Computer Science and Communications Engineering Laboratory A
Algorithms and Data Structures

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Objectives of experiments

- Develop the ability to devise judgement algorithms through game creation

- Develop the ability to solve problems by dividing them

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Details of the game

Connect4

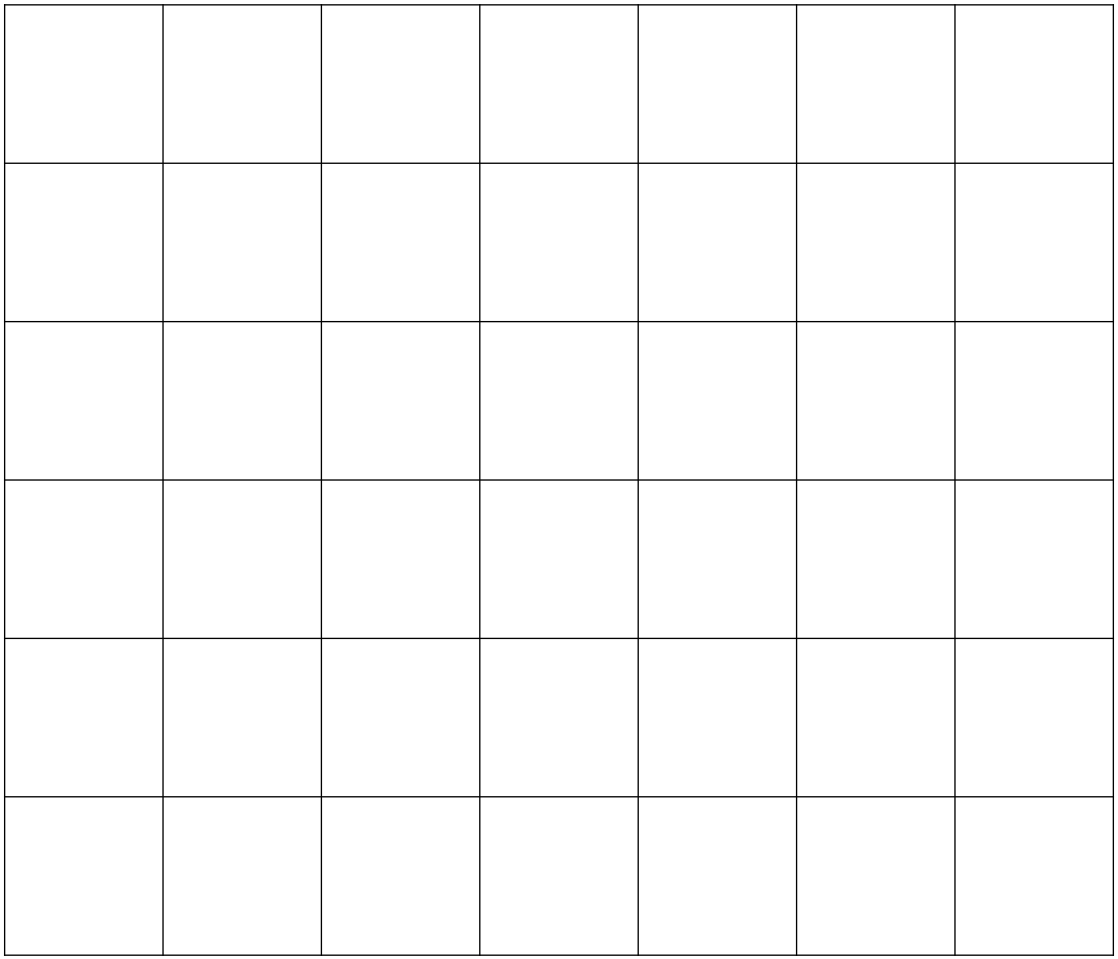
- Two-player board game
- Place the colored pieces alternately
- A player wins when she lined up her four pieces vertically, horizontally or diagonally first

Connect4

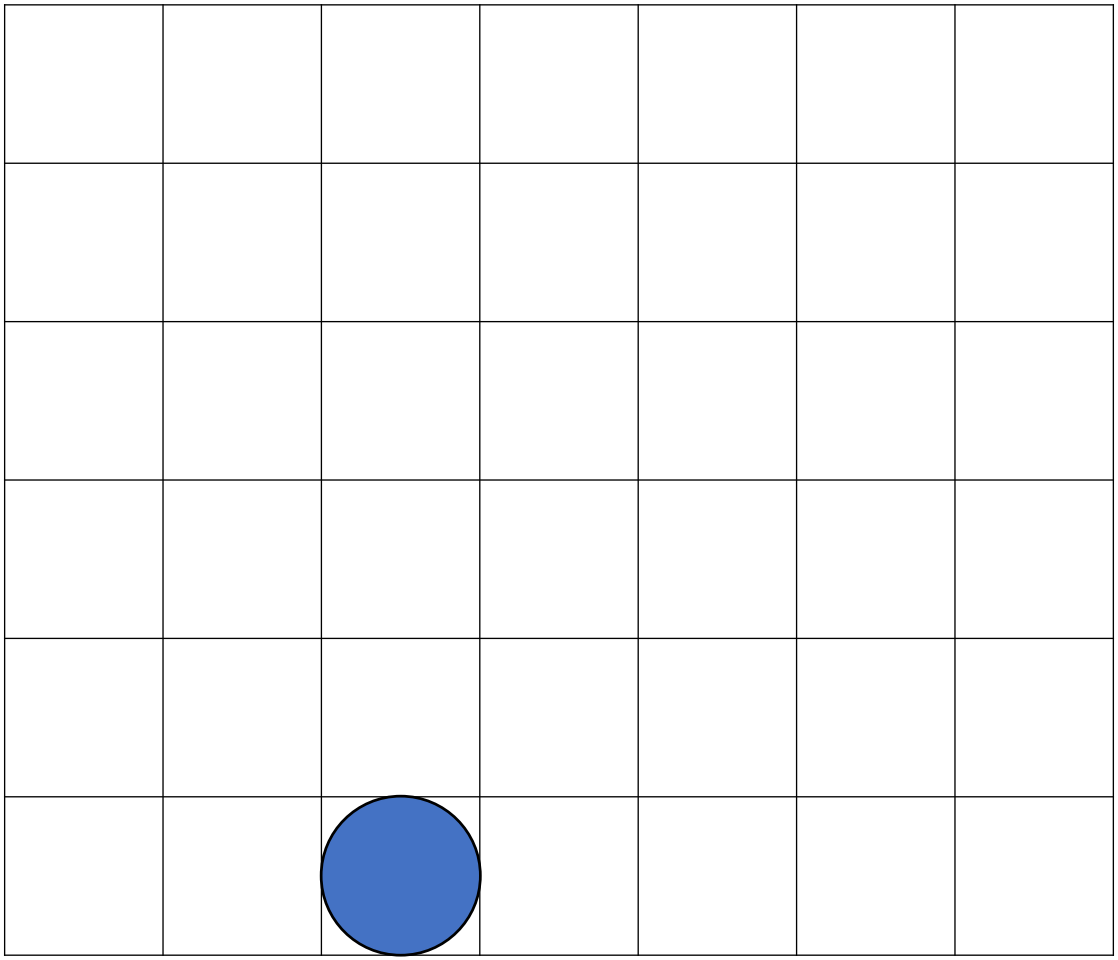
- **Connect4** is a two-player connection board game, in which the players choose a color and then take turns dropping colored discs into a seven-column, six-row vertically suspended grid. The pieces fall straight down, occupying the lowest available space within the column. The objective of the game is to be the first to form a horizontal, vertical, or diagonal line of four of one's own discs.

https://en.wikipedia.org/wiki/Connect_Four.

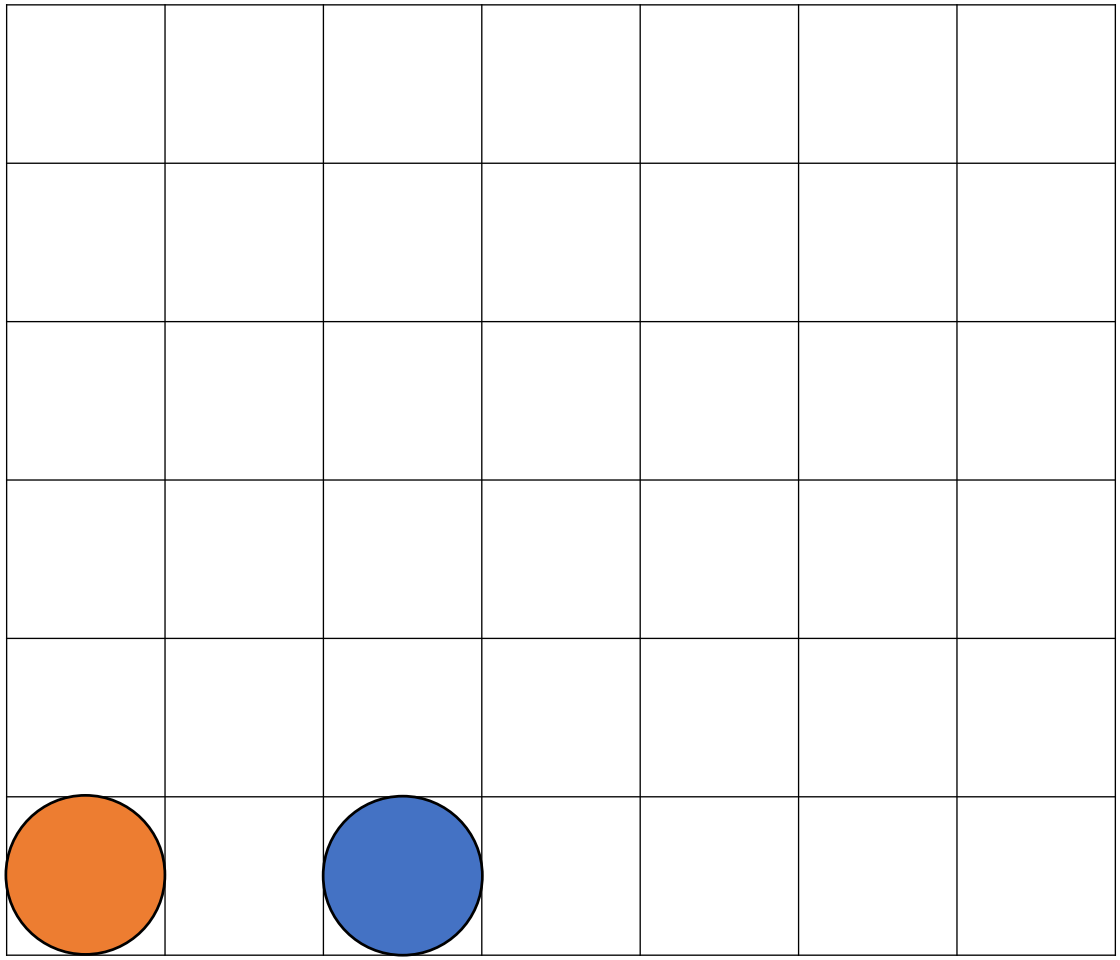
How to play 0/18



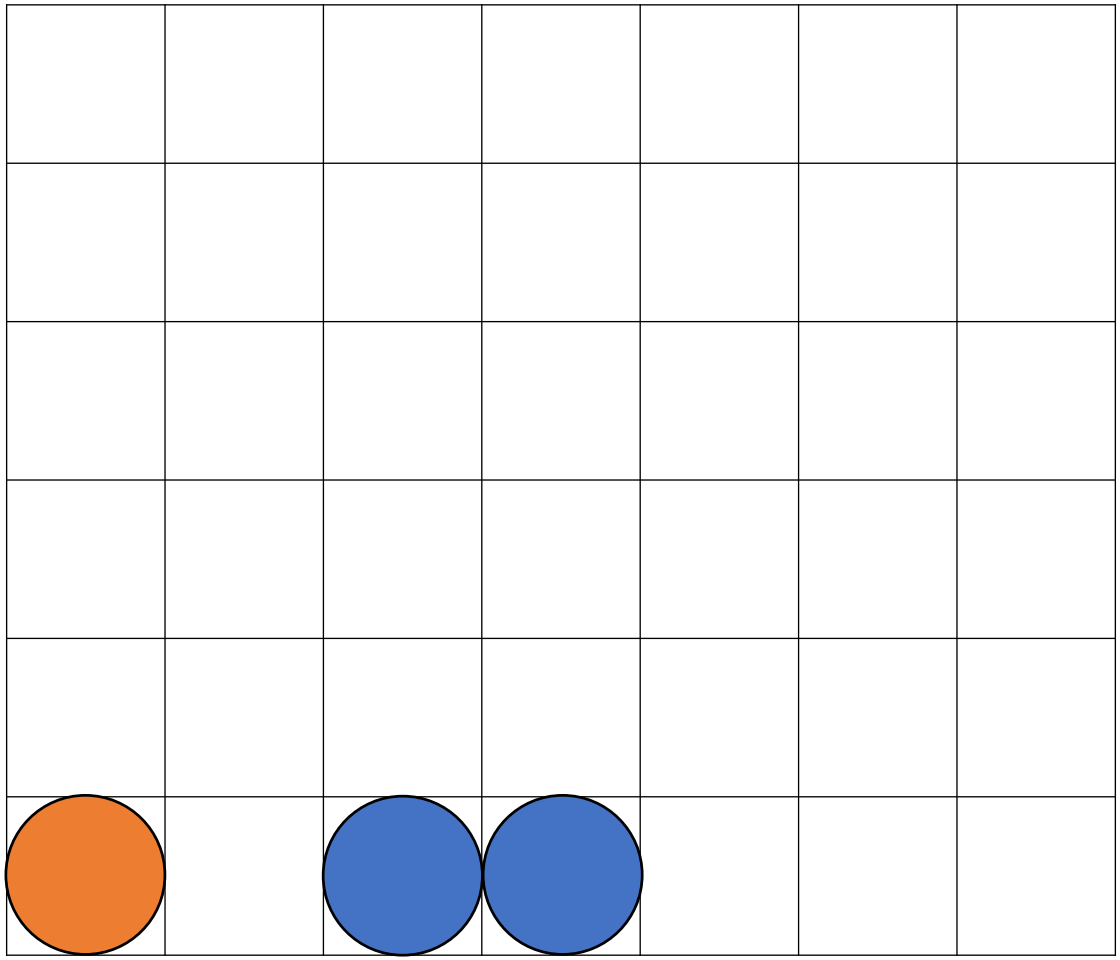
How to play 1/18



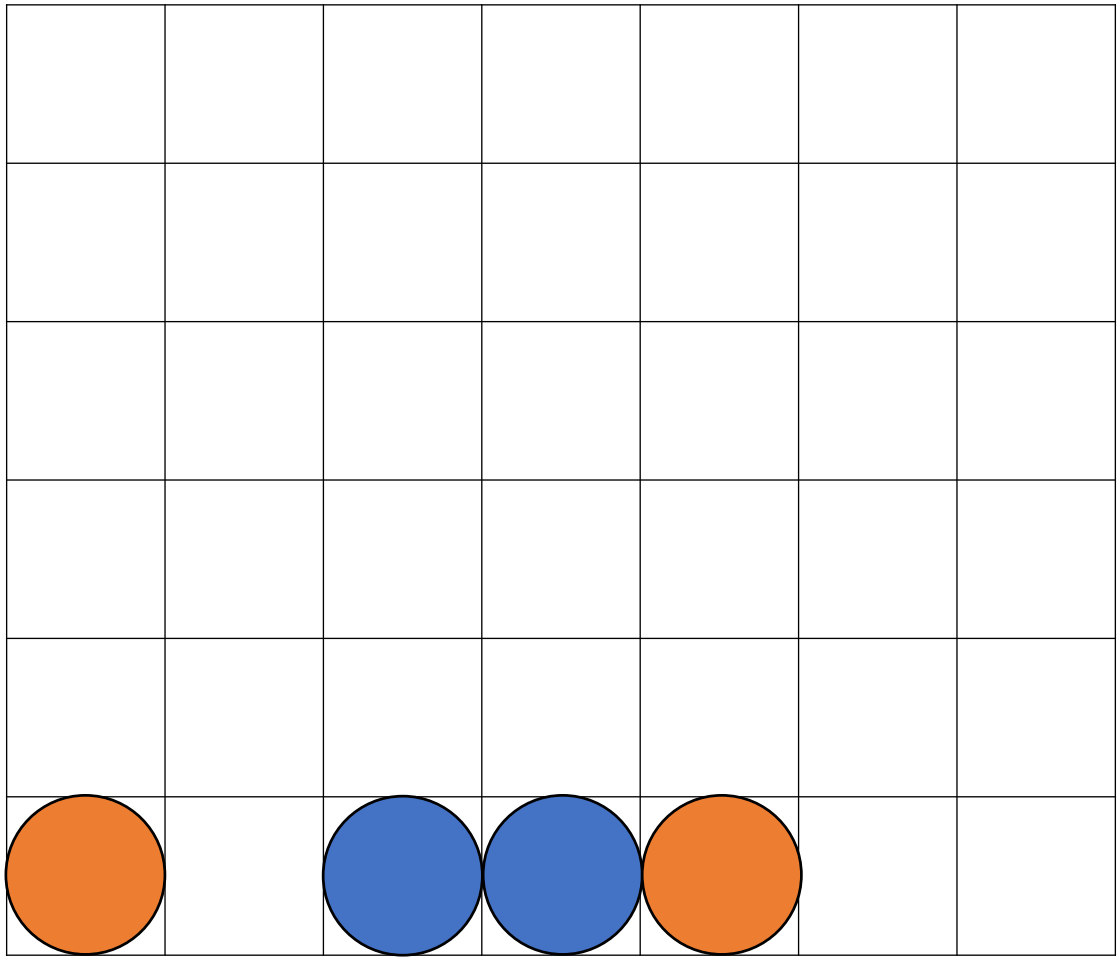
How to play 2/18



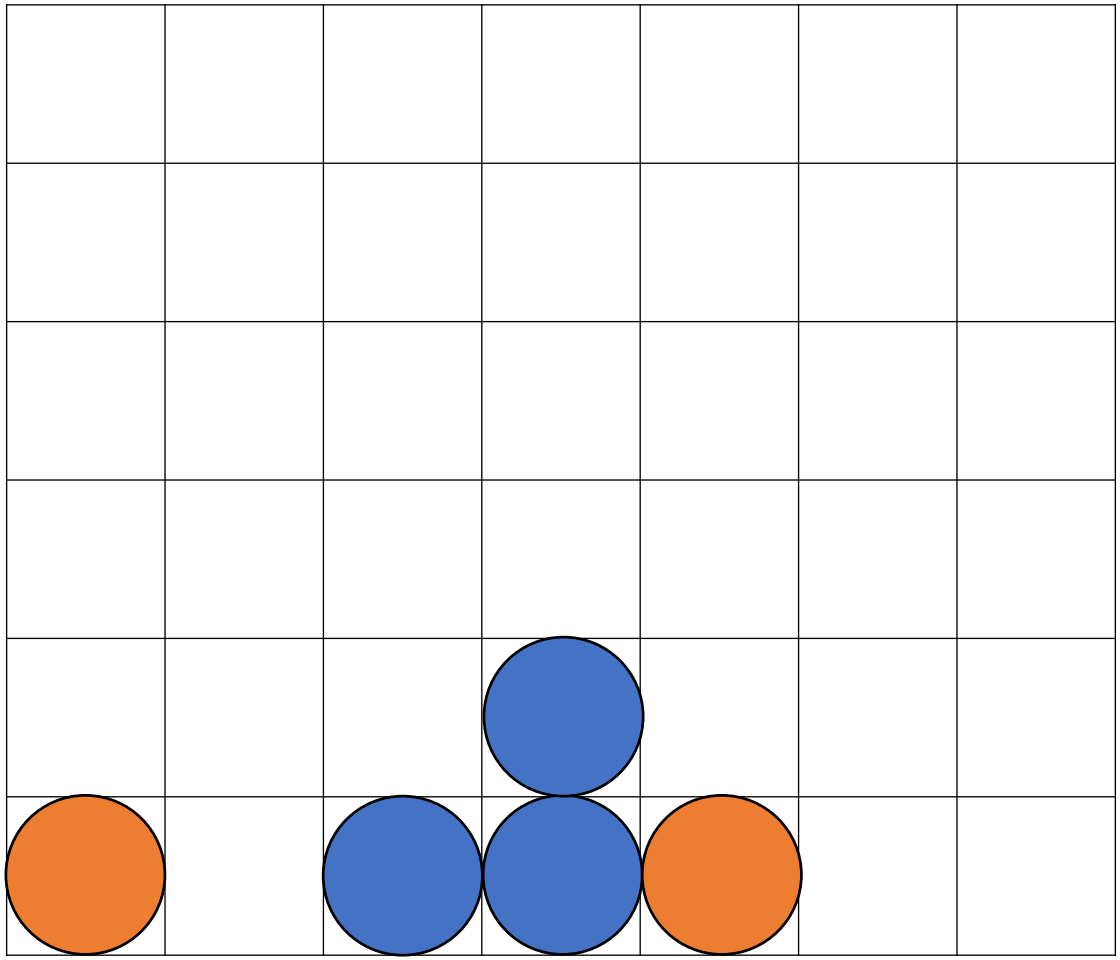
How to play 3/18



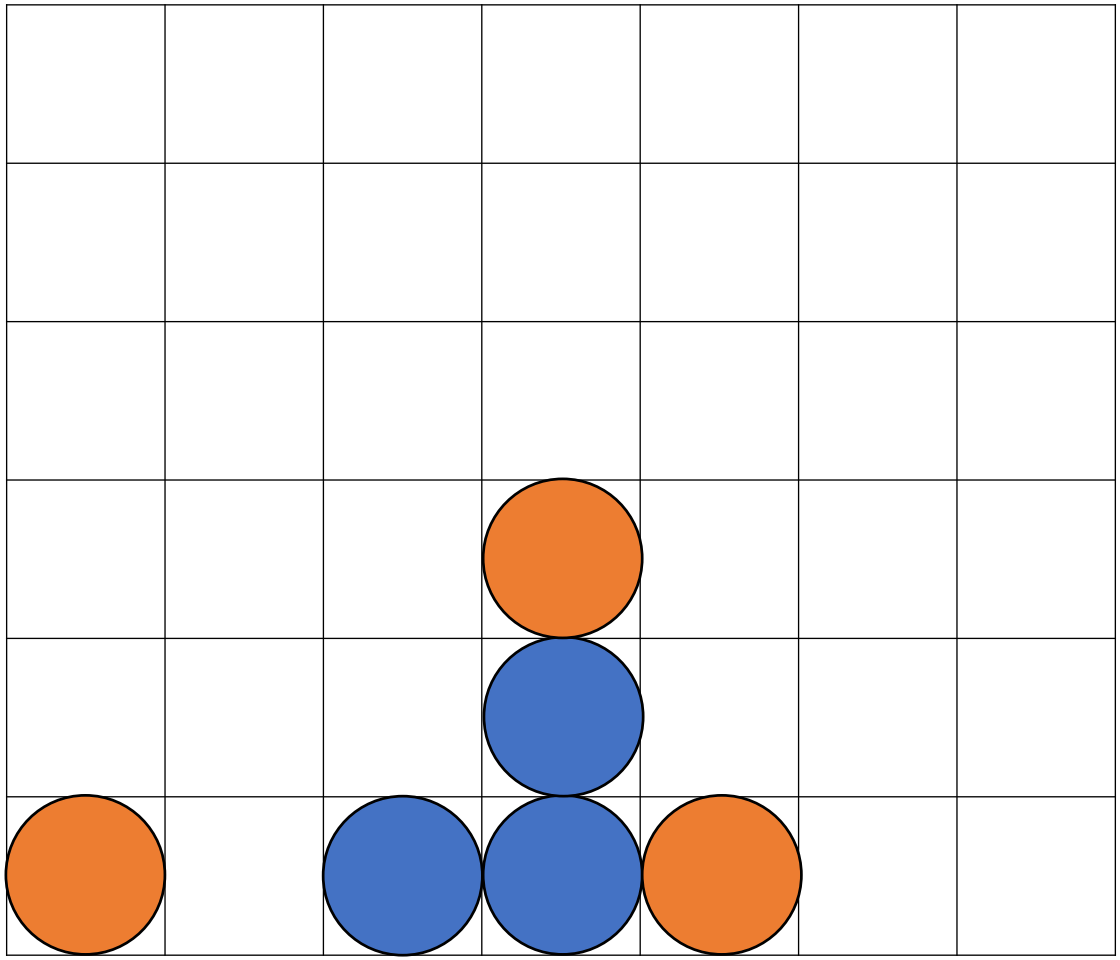
How to play 4/18



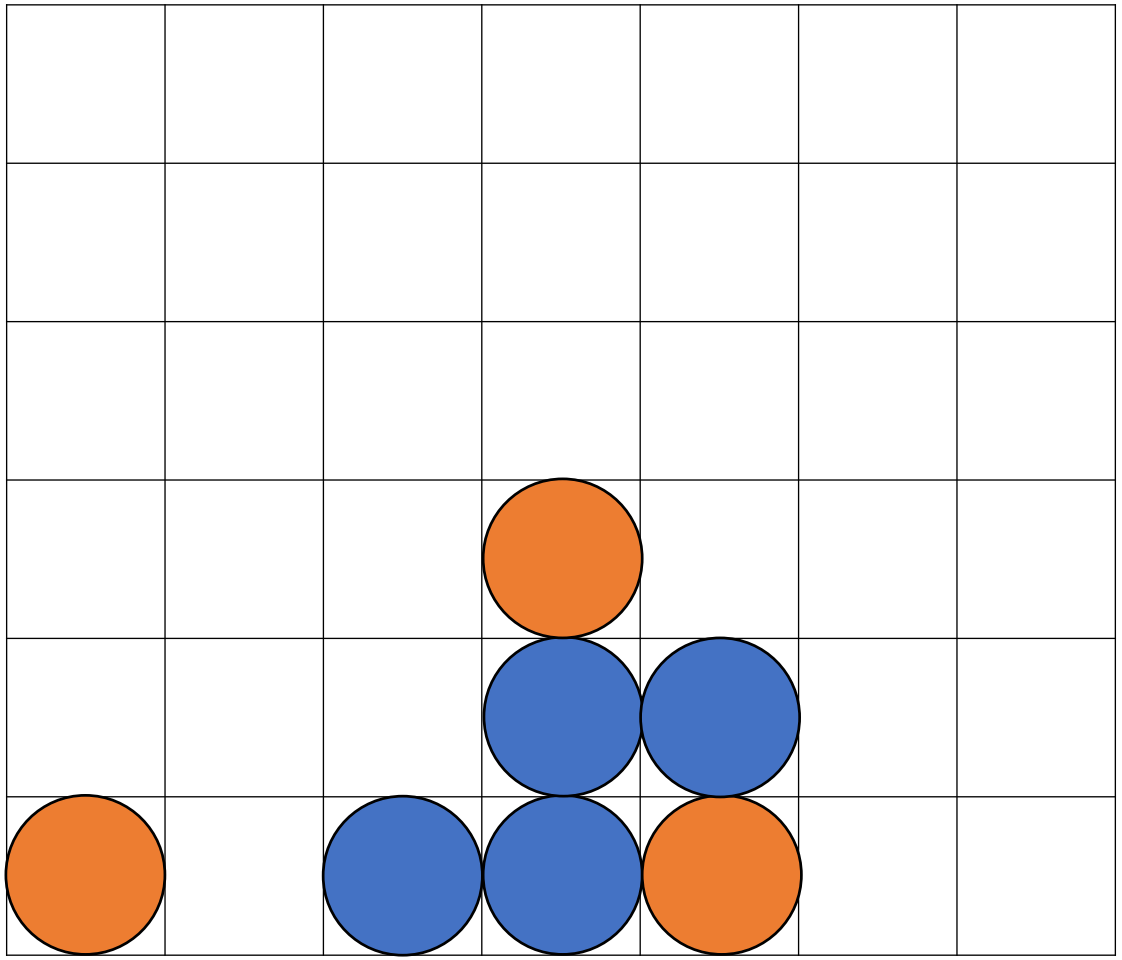
How to play 5/18



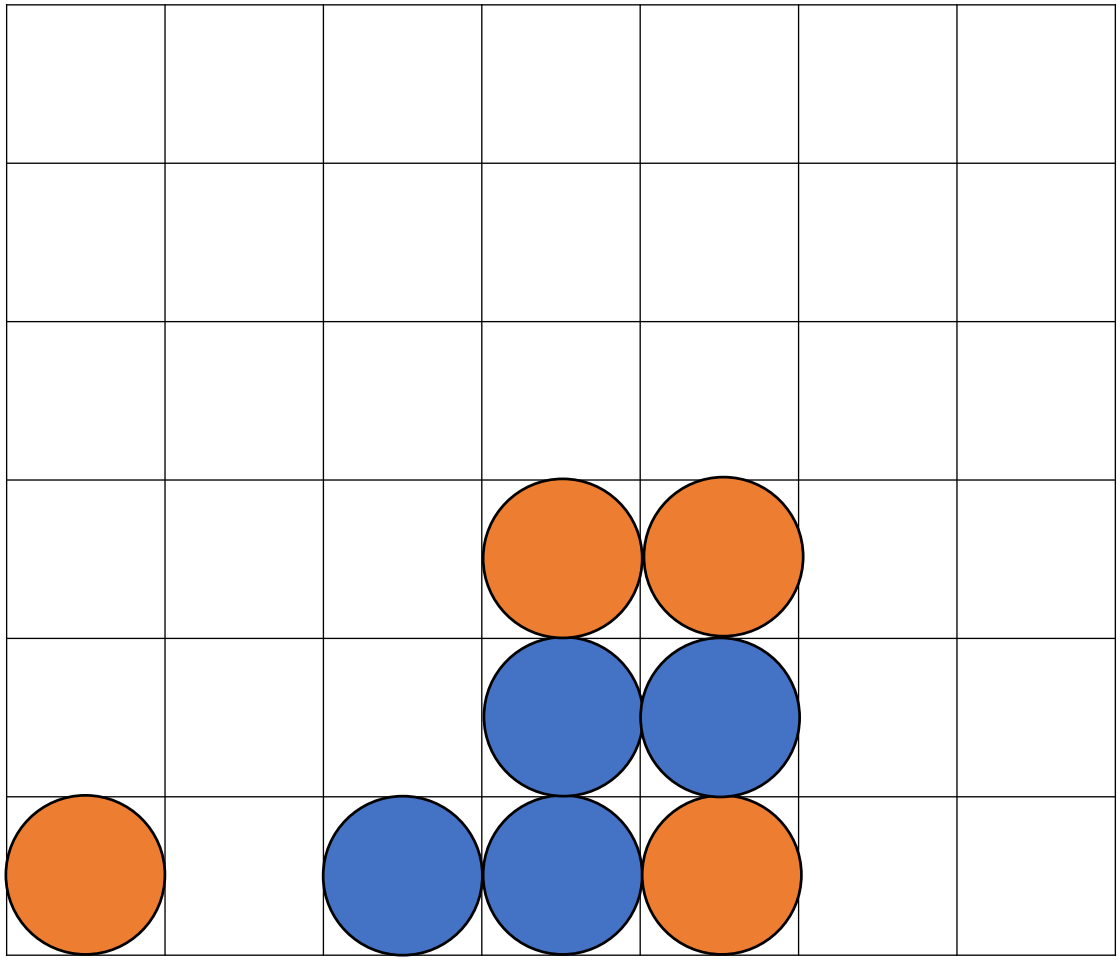
How to play 6/18



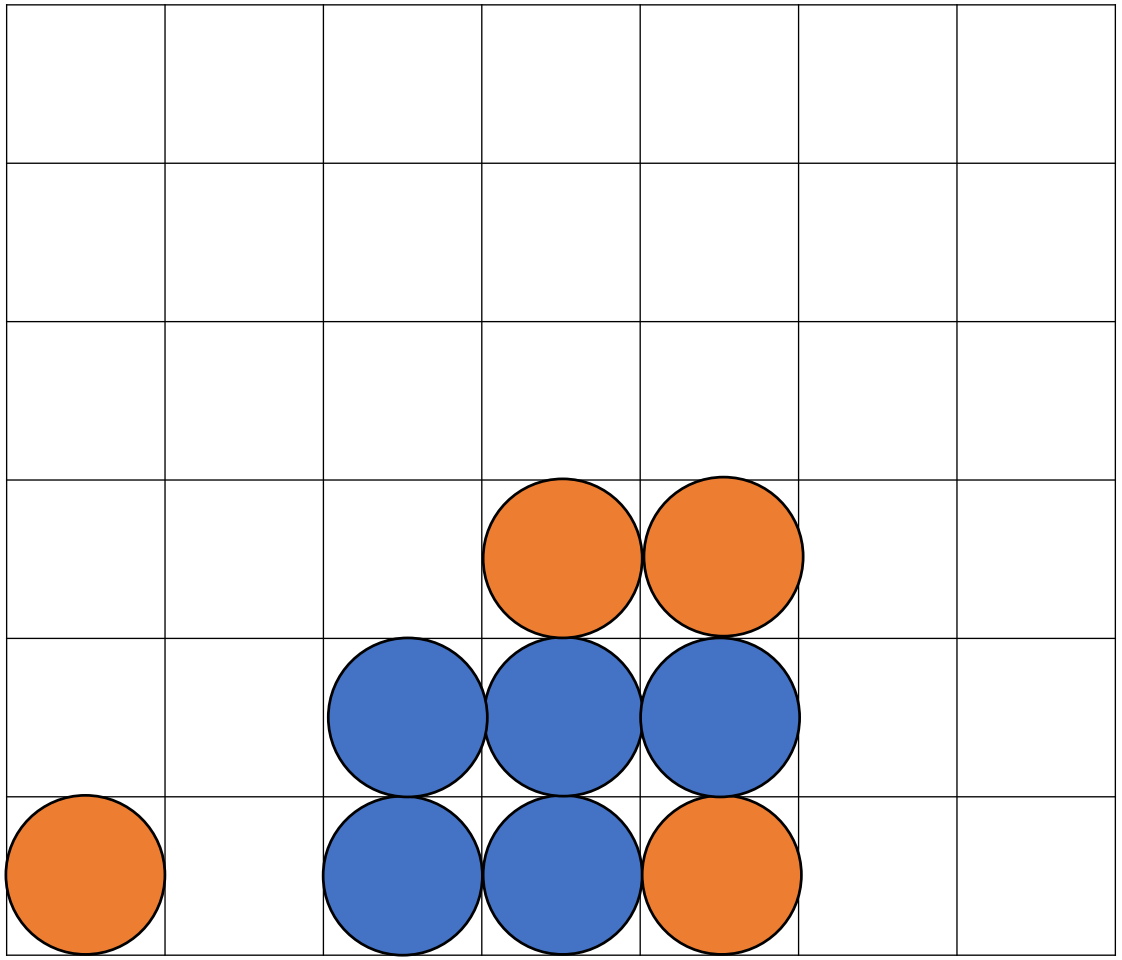
How to play 7/18



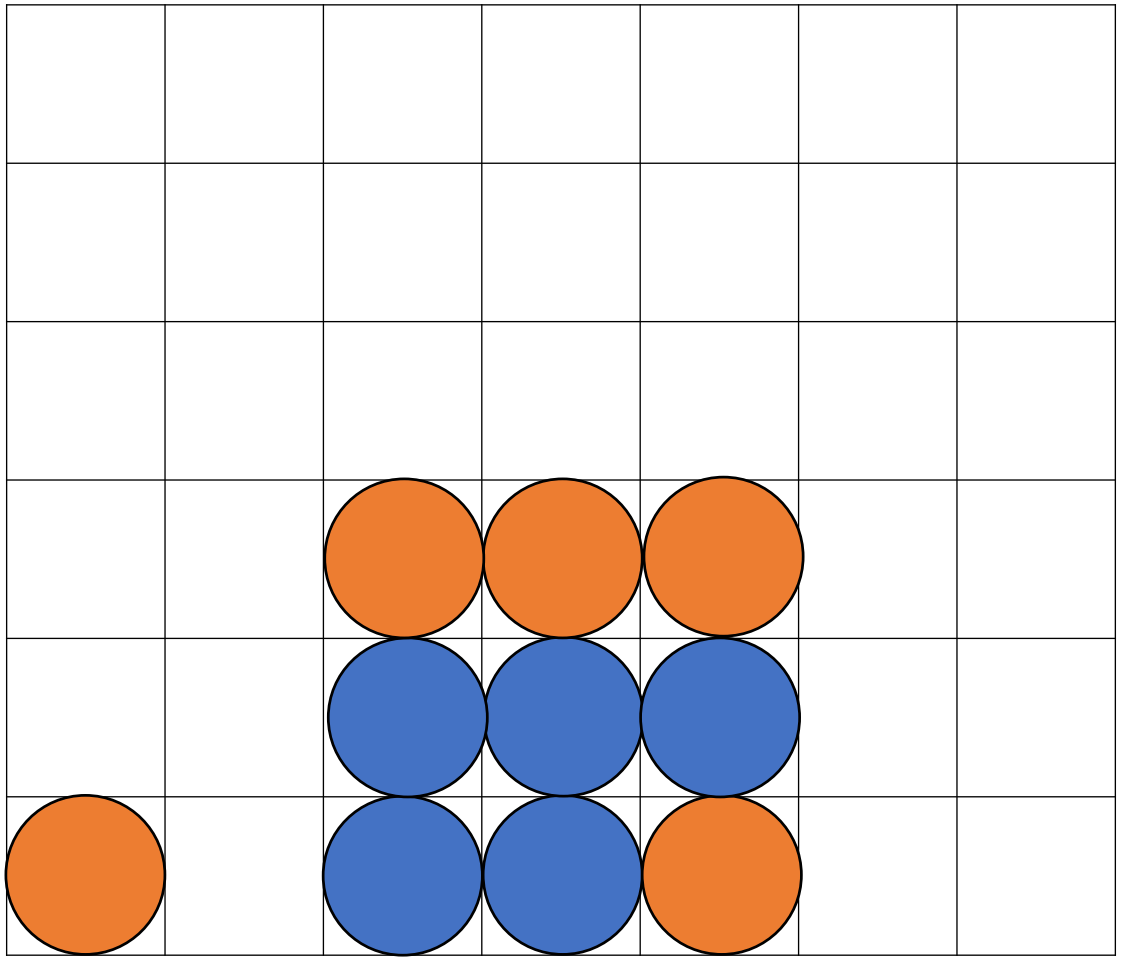
How to play 8/18



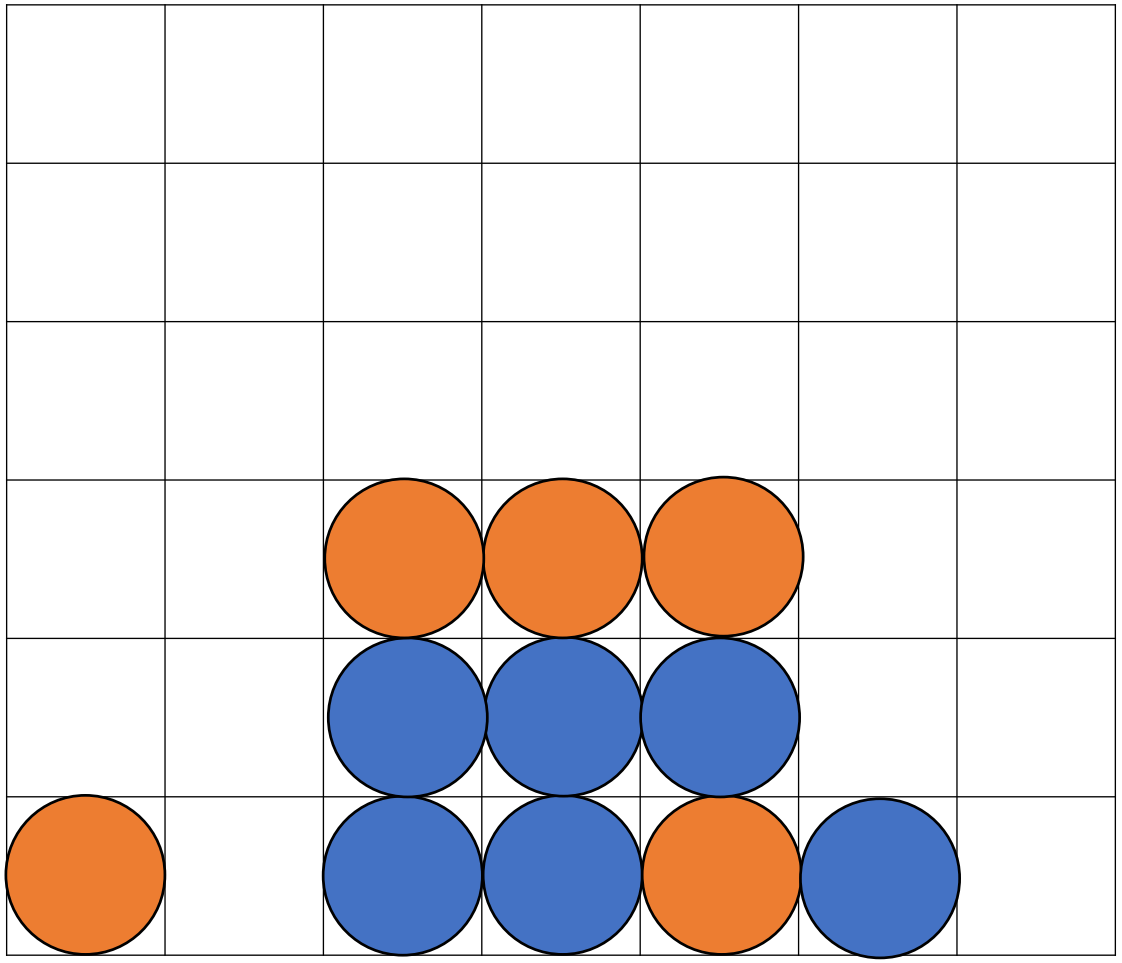
How to play 9/18



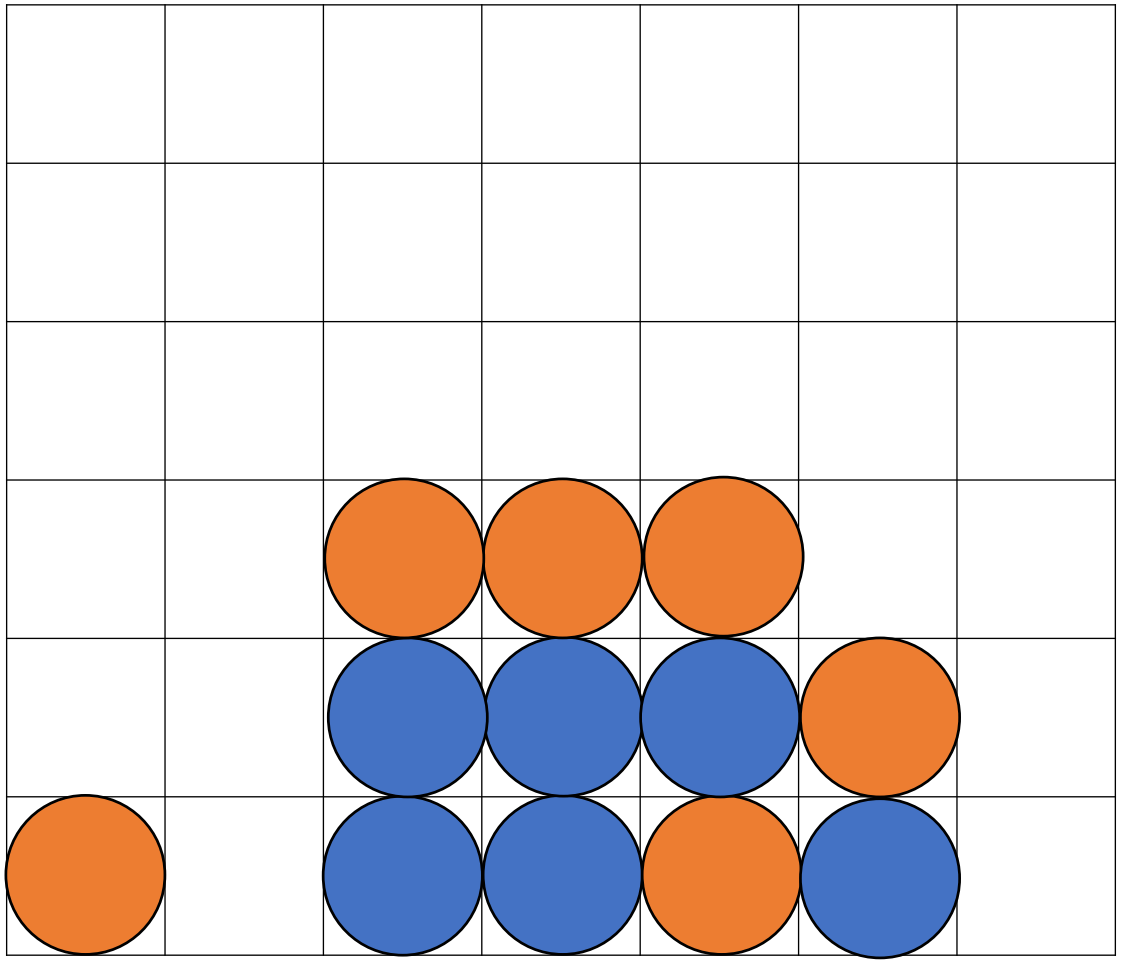
How to play 10/18



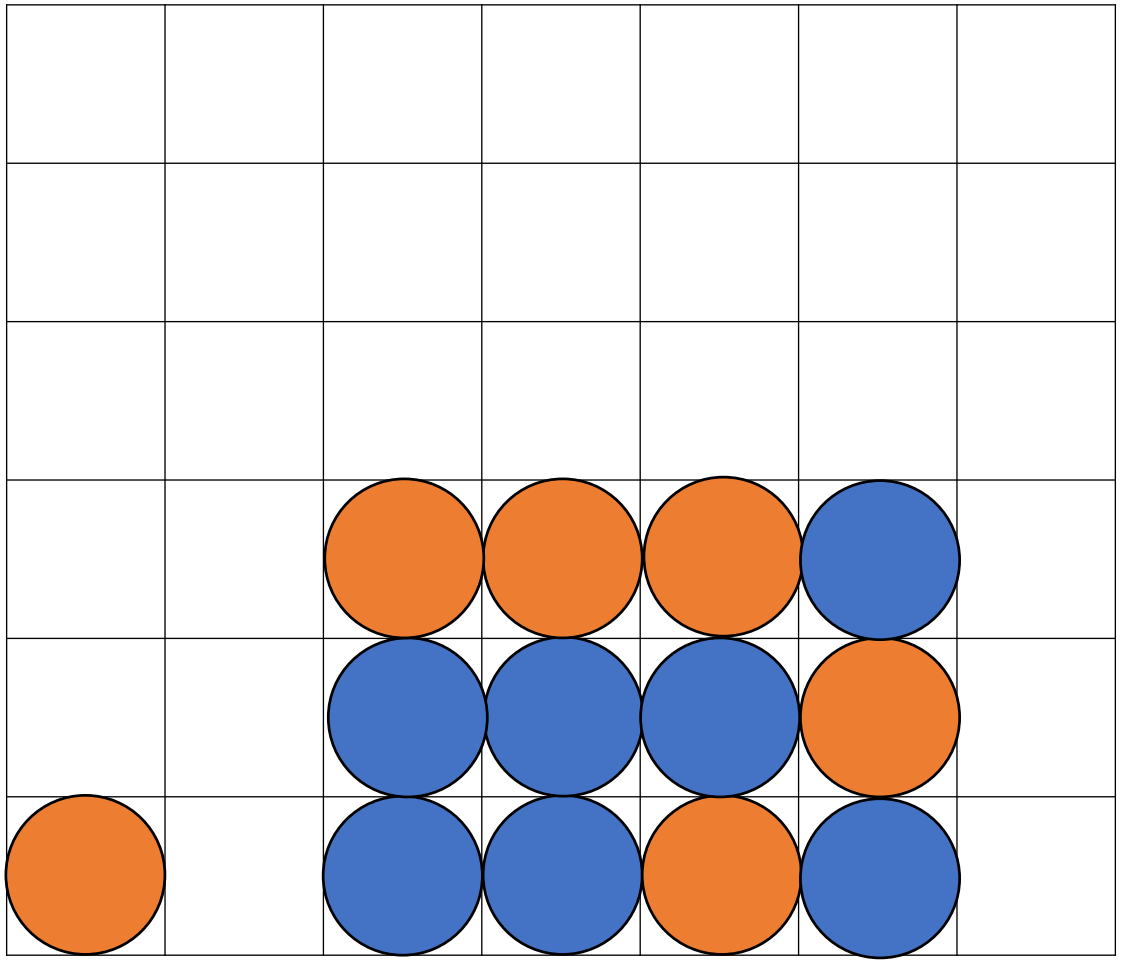
How to play 11/18



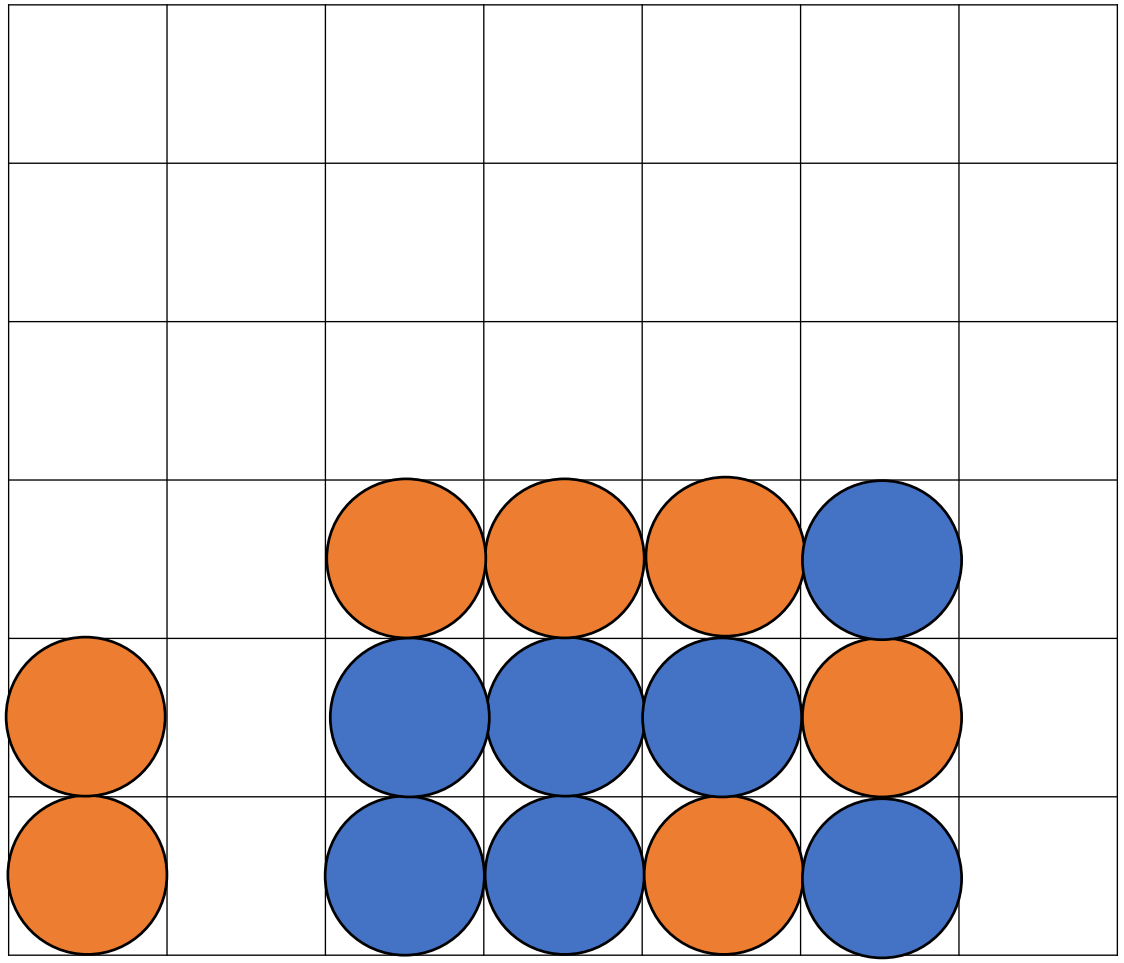
How to play 12/18



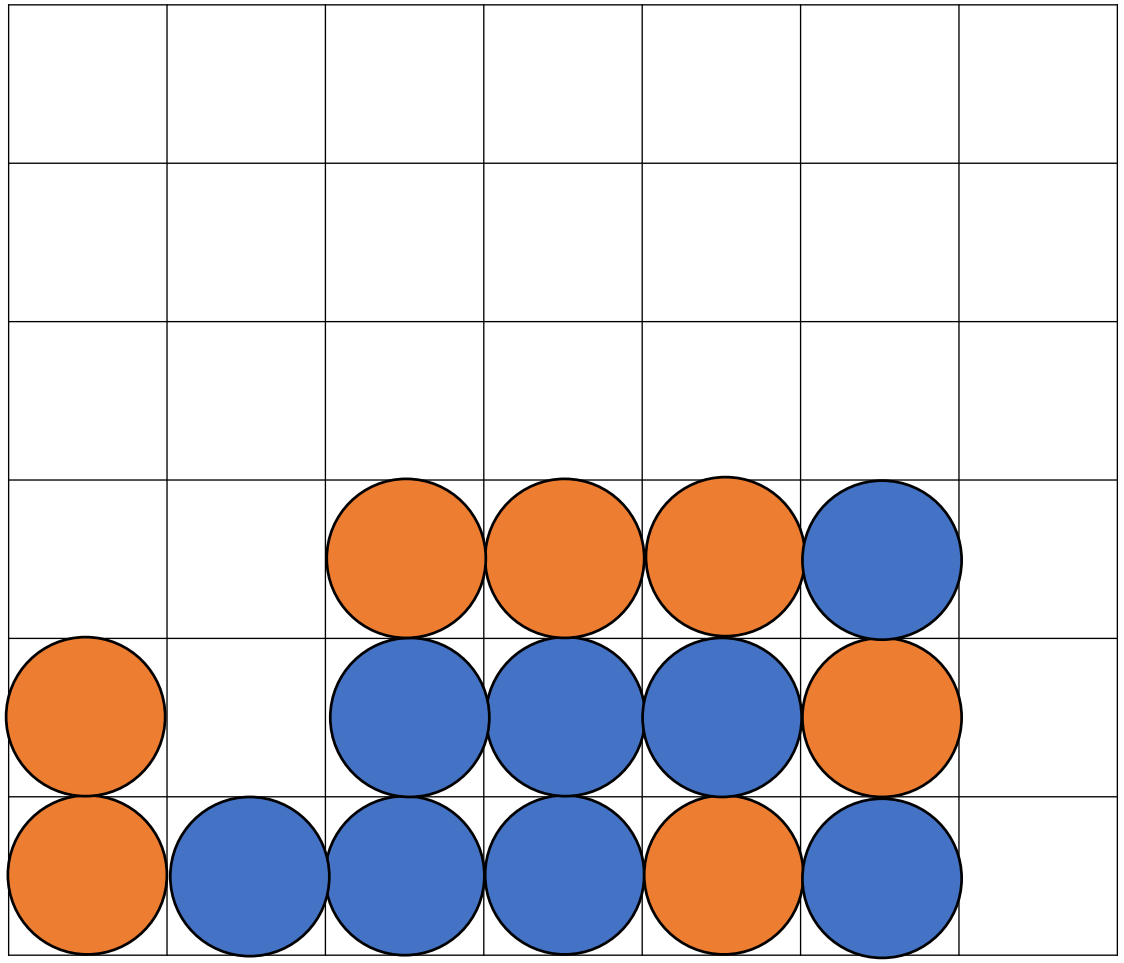
How to play 13/18



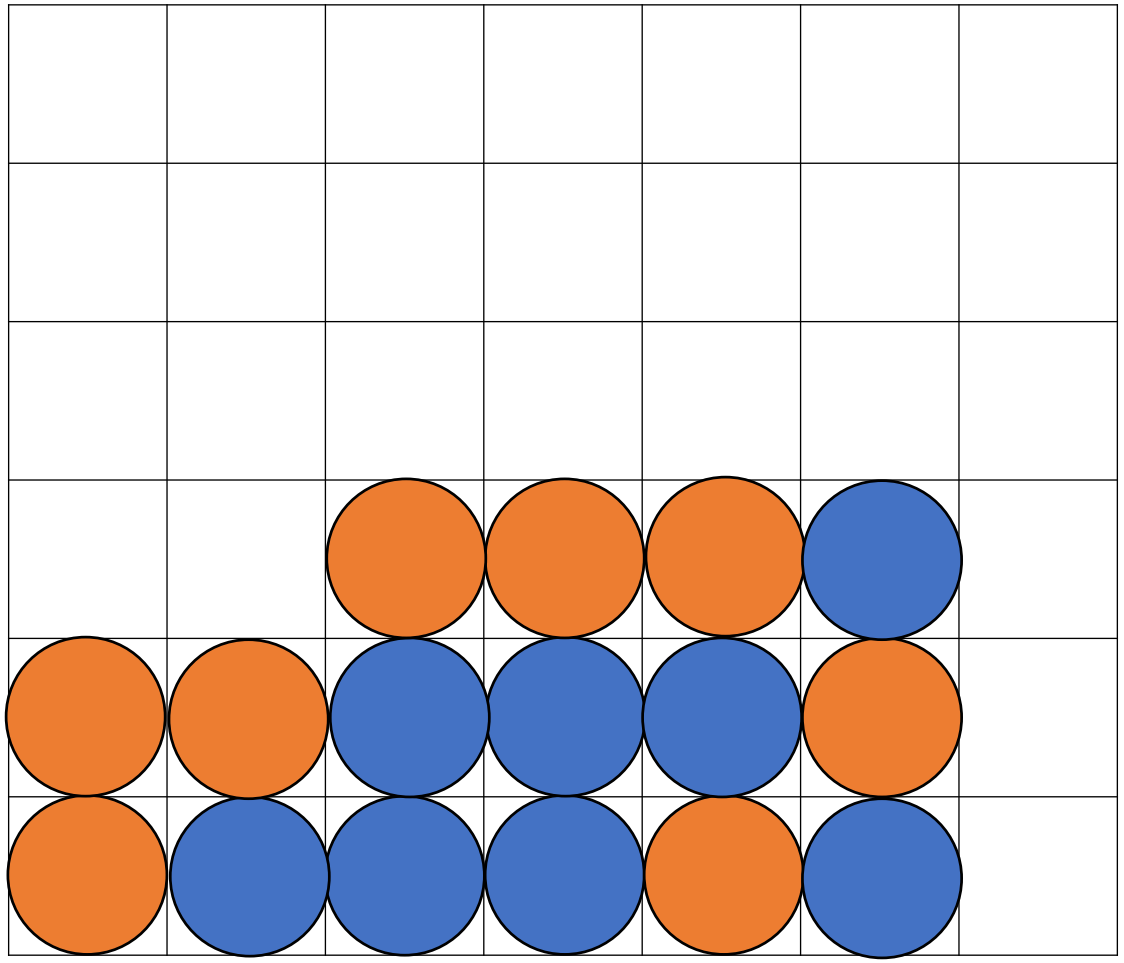
How to play 14/18



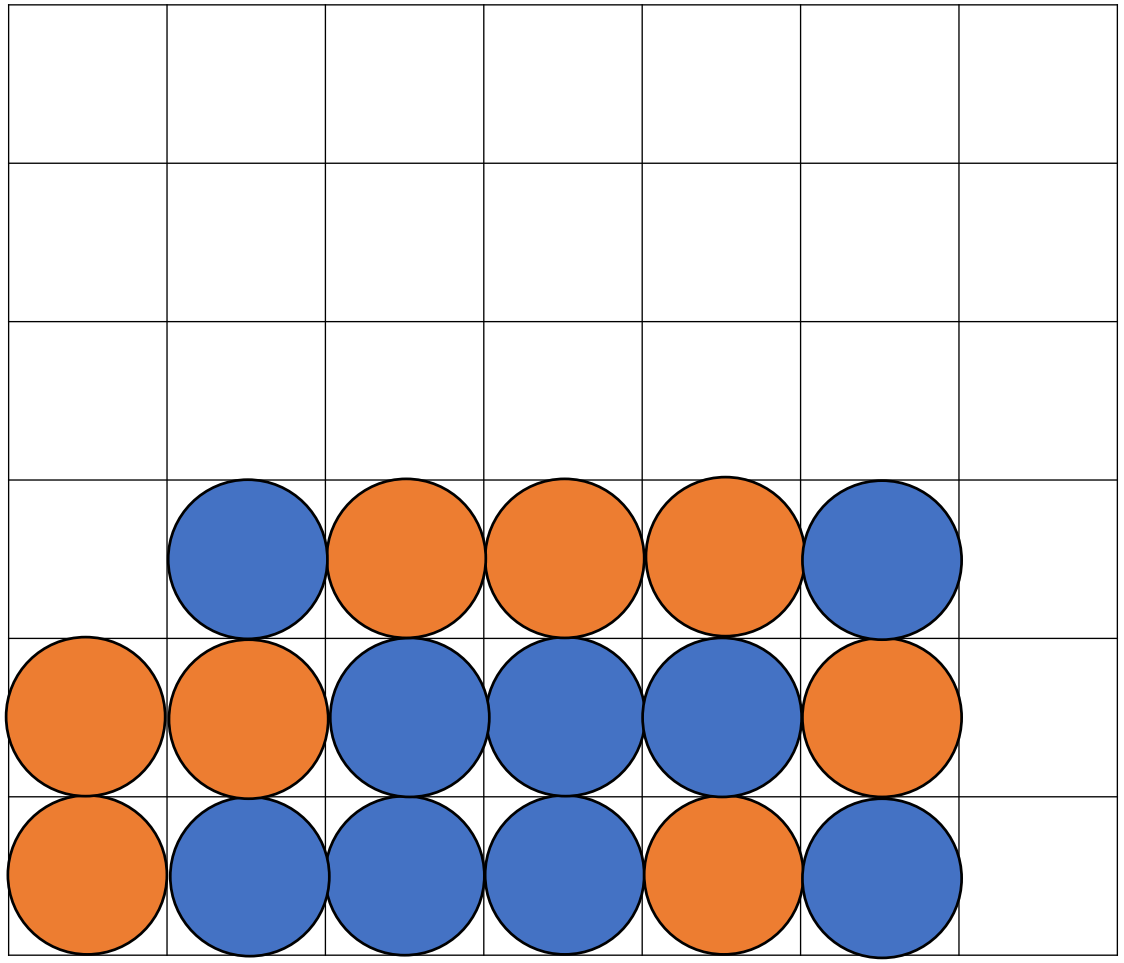
How to play 15/18



How to play 16/18

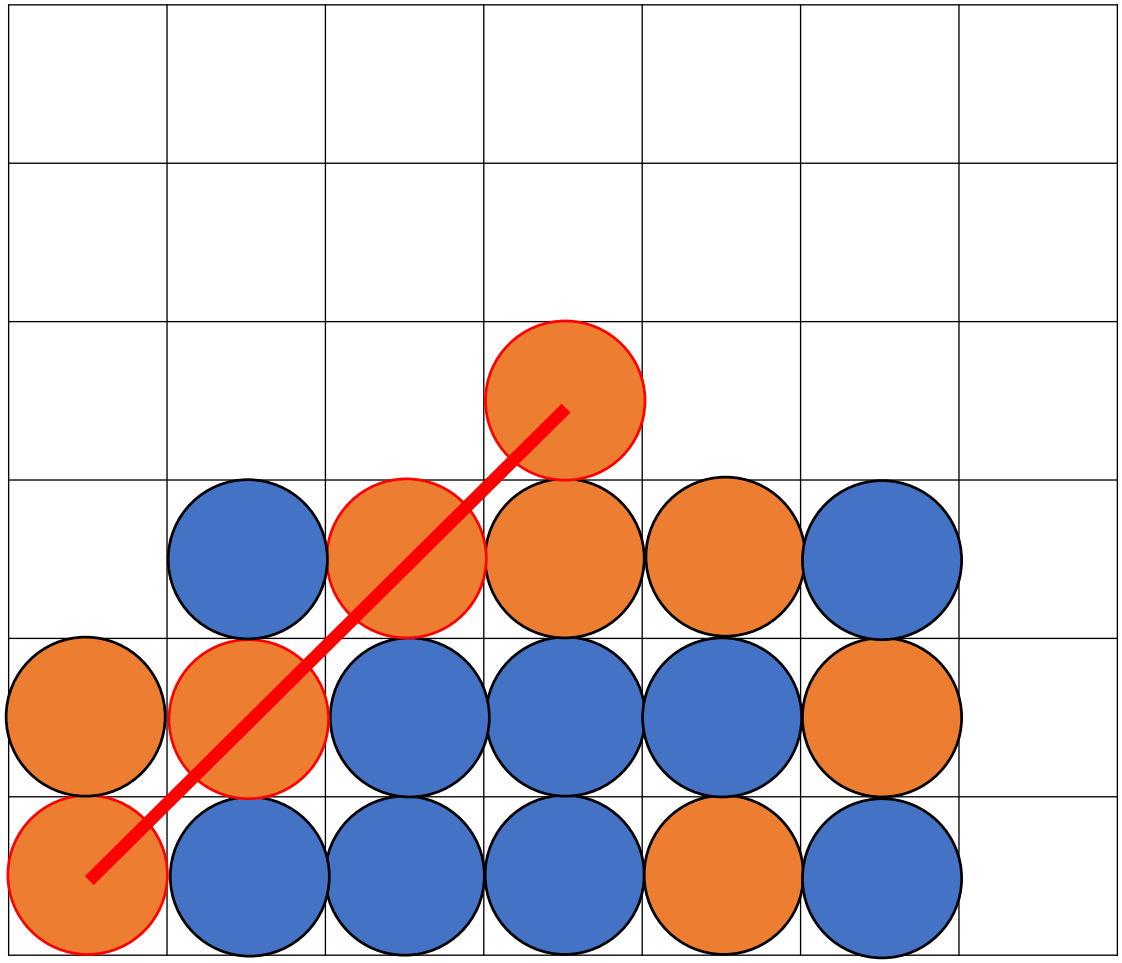


How to play 17/18



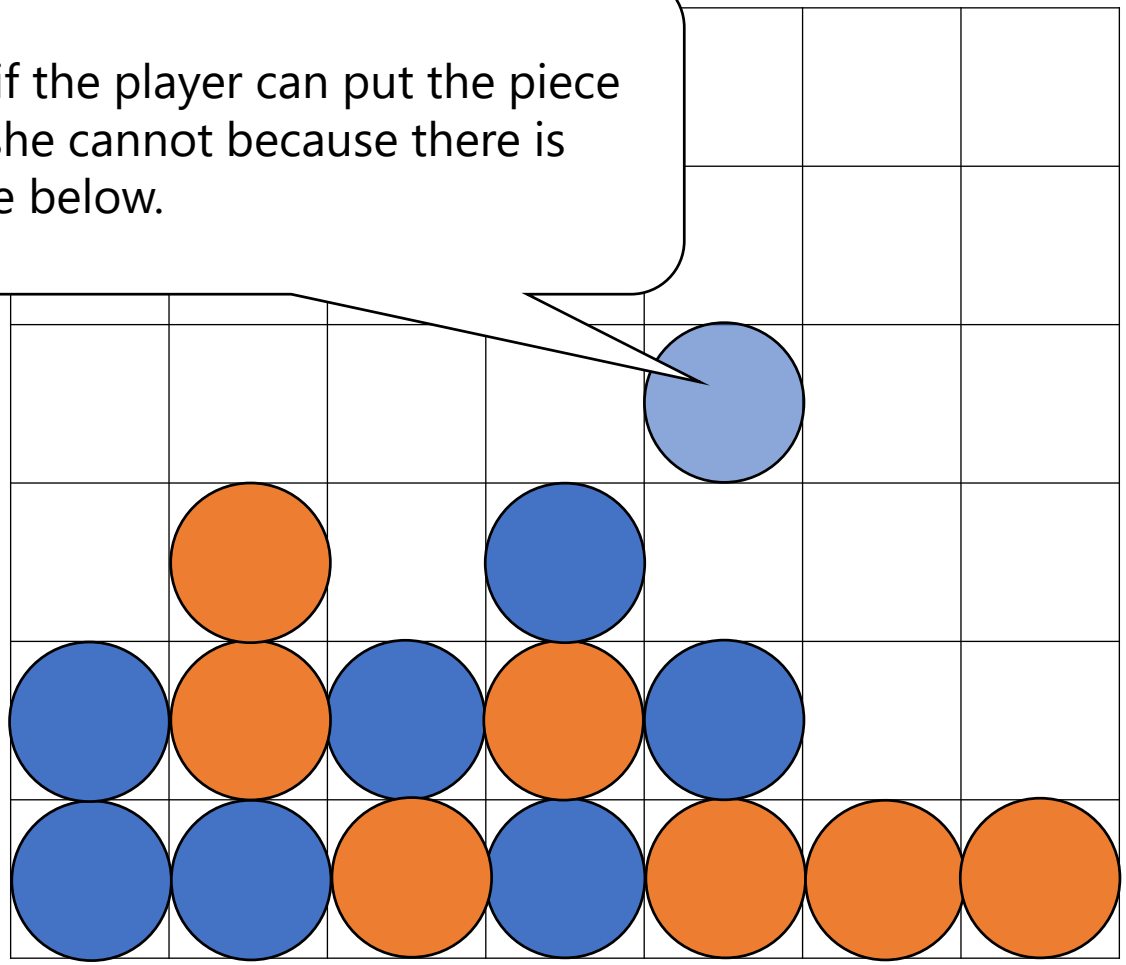
How to play 18/18

win !



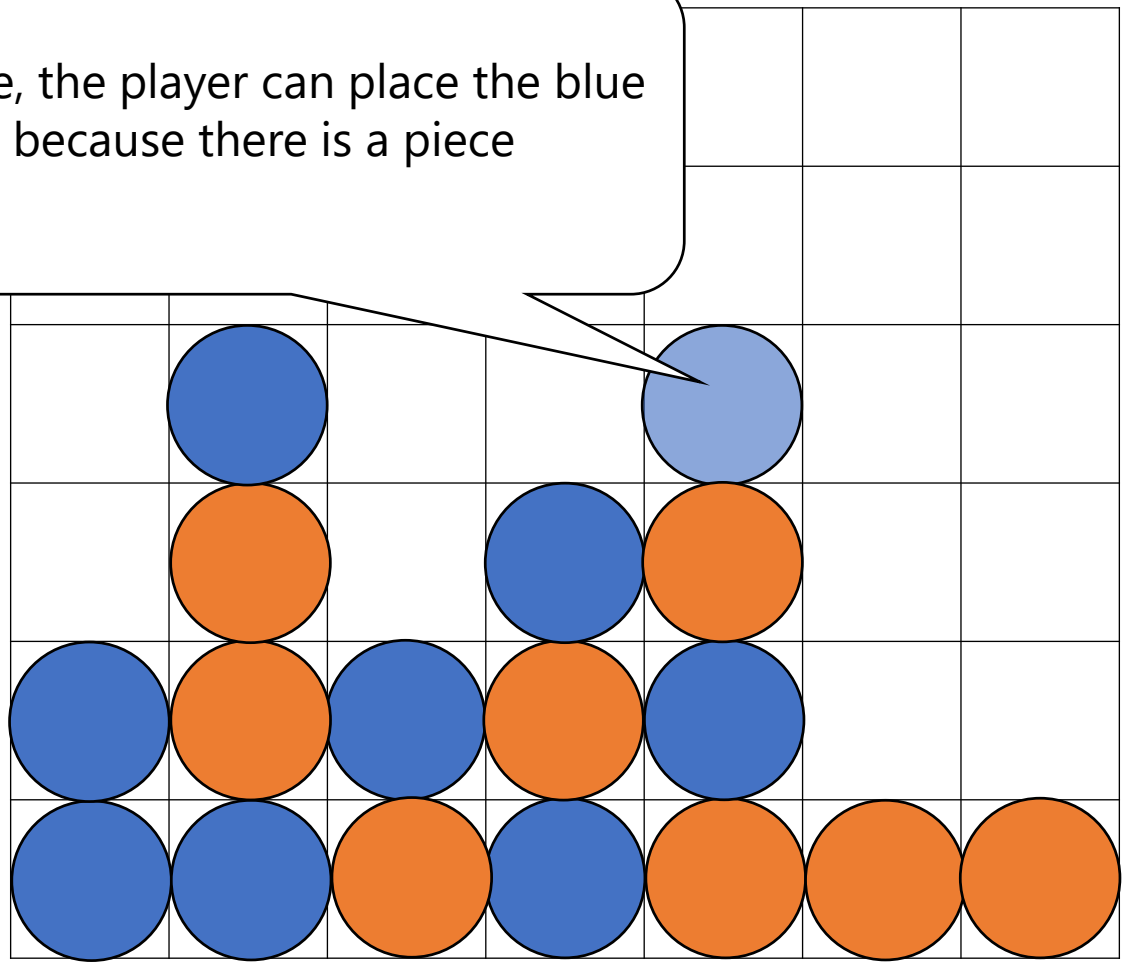
Remark on placing a piece

Blue wins if the player can put the piece here, but she cannot because there is not a piece below.



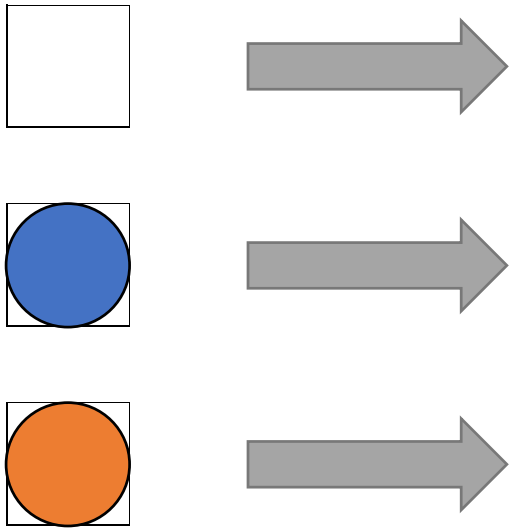
Remark on placing a piece

In this case, the player can place the blue piece here because there is a piece below.



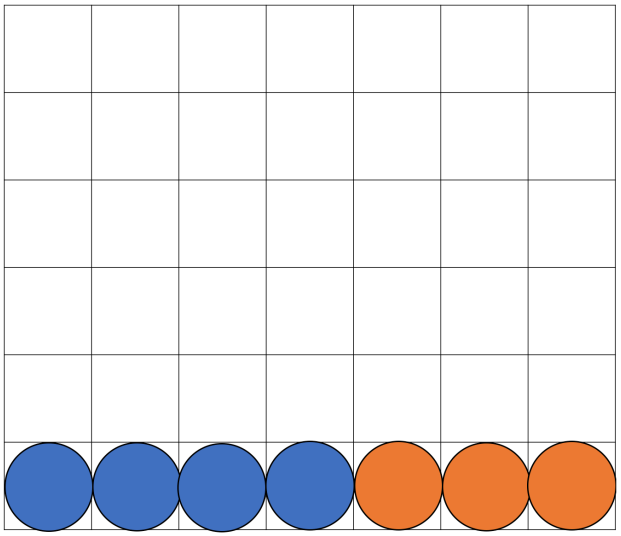
Example of implementation of the board 1/2

The board is often represented by a two-dimensional array in the source code. First, an empty space, a space with a blue piece, and a space with an orange piece are transformed as follows.



Example of implementation of the board 2/2

Using the transformation explained before, we can represent
the entire board as follows and implement the program that process it.



```
Board = [[“  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”],
         [[“  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”],
         [[“  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”],
         [[“  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”],
         [[“  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”, “  ”],
         [“O”, “O”, “O”, “O”, “X”, “X”, “X”]]

for(i=0; i<6; i++){
  for(j=0; j<7; j++){
    //write the code for Board[i][j]
  }
}
```

Outline of the experiment

Outline of the experiment

- Implement the game step by step.
- Implementation is divided into four steps.
- Each step forms an exercise.
- You can use any programming language.

Steps of implementing the game

In this experiment, you implement the game in the following steps.

1: Judgement of winner (vertical/horizontal)

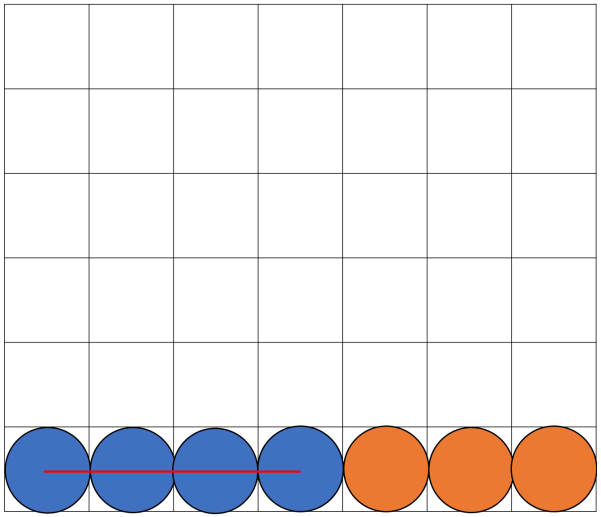
2: Judgement of winner (diagonal)

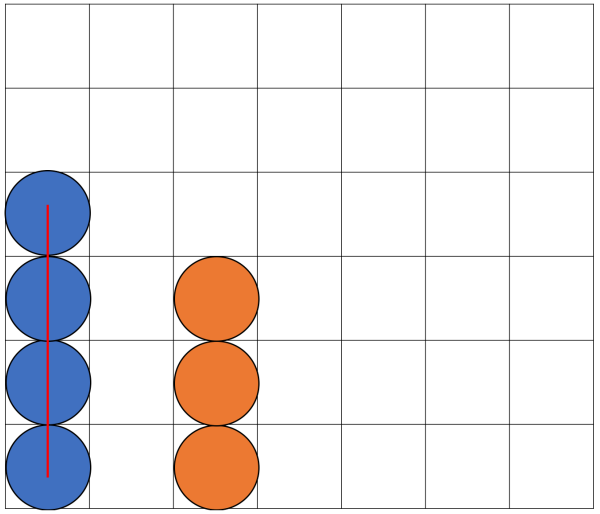
3: Functionality of placing a piece

4: Completion of implementation of the game

Exercise 1: Judgement of winner (vertical/horizontal)

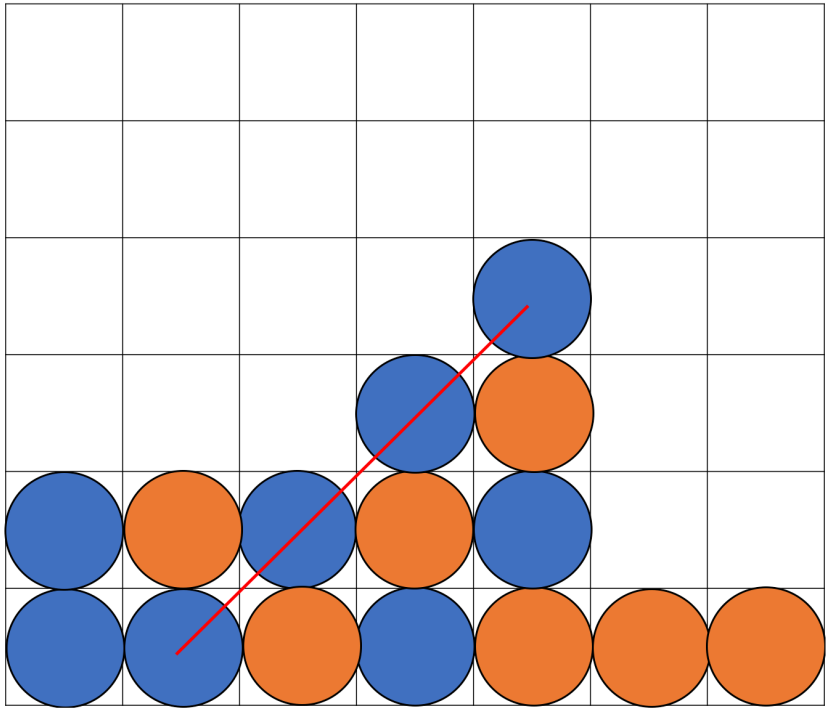
As the first step, implement detection of a vertical or a horizontal line of four pieces of the same color to determine the end of the game





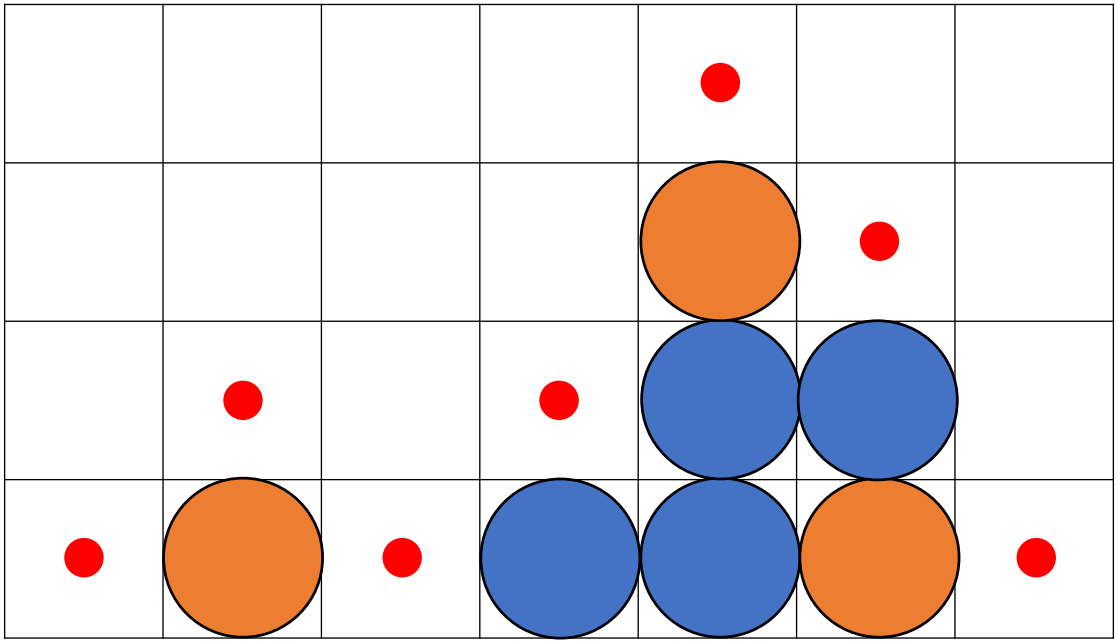
Exercise 2: Judgement of winner (diagonal)

Next, detect a diagonal line of four pieces of the same color.



Exercise 3: Functionality of placing a piece

In Exercise 3, implement the functionality for the players to place the pieces alternately. Note that they cannot place the pieces against gravity. (As for the example below, they can only place a piece in the space indicated by ● .



Exercise 3: Functionality of placing a piece

While you can implement in your own way, you can use the following example.

E.g. You can place a piece by inputting its coordinate using the keyboard.

```
X:3
Y:4
Placed the piece at (3,4)!
```

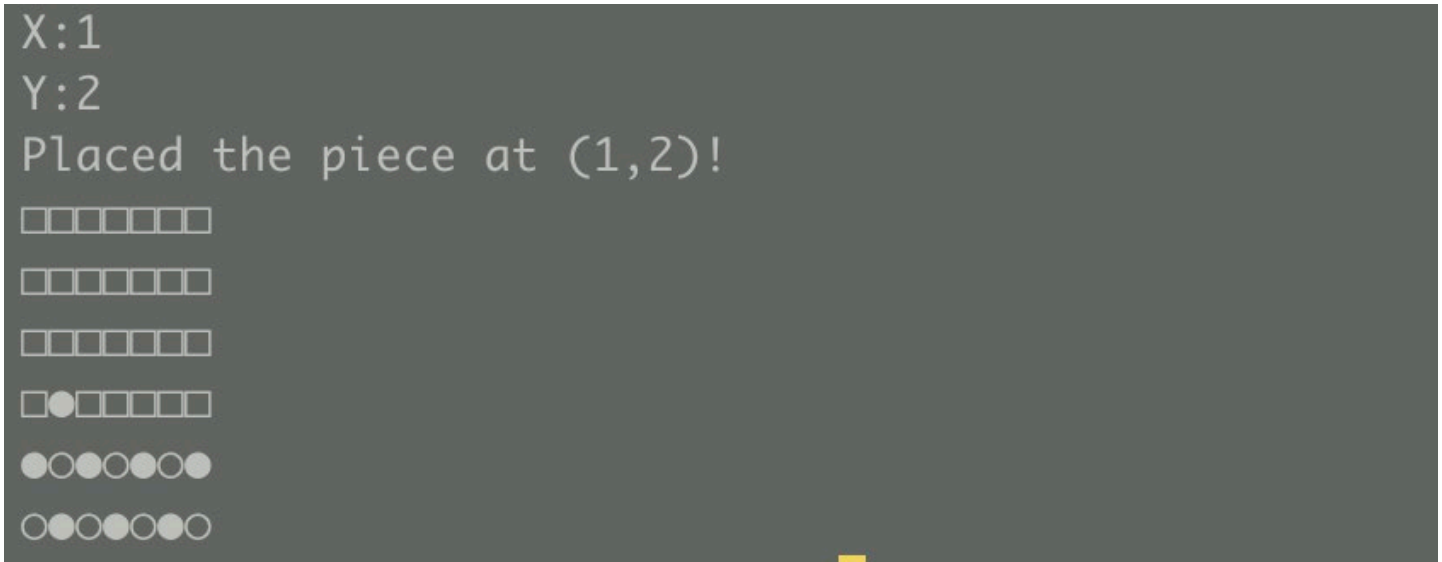
Exercise 4: Completion of implementation of the game

You will have implemented the functionality of judging the winner in Exercises 1 and 2, and the functionality of placing a piece in Exercise 3. Exercise 4 requires to compose the functionalities and enable us to play the game.

While you can implement in your own way, you can refer to the next slide.

Exercise 4: Completion of implementation of the game (example)

For example, you can implement the game by displaying the current state of the board when the player places a piece by specifying its coordinate.



Grading Policies

- You must submit your report by 17th, January, 2023.
- Your report must include source code, execution results of each exercise and the followings;
  - Originality and ingenuity of the algorithms you implemented if any
  - Comparison of the algorithms if you implemented several ones
- Your overall grade will be decided based on ease of understanding of your report as well as the report content.

Supplements

Introduction of online compilers

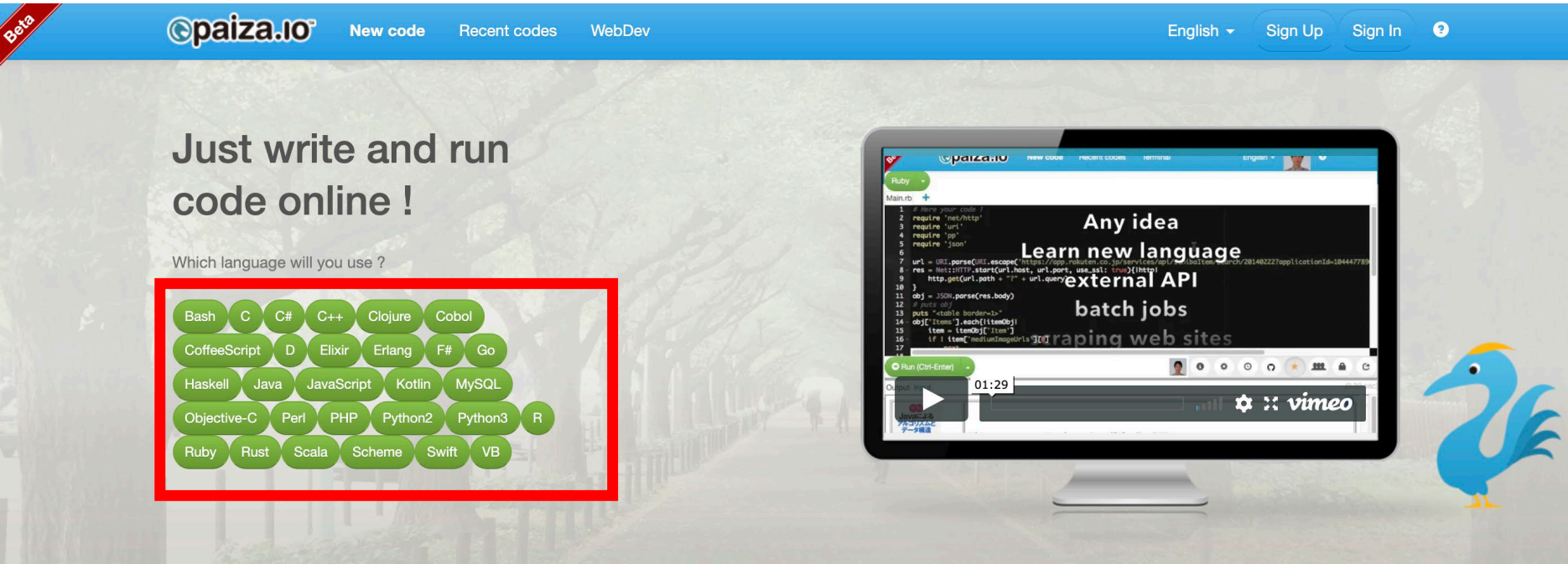
Online compilers enable you to compile and execute programs of various languages such as C and Java. They will help you if you have difficulties in setting the programming environments

paiza.io: https://paiza.io/en

Introduction of online compilers

If you choose a language you want to use in the red rectangle, an editor appears and you can start coding.

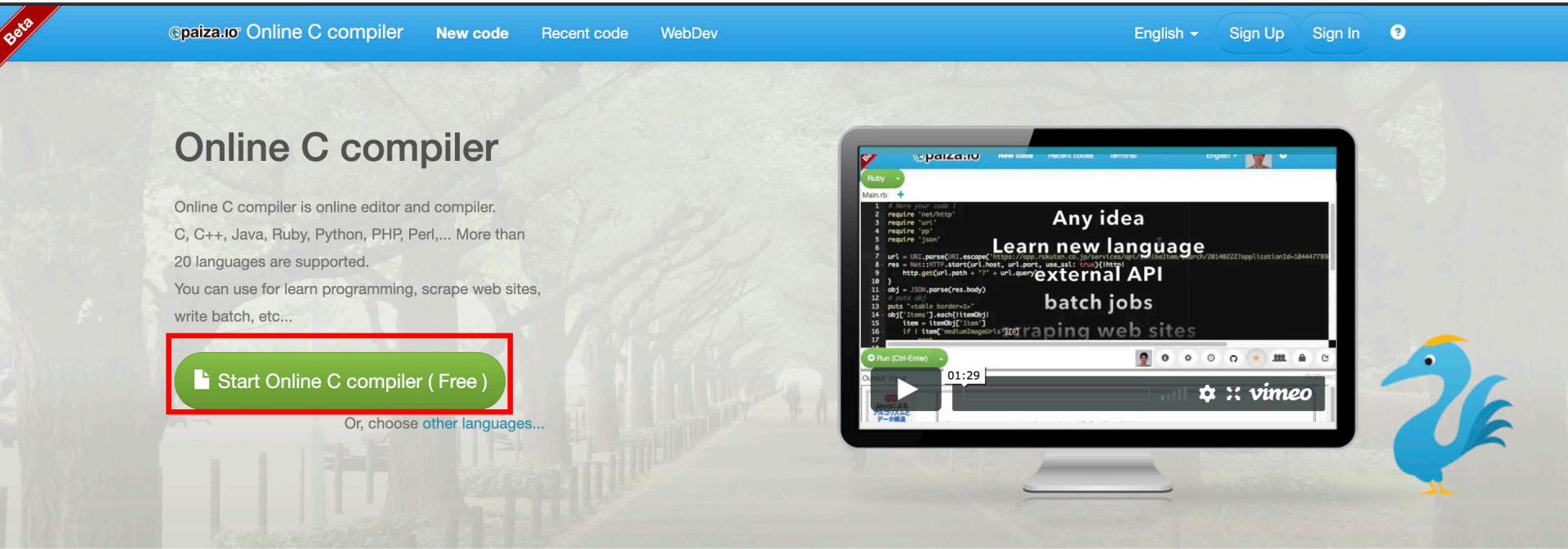
paiza.io: https://paiza.io/en



Introduction of online compilers

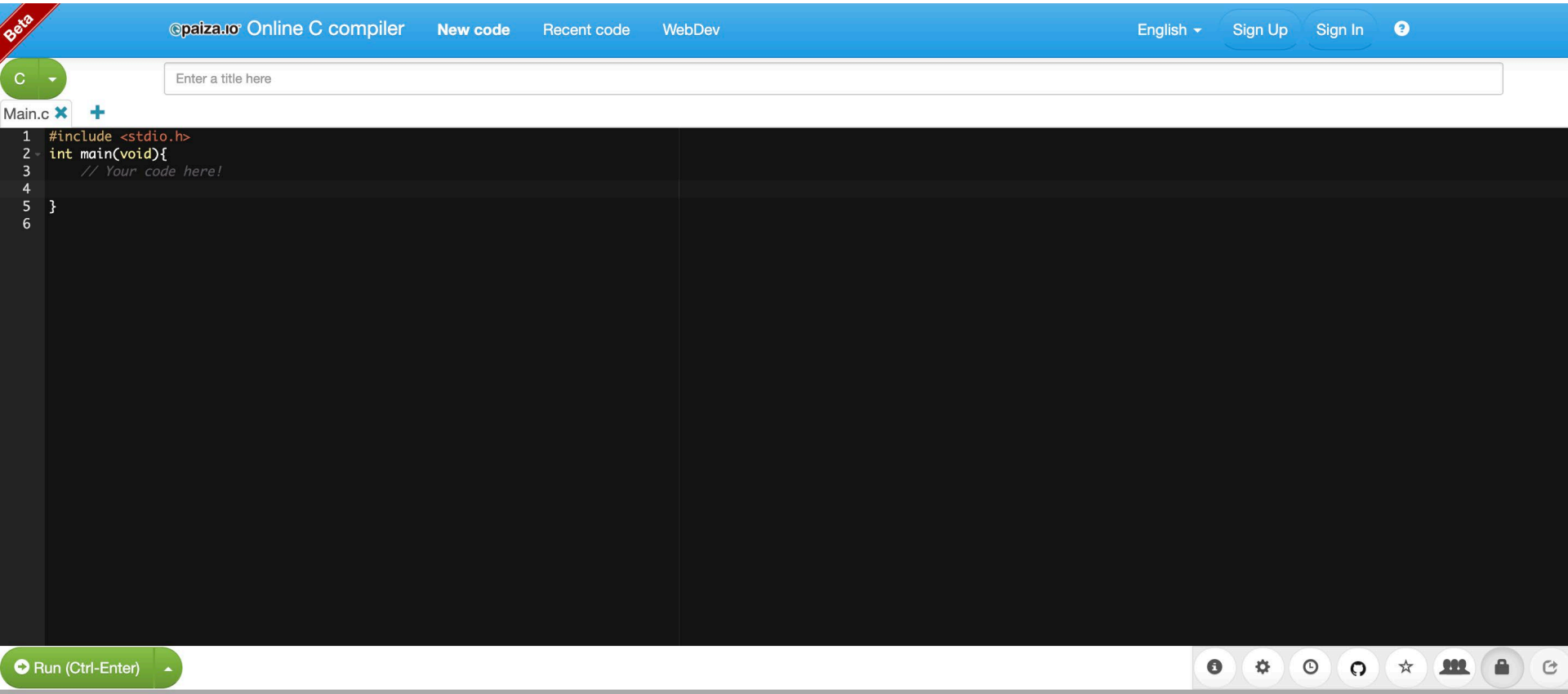
If you choose a language you want to use in the red rectangle and click the Start button, an editor appears and you can start coding.

paiza.io: https://paiza.io/en



Introduction of online compilers

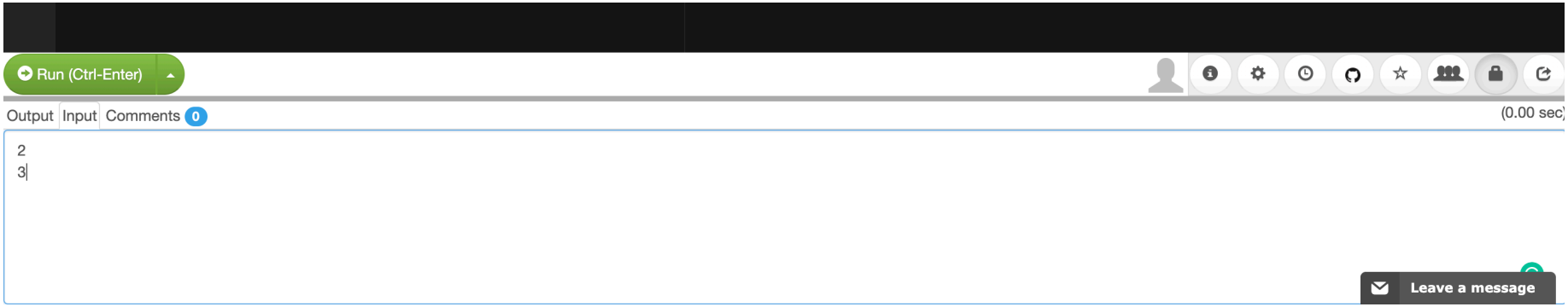
You type the code in the black part of the editor. If you click the Run button, the code is compiled and executed.



Introduction of online compilers

When you use the standard input needed in Exercises 3, 4, etc., you need to input the data in the “input” tab at the bottom of the editor.

If it is inconvenient in playing the game, it will be better to prepare for programming language environments in your PC and use them.



Introduction of Connect4

For those who feel difficult in understanding Connect4, I introduce the following games you can play in practice.

- 4 in a Line

- Nintendo Clubhouse Games: 51 Worldwide Classics (Four-in-a-row)（Nintendo Switch）