Replica Board Game Implementation

FEUP - Functional and Logic Programming (PFL) 2024/2025

Group Information

Name	Student Number	Contribution %	Tasks Performed
Gonçalo Guedes da Conceição	up202206456	50%	Get piece based on move, Choose move, Valid moves, Move validation, White Player 1 move validation, Game Over, PC level 1 and level 2 implementation, Value
Gonçalo de Abreu Matias	up202108703	50%	Menu Implementation, Board Implementation, Display game, Choose move, Move validation, Black Player 2 move validation, King pieces capture, Game Over, Transform Friend piece into king, README, Intermediate and near-final game states for demo

Installation and Execution

Windows

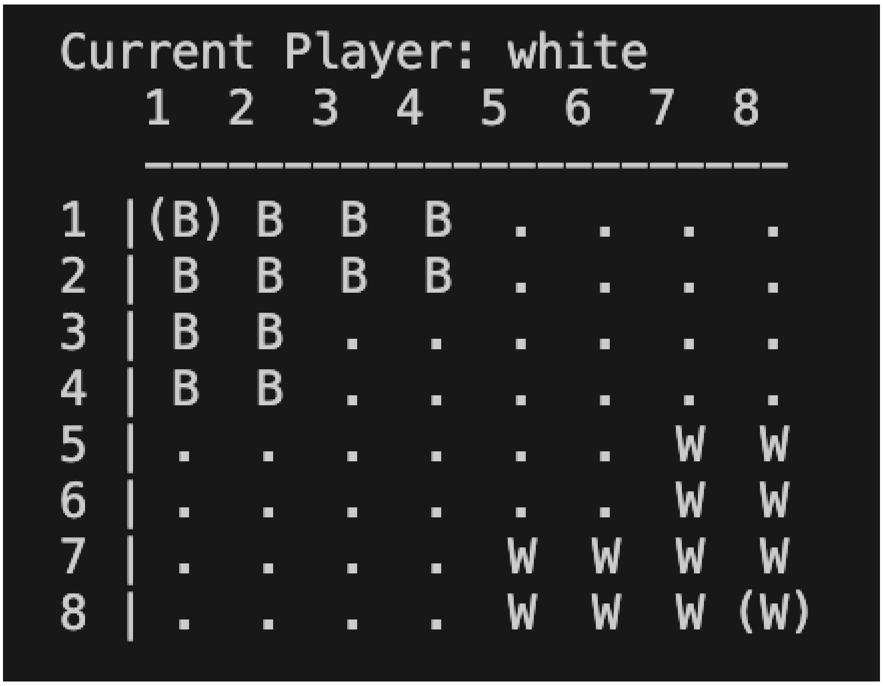
1. Install SICStus Prolog 4.9 following the official installation guide
2. Navigate to the game directory
3. Launch SICStus Prolog
4. Consult the main game file: `consult('game.pl').`
5. Start the game by typing: `play.`

Linux

1. Install SICStus Prolog 4.9 using your distribution's package manager
2. Follow the same steps 2-5 as Windows

Game Description

Replica is a strategic two-player board game played on an 8x8 chessboard. The game combines elements of checkers with unique movement and transformation mechanics.



```
Current Player: white
   1  2  3  4  5  6  7  8
   ----------------------
1 |(B) B  B  B  .  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  .  .  .  .  .
5 | .  .  .  .  .  .  W  W
6 | .  .  .  .  .  .  W  W
7 | .  .  .  .  W  W  W  W
8 | .  .  .  .  W  W  W (W)
```

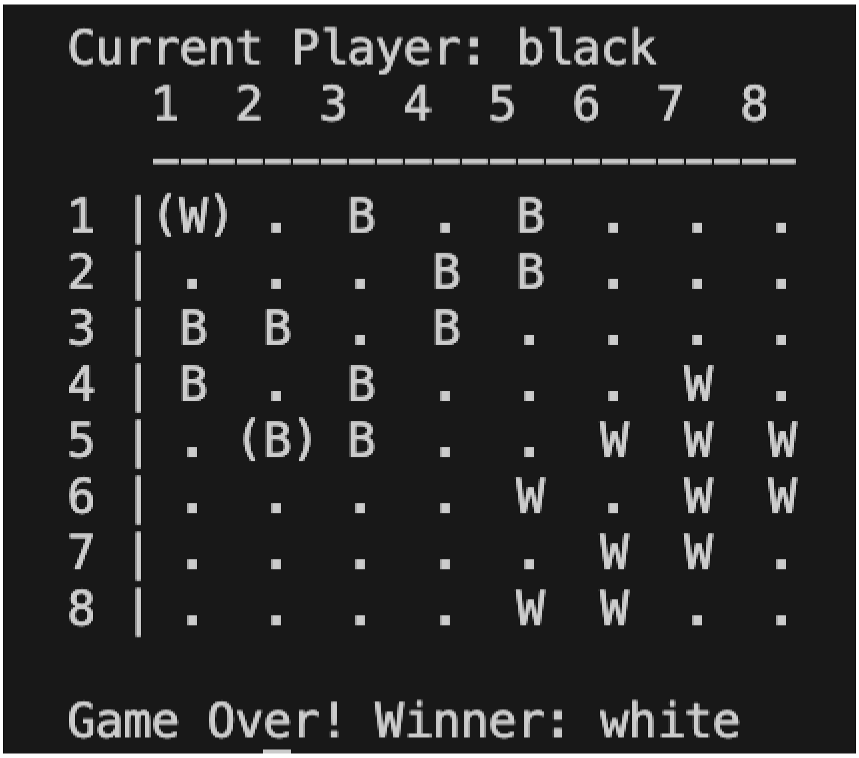
Figure 1: Initial Game Board

Basic Rules

- Players start with 12 pieces each (11 regular pieces and 1 king)
- Pieces move in three ways:
  1. Step: One square forward
  2. Jump: Multiple squares over friendly pieces
  3. Transform: Convert regular piece to king

Victory Conditions

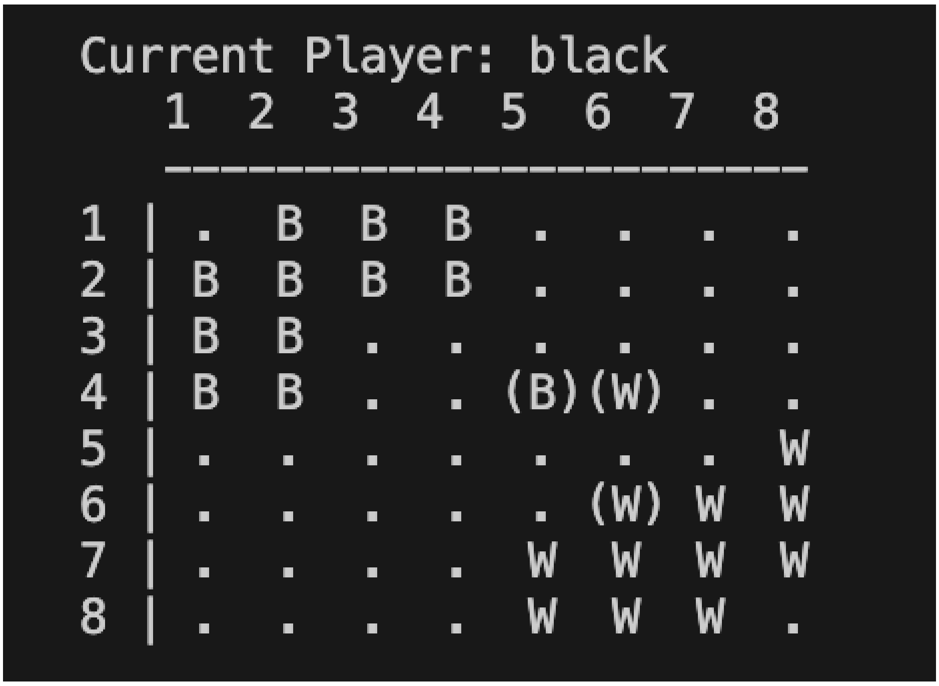
- Moving a king to the opponent's corner



```
Current Player: black
   1  2  3  4  5  6  7  8
   ----------------------
1 |(W) .  B  .  B  .  .  .
2 | .  .  .  B  B  .  .  .
3 | B  B  .  B  .  .  .  .
4 | B  .  B  .  .  .  W  .
5 | . (B) B  .  .  W  W  W
6 | .  .  .  .  W  .  W  W
7 | .  .  .  .  .  W  W  .
8 | .  .  .  .  W  W  .  .

Game Over! Winner: white
```

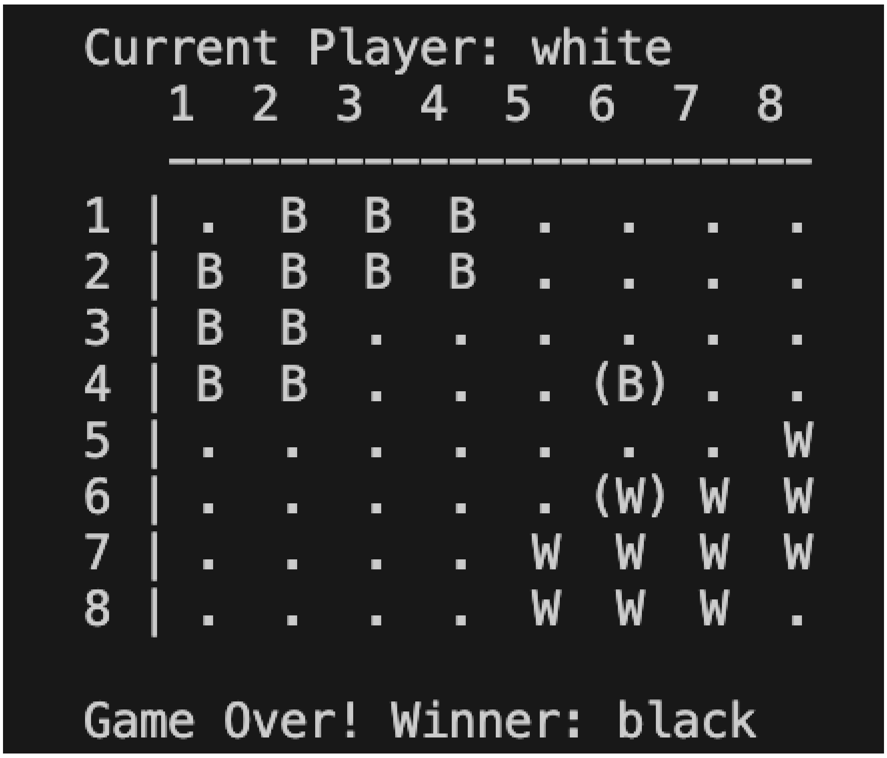
Figure 2: First victory condition

- Capturing the opponent's king (any)



```
Current Player: black
   1  2  3  4  5  6  7  8
   ------------------------
1 | .  B  B  B  .  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  . (B)(W) .  .
5 | .  .  .  .  .  .  .  W
6 | .  .  .  .  . (W) W  W
7 | .  .  .  .  W  W  W  W
8 | .  .  .  .  W  W  W  .
```

Figure 3: Second victory condition



```
Current Player: white
   1  2  3  4  5  6  7  8
   ------------------------
1 | .  B  B  B  .  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  .  . (B) .  .
5 | .  .  .  .  .  .  .  W
6 | .  .  .  .  . (W) W  W
7 | .  .  .  .  W  W  W  W
8 | .  .  .  .  W  W  W  .

Game Over! Winner: black
```

Figure 4: Victory

Information Sources

- Replica on Board Game Geek
- Official documentation from designer

Game Extension Considerations

1. **Variable Board Sizes**
   - Current implementation uses 8x8 board
   - Code structured to allow future board size modifications
   - Movement calculations independent of board size

2. **Optional Rules**
    - Framework in place for additional king powers
    - Simplified ruleset for beginners possible
    - Advanced rules for experts can be added

Game Logic

Game Configuration Representation

The game configuration is represented using the following structure:

```
state(Board, Player, GameConfig)
```

- Board: 8x8 matrix representing the game board
- Player: current player (white/black)
- GameConfig: game mode and AI configuration

Internal Game State Representation

Pieces are represented as:

- `empty`: Empty square
- `w`: White piece
- `b`: Black piece
- `wk`: White king
- `bk`: Black king

Example Game States

Here are examples of different game states showing how the board is represented internally:

1. Initial State

```
[
    [bk,b,b,b,empty,empty,empty,empty],
    [b,b,b,b,empty,empty,empty,empty],
    [b,b,empty,empty,empty,empty,empty,empty],
    [empty,empty,empty,empty,empty,empty,empty,empty],
    [empty,empty,empty,empty,empty,w,w,w],
    [empty,empty,empty,empty,w,w,w,w],
    [empty,empty,empty,empty,w,w,w,wk]
]
```

2. Intermediate State (After Several Moves)

```
[
    [bk,b,empty,b,empty,empty,empty,empty],
    [b,empty,b,b,empty,empty,empty,empty],
    [b,b,empty,empty,empty,w,empty,empty],
    [empty,empty,empty,empty,empty,empty,empty,empty],
    [empty,empty,empty,empty,empty,w,w,empty],
    [empty,empty,empty,empty,w,w,empty,w],
    [empty,empty,empty,empty,w,empty,w,wk]
]
```

3. Final State (White Wins by King Capture)

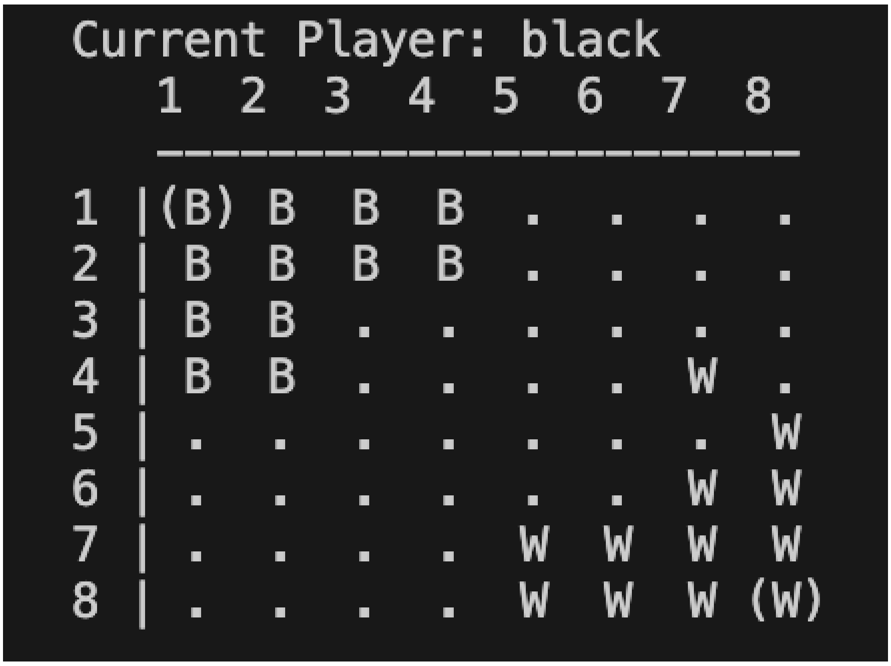
```
[
    [empty,b,empty,b,empty,empty,empty,empty],
    [b,empty,b,b,empty,empty,empty,empty],
    [b,b,empty,empty,empty,w,empty,empty],
    [empty,empty,empty,empty,empty,empty,empty,empty],
    [empty,empty,empty,empty,empty,w,w,empty],
    [empty,empty,empty,empty,w,w,empty,w],
    [empty,empty,empty,empty,w,empty,w,wk]
]
```

Move Representation

Moves are represented as:

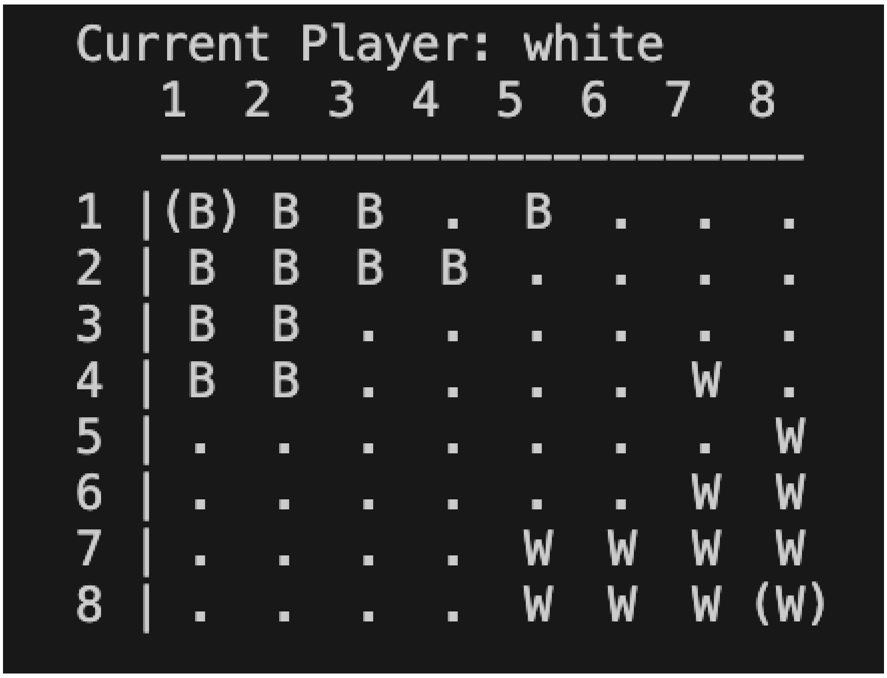
```
(PieceRow, PieceColumn, Direction)
```

- PieceRow, PieceColumn: Coordinates (1-8)
- Direction: 'H' (Horizontal), 'V' (Vertical), 'D' (Diagonal), 'T' (Transform)
- To use Transform a king has to be selected before, and then it will be asked for the coordinates of the piece to transform



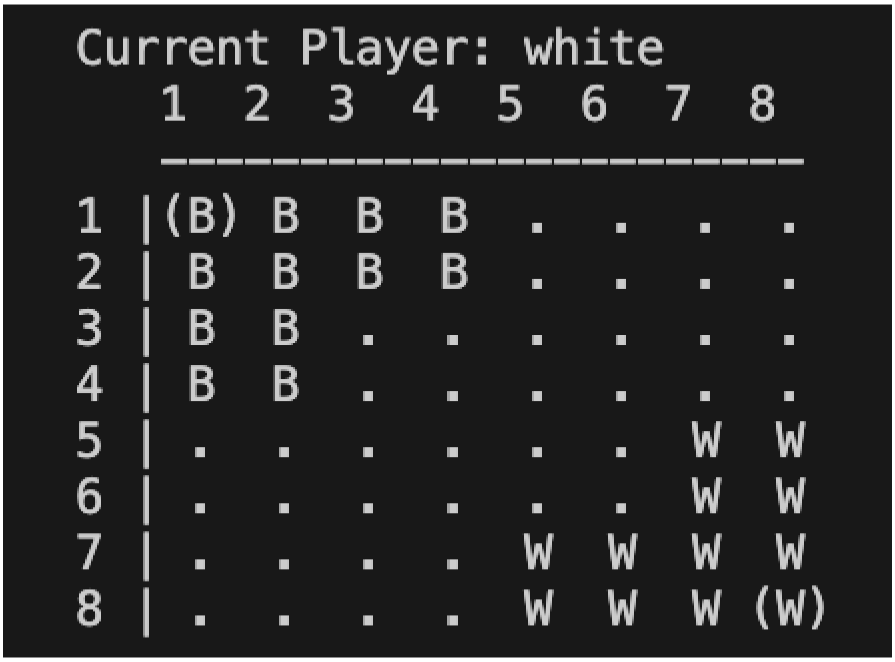
```
Current Player: black
    1  2  3  4  5  6  7  8
    ------------------------
1 |(B) B  B  B  .  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  .  .  .  W  .
5 | .  .  .  .  .  .  .  W
6 | .  .  .  .  .  .  W  W
7 | .  .  .  .  W  W  W  W
8 | .  .  .  .  W  W  W (W)
```

Figure 5: Game Horizontal Feature



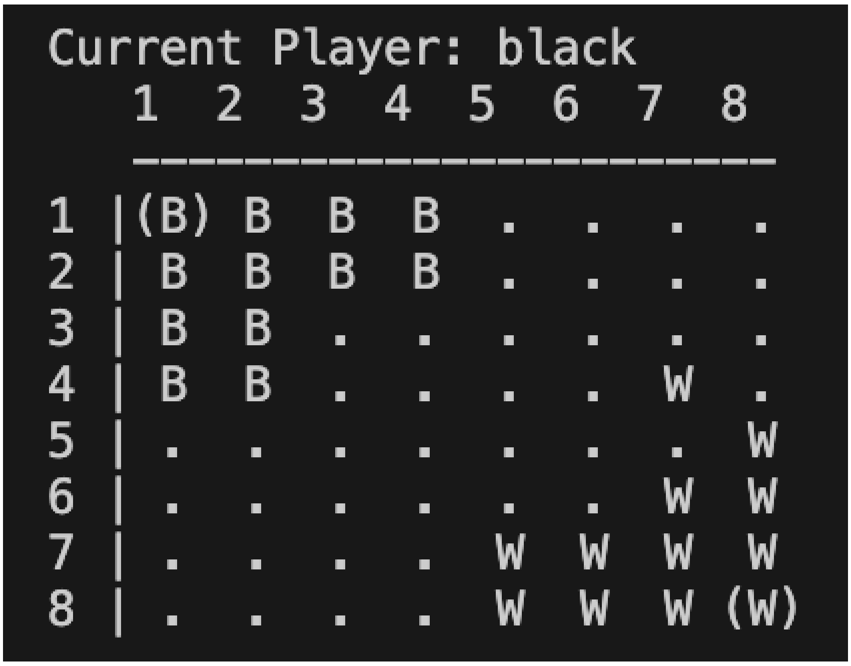
```
Current Player: white
    1  2  3  4  5  6  7  8
    ------------------------
1 |(B) B  B  .  B  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  .  .  .  W  .
5 | .  .  .  .  .  .  .  W
6 | .  .  .  .  .  .  W  W
7 | .  .  .  .  W  W  W  W
8 | .  .  .  .  W  W  W (W)
```

Figure 6: Game Horizontal Feature



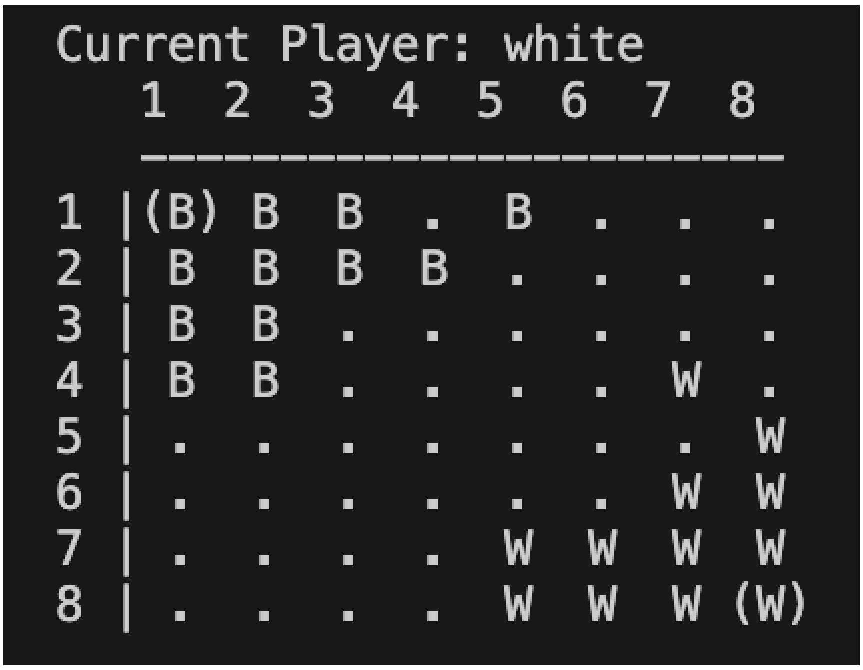
```
Current Player: white
   1  2  3  4  5  6  7  8
   ----------------------
1 |(B) B  B  B  .  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  .  .  .  .  .
5 | .  .  .  .  .  .  W  W
6 | .  .  .  .  .  .  W  W
7 | .  .  .  .  W  W  W  W
8 | .  .  .  .  W  W  W (W)
```

Figure 5: Game Vertical Feature



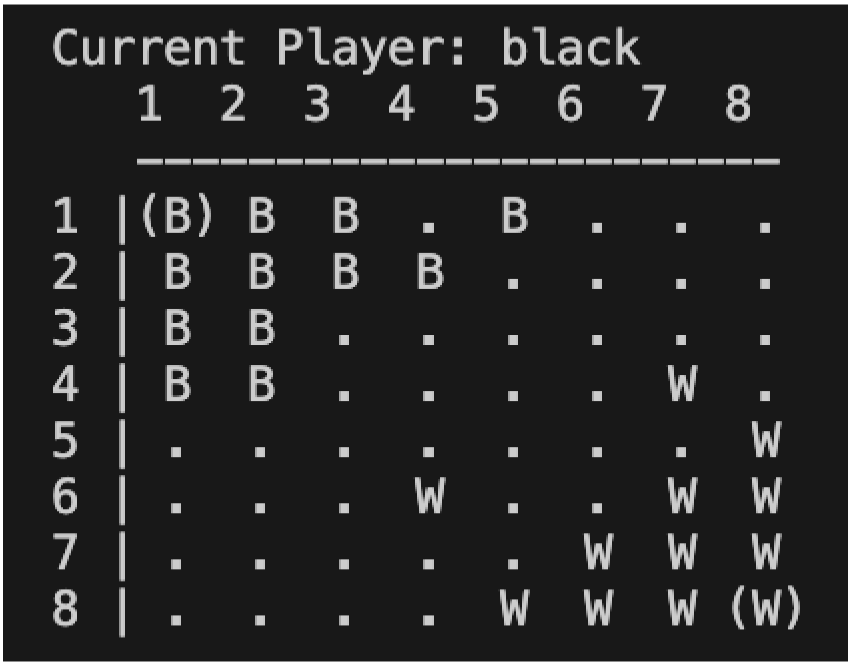
```
Current Player: black
   1  2  3  4  5  6  7  8
   ----------------------
1 |(B) B  B  B  .  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  .  .  .  W  .
5 | .  .  .  .  .  .  .  W
6 | .  .  .  .  .  .  W  W
7 | .  .  .  .  W  W  W  W
8 | .  .  .  .  W  W  W (W)
```

Figure 6: Game Vertical Feature



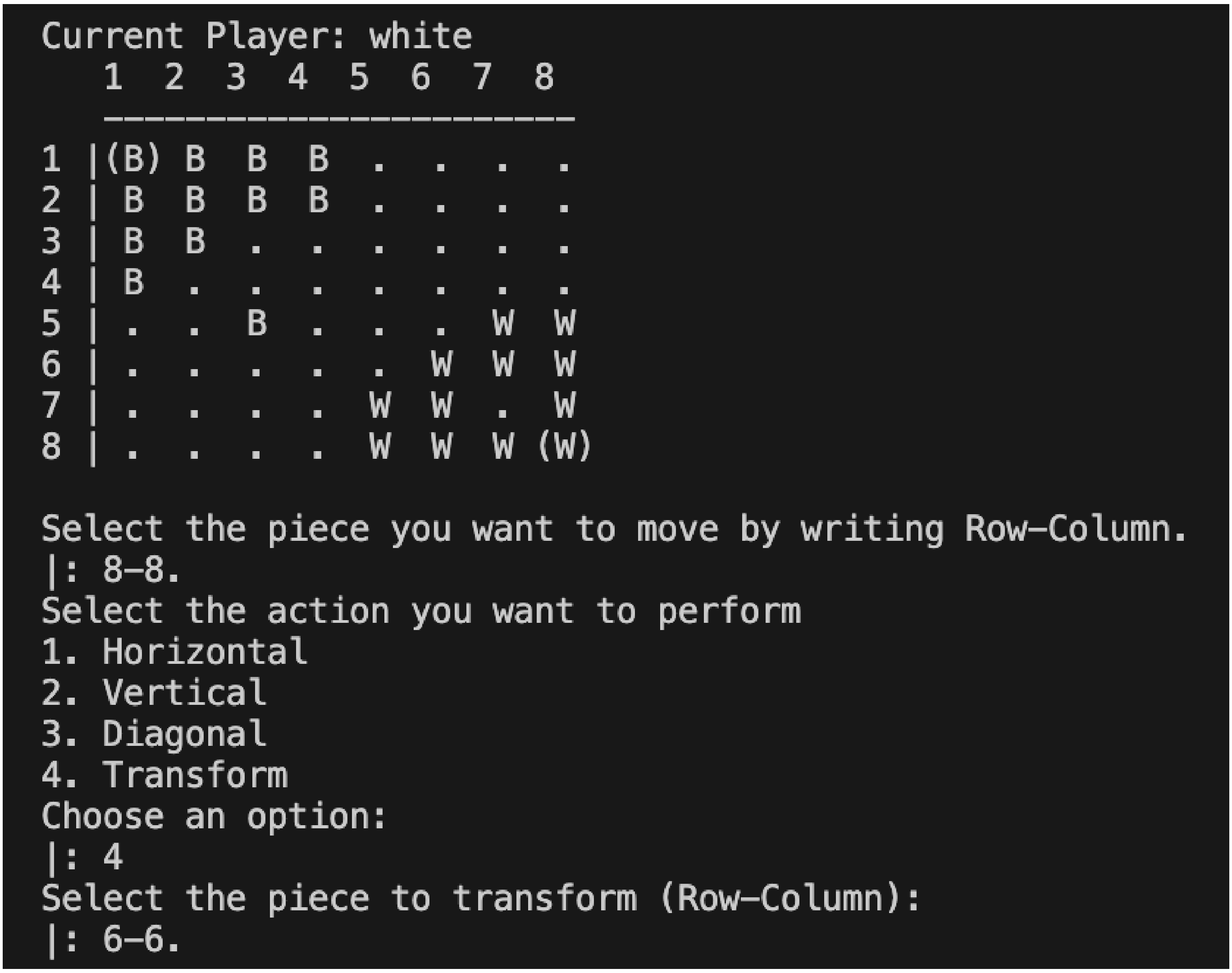
```
Current Player: white
    1  2  3  4  5  6  7  8
    ----------------------
1 |(B) B  B  .  B  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  .  .  .  W  .
5 | .  .  .  .  .  .  .  W
6 | .  .  .  .  .  .  W  W
7 | .  .  .  .  W  W  W  W
8 | .  .  .  .  W  W  W (W)
```

Figure 7: Game Diagonal Feature



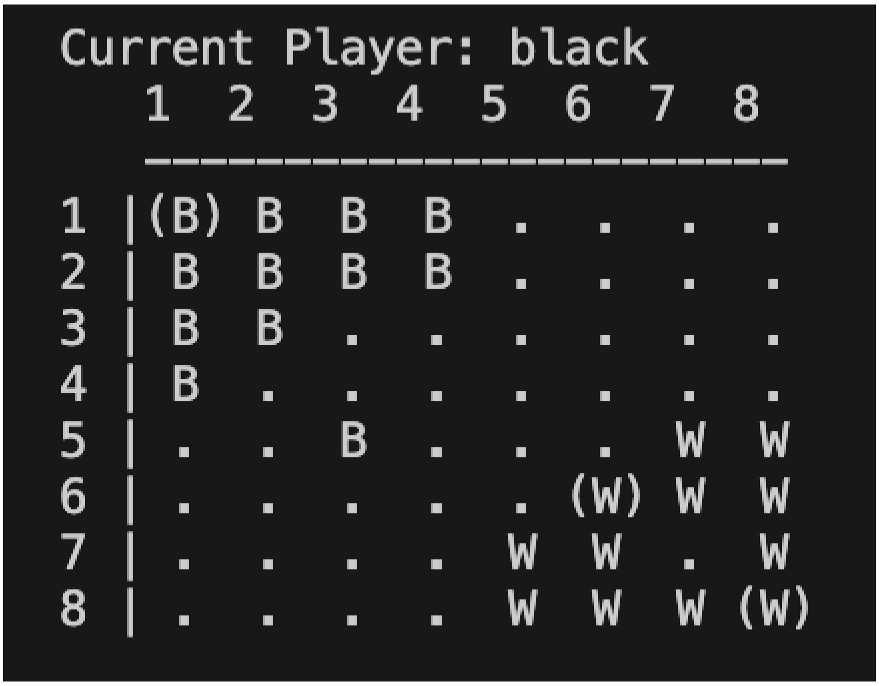
```
Current Player: black
    1  2  3  4  5  6  7  8
    ----------------------
1 |(B) B  B  .  B  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  B  .  .  .  .  W  .
5 | .  .  .  .  .  .  .  W
6 | .  .  .  W  .  .  W  W
7 | .  .  .  .  .  W  W  W
8 | .  .  .  .  W  W  W (W)
```

Figure 8: Game Diagonal Feature



```
Current Player: white
   1  2  3  4  5  6  7  8
   -----------------------
1 |(B) B  B  B  .  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  .  .  .  .  .  .  .
5 | .  .  B  .  .  .  W  W
6 | .  .  .  .  .  W  W  W
7 | .  .  .  .  W  W  .  W
8 | .  .  .  .  W  W  W (W)

Select the piece you want to move by writing Row-Column.
|: 8-8.
Select the action you want to perform
1. Horizontal
2. Vertical
3. Diagonal
4. Transform
Choose an option:
|: 4
Select the piece to transform (Row-Column):
|: 6-6.
```

Figure 9: Game Transform Feature



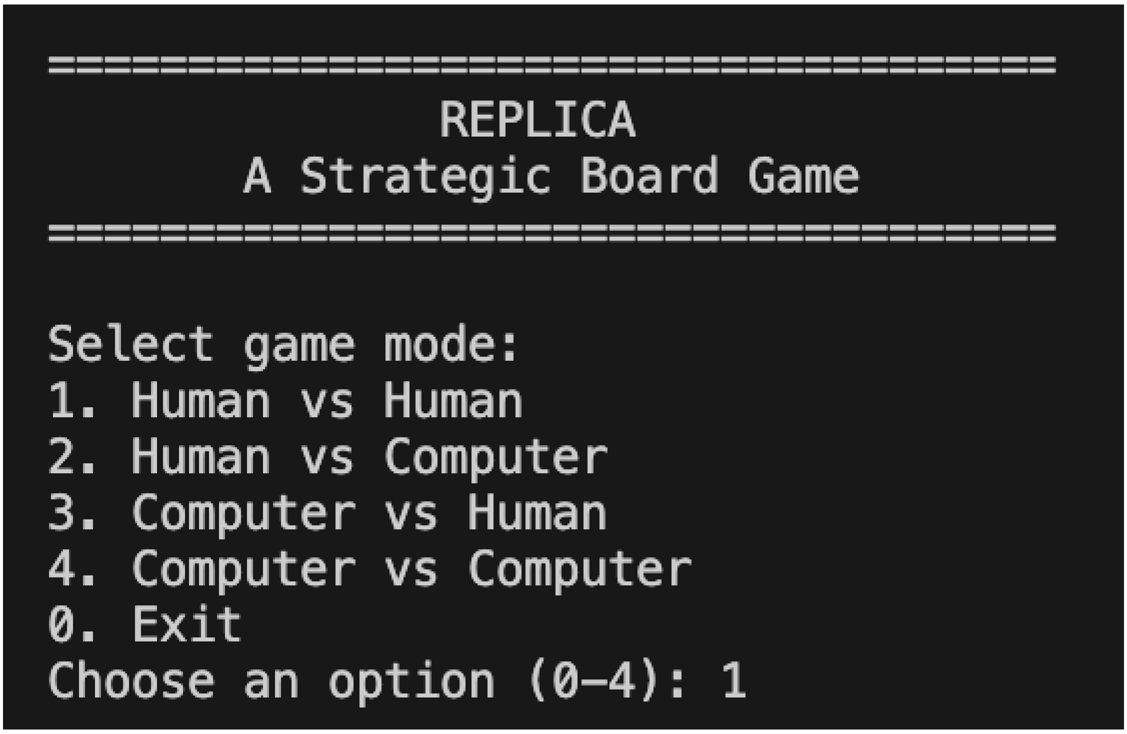
```
Current Player: black
   1  2  3  4  5  6  7  8
   -----------------------
1 |(B) B  B  B  .  .  .  .
2 | B  B  B  B  .  .  .  .
3 | B  B  .  .  .  .  .  .
4 | B  .  .  .  .  .  .  .
5 | .  .  B  .  .  .  W  W
6 | .  .  .  .  . (W) W  W
7 | .  .  .  .  W  W  .  W
8 | .  .  .  .  W  W  W (W)
```

Figure 10: Game Transform Feature

User Interaction

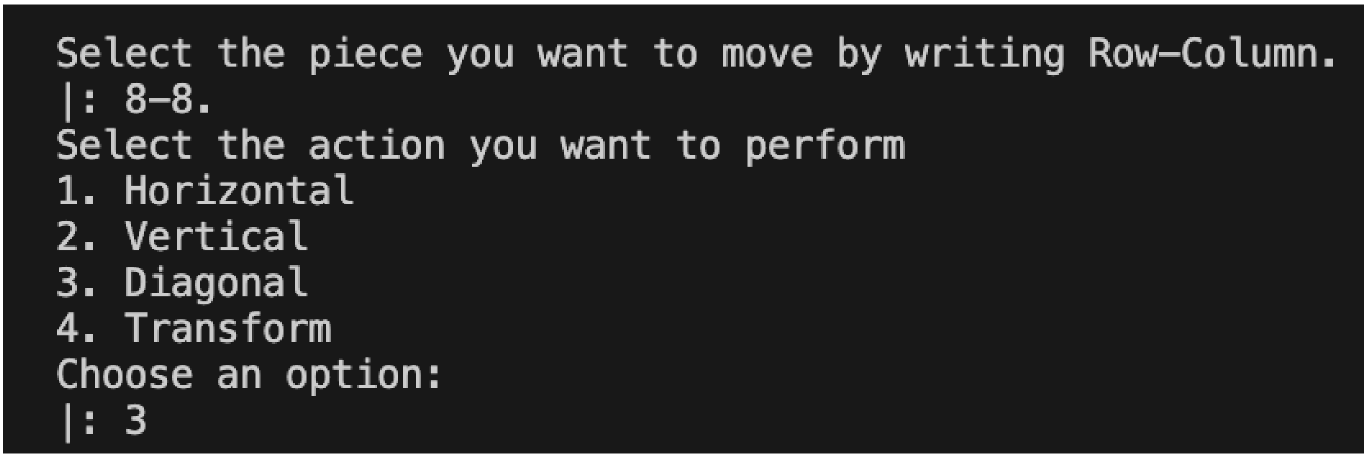
- Menu-driven interface with clear options
- Input validation for:

  - Menu selections (1-4)
  - Move coordinates (1-8)
  - Movement direction
- Error messages for invalid inputs
- Board visualization after each move



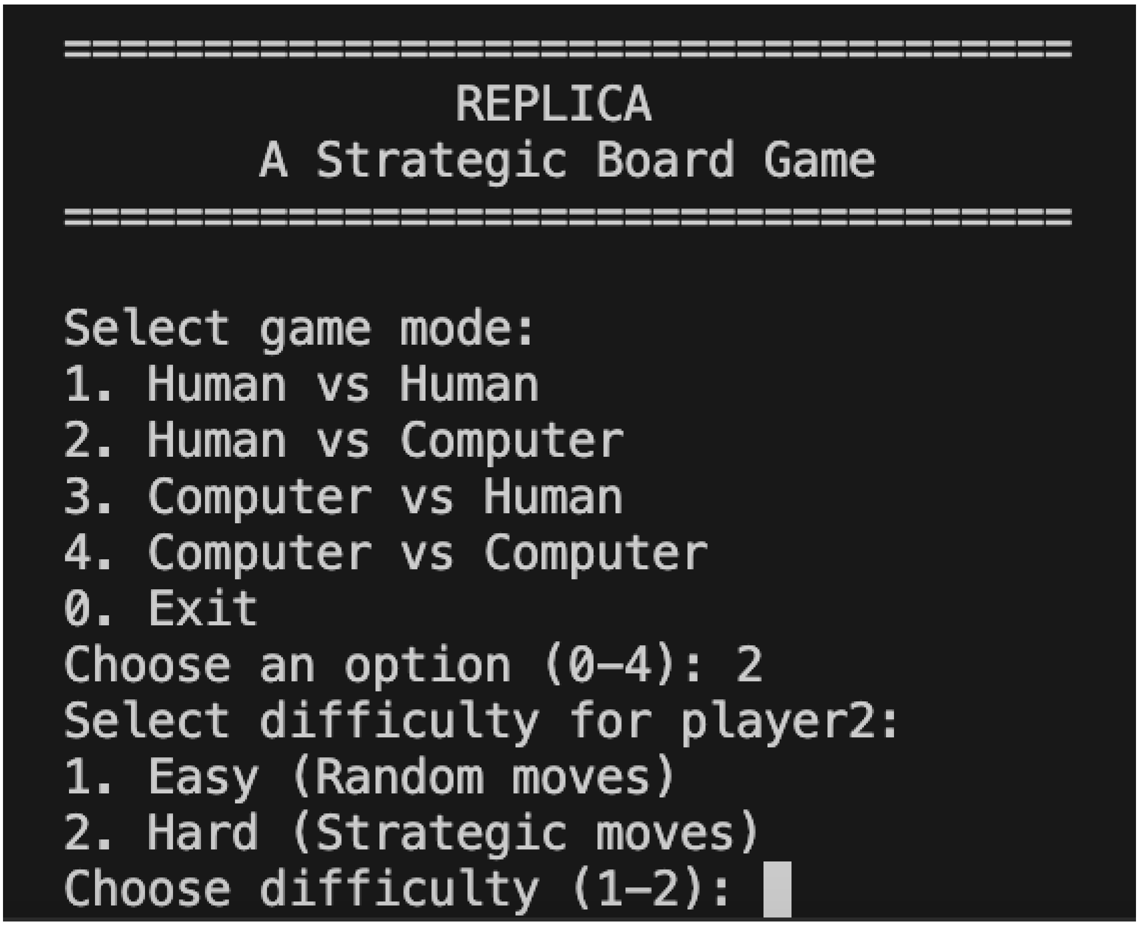
```
====================================
              REPLICA
       A Strategic Board Game
====================================

Select game mode:
1. Human vs Human
2. Human vs Computer
3. Computer vs Human
4. Computer vs Computer
0. Exit
Choose an option (0-4): 1
```

Figure 11: Initial Game Menu



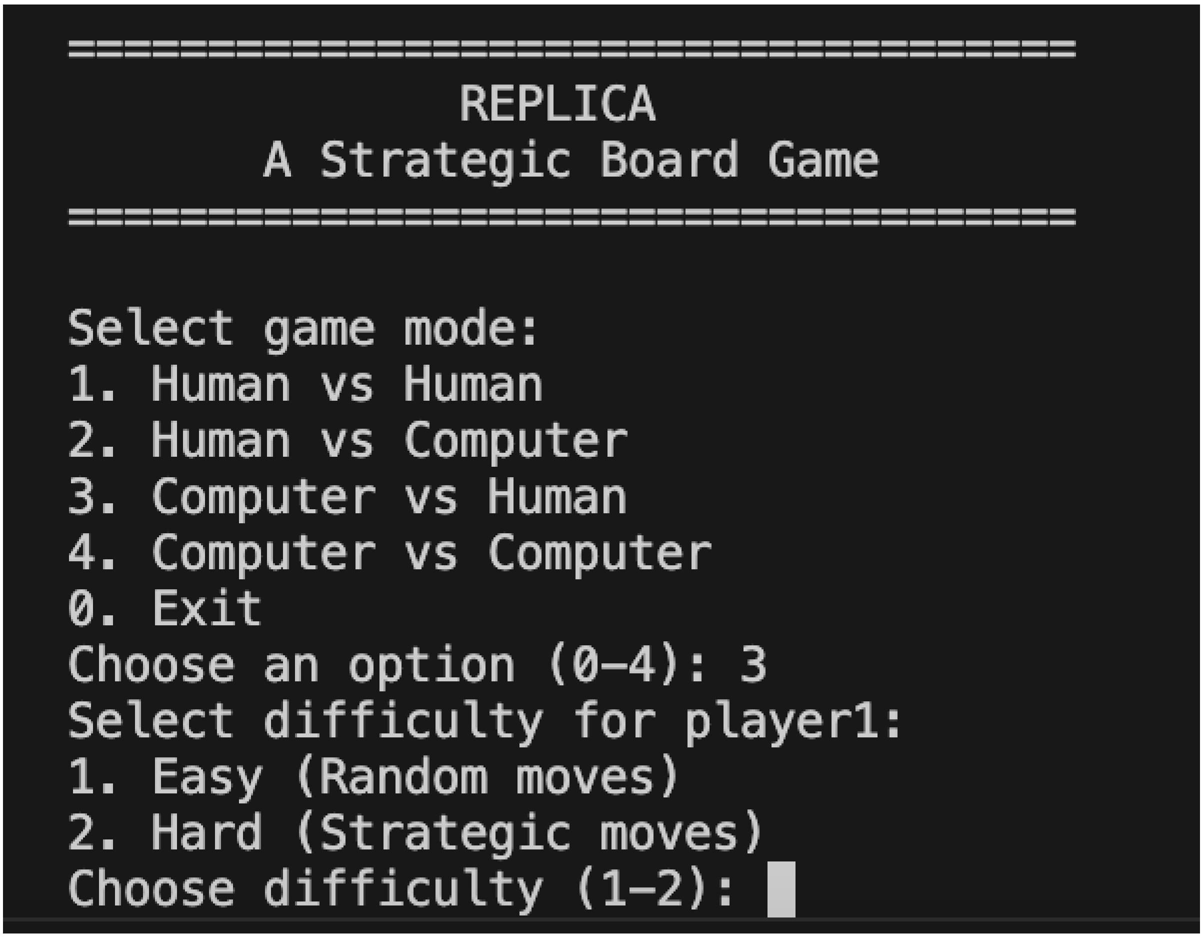
```
Select the piece you want to move by writing Row-Column.
|: 8-8.
Select the action you want to perform
1. Horizontal
2. Vertical
3. Diagonal
4. Transform
Choose an option:
|: 3
```

Figure 12: Game Menu Human-Human Move



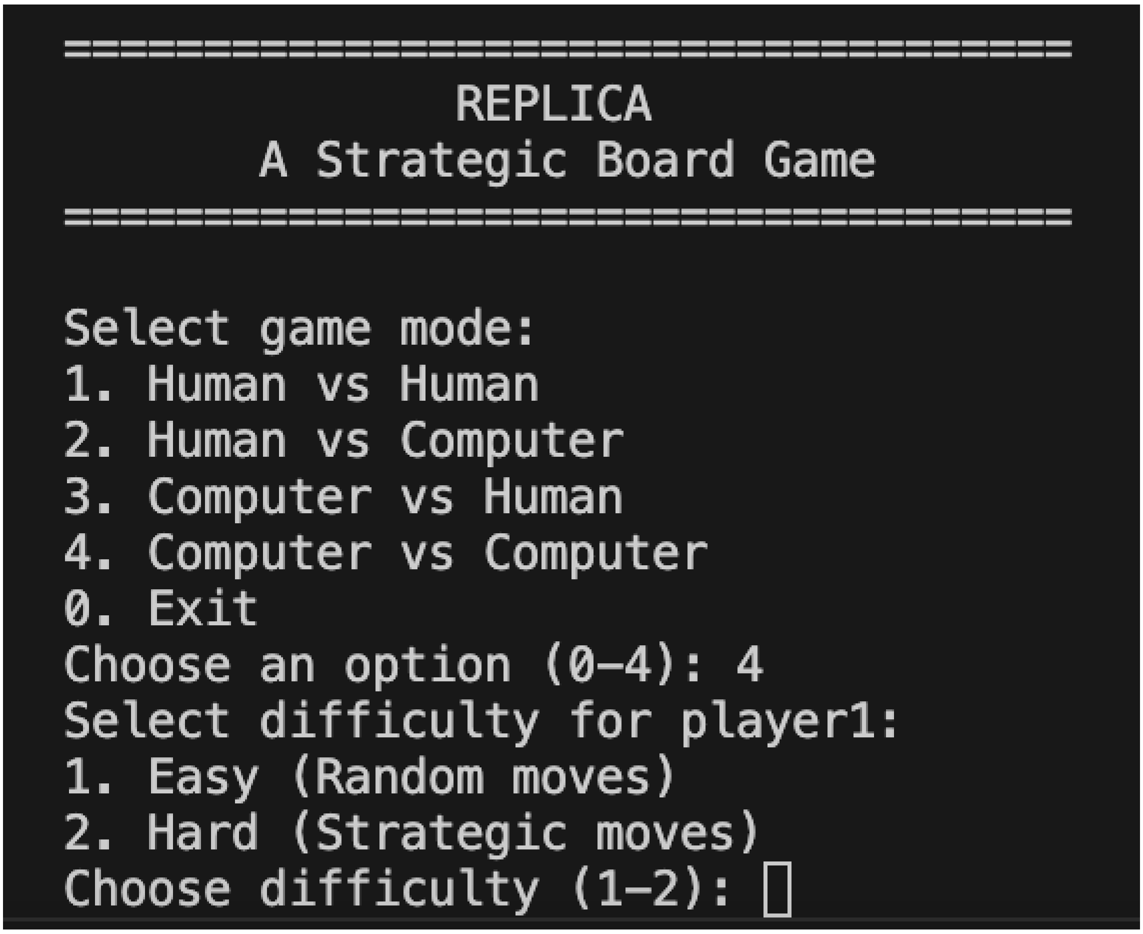
```
====================================
              REPLICA
       A Strategic Board Game
====================================


Select game mode:
1. Human vs Human
2. Human vs Computer
3. Computer vs Human
4. Computer vs Computer
0. Exit
Choose an option (0-4): 2
Select difficulty for player2:
1. Easy (Random moves)
2. Hard (Strategic moves)
Choose difficulty (1-2):
```

Figure 13: Game Menu Human-Computer



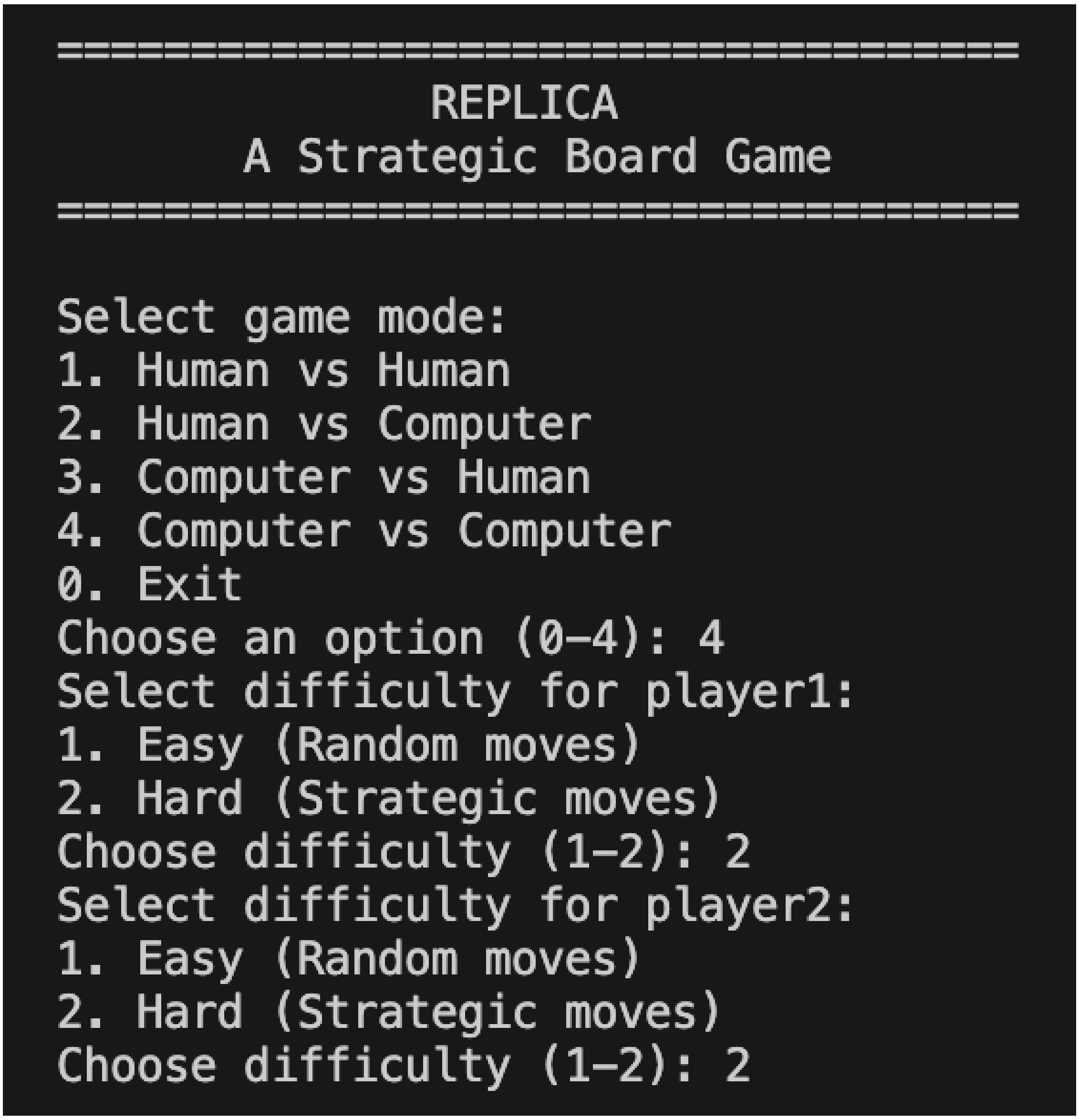
```
====================================
              REPLICA
       A Strategic Board Game
====================================


Select game mode:
1. Human vs Human
2. Human vs Computer
3. Computer vs Human
4. Computer vs Computer
0. Exit
Choose an option (0-4): 3
Select difficulty for player1:
1. Easy (Random moves)
2. Hard (Strategic moves)
Choose difficulty (1-2):
```

Figure 14: Game Menu Computer-Human



```
====================================
              REPLICA
       A Strategic Board Game
====================================

Select game mode:
1. Human vs Human
2. Human vs Computer
3. Computer vs Human
4. Computer vs Computer
0. Exit
Choose an option (0-4): 4
Select difficulty for player1:
1. Easy (Random moves)
2. Hard (Strategic moves)
Choose difficulty (1-2): 
```

Figure 15: Game Menu Computer-Computer



```
====================================
              REPLICA
       A Strategic Board Game
====================================

Select game mode:
1. Human vs Human
2. Human vs Computer
3. Computer vs Human
4. Computer vs Computer
0. Exit
Choose an option (0-4): 4
Select difficulty for player1:
1. Easy (Random moves)
2. Hard (Strategic moves)
Choose difficulty (1-2): 2
Select difficulty for player2:
1. Easy (Random moves)
2. Hard (Strategic moves)
Choose difficulty (1-2): 2
```

Figure 16: Game Menu Computer-Computer

Conclusions

Current Limitations

- Basic AI implementation
- Limited undo/redo functionality
- No game state saving

Future Improvements

1. Enhanced AI with deeper strategic thinking, that also focus on placing the king on the opposite corner and can avoid places where pieces can be captured
2. GUI implementation

Bibliography

1. SICStus Prolog Documentation
2. Replica Board Game Official Rules