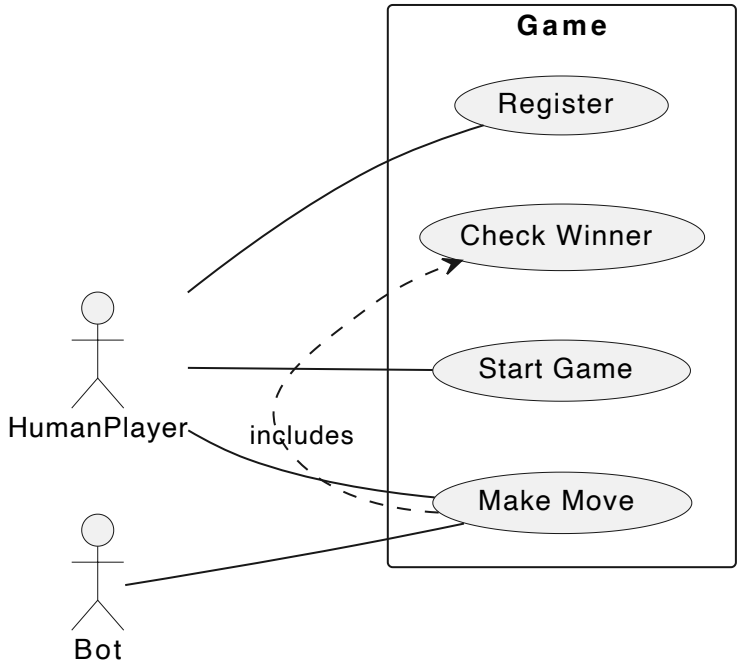
Entities and their attributes

- Game
    - Board
    - Players
- Board
    - Cells
- Cell
    - Row

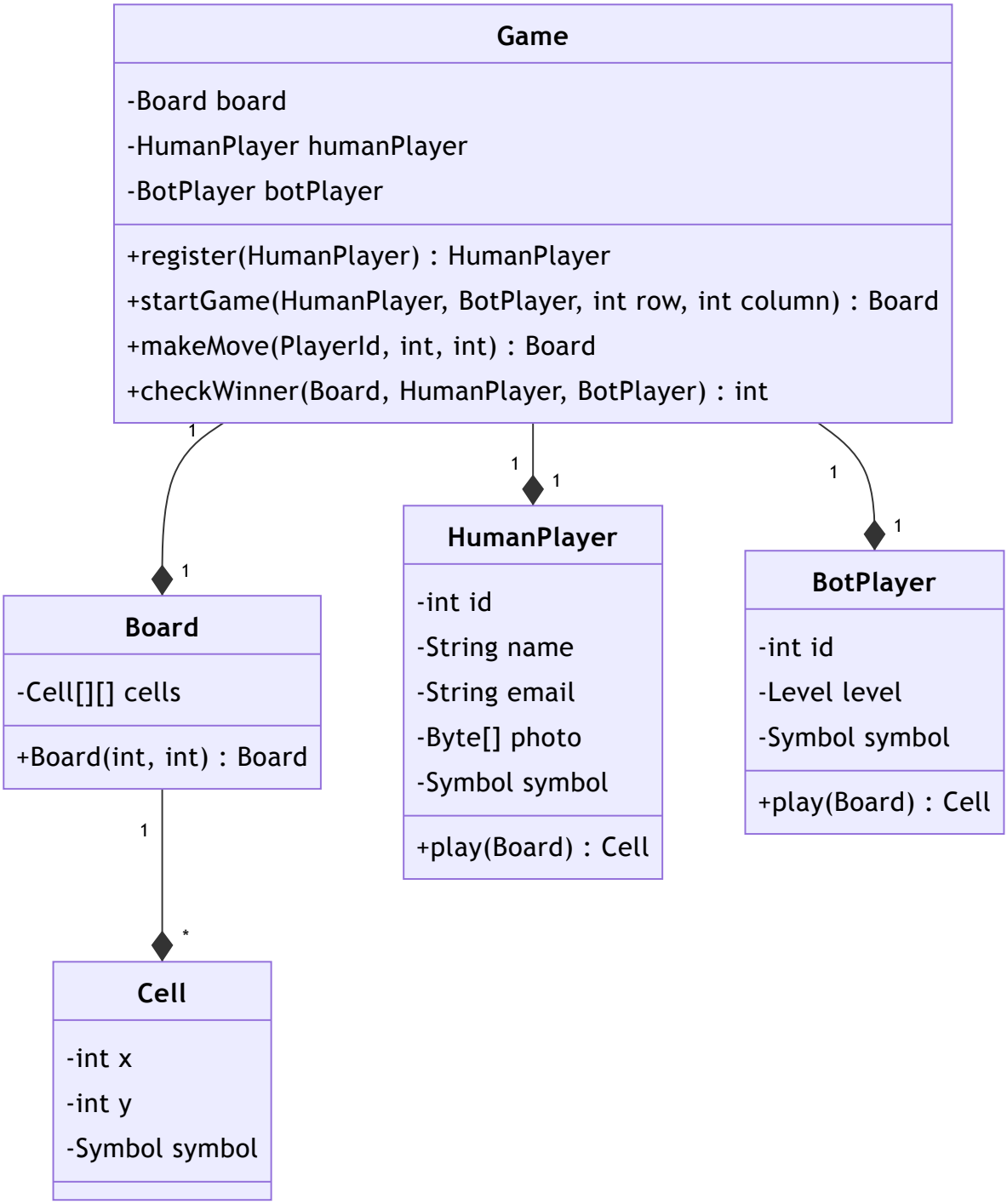
    - Column
    - Symbol
- Human Player
    - Name
    - Email
    - Profile Image
- Bot Player
    - Difficulty Level

Design

Use Case Diagram



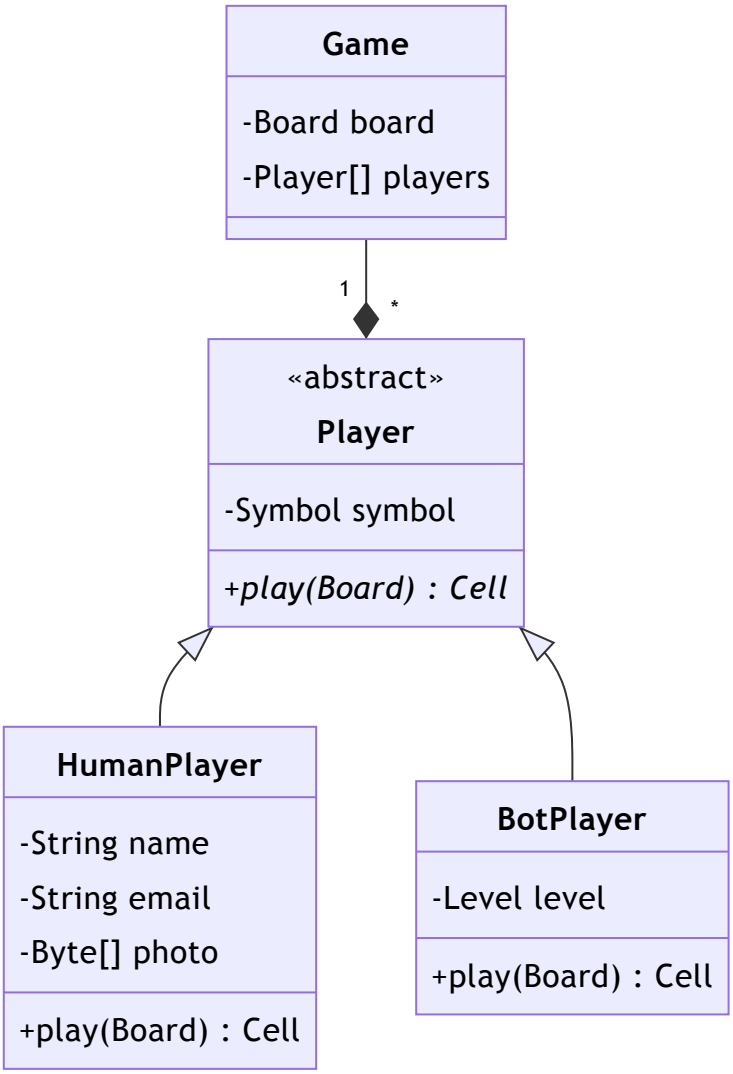
Initial Design



- 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.~~
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Tight coupling

-HumanPlayer
-BotPlayer
-Player[] players
```
mermaid
```

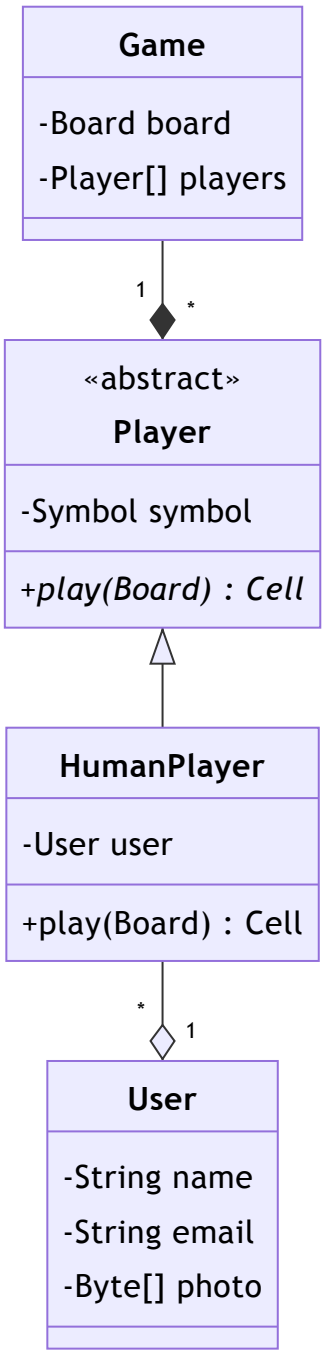
OCP and SRP violation in play method - Strategy

Huge memory consumption - Flyweight

- Paul Morphy

- Instance 1 -
    - name - Paul Morphy
    - email - paul@blind.in (mailto:paul@blind.in)
    - photo - 5MB
    - symbol - O
- Instance 2 -
    - name - Paul Morphy
    - email - paul@blind.in (mailto: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



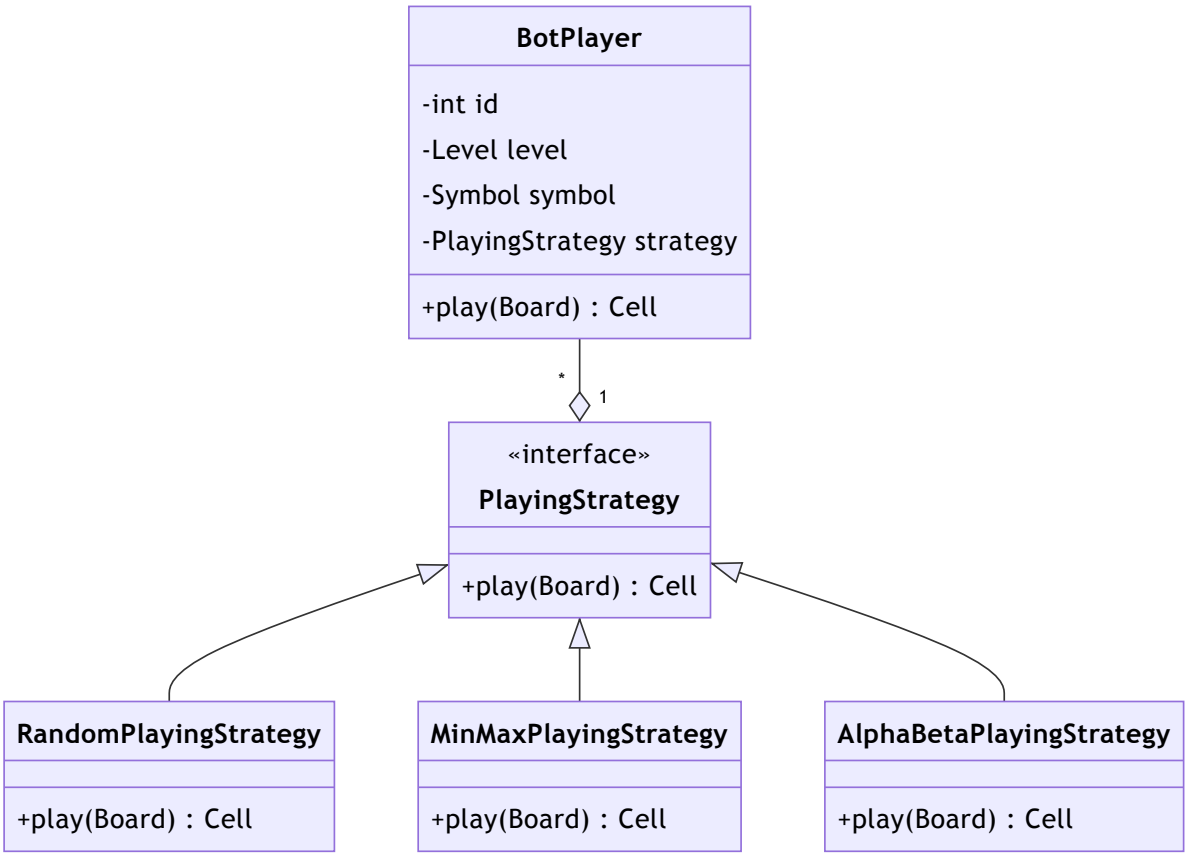
- Problems so far
- OCP and SRP violation in play method.

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