Assignment 3

Instructions

- Unless specified otherwise,
  - you can use anything in the Python Standard Library;
  - don't use any third-party library in your code for this assignment;
  - you can assume all user inputs are always valid and require no validation.
- The underlined blue texts in the Sample Runs section of each question refers to the user inputs. It does NOT mean that your program needs to underline them.
- Please follow closely the format of the sample output for each question. Your program should produce **exactly** the same output as the sample (same text, symbols, letter case, spacing, etc.). The output for each question should end with a single newline character, which has been provided by the `print()` function by default.
- Please follow exactly the specified name, parameter list and return value(s) for the functions to be written if a question has stated (for easier grading). You may define additional functions for specific tasks or further task decomposition in any question if you see fit.
- Name your script files as instructed in each question (case-sensitive). Using other names may affect our marking and may result in deduction.
- Your source files will be tested in script mode rather than interactive mode.
- You are highly encouraged to annotate your functions to provide type information for parameters and return values, and include suitable comments in your code to improve the readability.

Question 1 – Pizza Orders (20%)

Write a script named `pizza.py` that implements a simulation of a business selling pizzas. Each pizza order comprises one or more pizzas. There are two classes involved — `Pizza` and `PizzaOrder`.

For the `Pizza` class, it defines two class variables:
- **`ingredients`**: a dictionary containing 15 ingredients for making pizzas. The key is an integer between 1 and 15; the value is the name of each ingredient like "Ham", "Cheese", "Beef", etc.
- **`flavors`**: a dictionary storing mappings of 5 flavors and their corresponding lists of ingredients. There are 4 preset flavors, like Hawaiian, Carbonara, etc., each of which maps to a hard-coded list of ingredients. The last flavor is "Custom" which maps to an empty list; choosing it means to allow users to select their preferred ingredients from the 15 choices for making the pizza.

For your convenience, the definitions of these two variables have been provided below:

```python
class Pizza:
    ingredients = {1:"Ham", 2:"Sausage", 3:"Bacon", 4:"Beef", 5:"Meatball",
                   6:"Spinach", 7:"Olive", 8:"Mushroom", 9:"Tomato",
                   10:"Eggplant", 11:"Garlic", 12:"Cheese", 13:"Pineapple",
                   14:"Onion", 15:"Caper"}

    flavors = {"Hawaiian": [1, 13], "Garden Feast": [6, 7, 8, 9, 10],
               "Meat Festival": [2, 3, 4, 5], "Carbonara": [3, 12],
               "Custom": []}
```

For the `PizzaOrder` class, it has a class variable `total_orders` which records the total number of pizza orders received thus far.

Complete the implementations of these two classes by following the instructions below.

(a) In `Pizza`'s constructor, create two instance variables:
- `self.flavor` which is assigned with the `flavor` argument passed (which is a string);
- `self.ingreds` which is assigned with the argument `custom_ingreds` (a list of integers) passed if `flavor` equals "Custom" or assigned with the preset list of ingredient id's in the `Pizza.ingredients` dictionary which responds to the `flavor` argument passed.

(b) Override the `__str__()` method of `Pizza` which should return a string agreeing with the sample run as shown below.

(c) In `PizzaOrder`'s constructor, create two instance variables
- `self.order` which is the order id number; it should be set to 1 for the first pizza order, 2 for the second, and so on. (Hint: make use of the class variable `total_orders` here)
- `self.pizza_list` which is initialized as an empty list for each new order. The constructor should keep displaying a select menu (by calling the `select_menu()` method) for the user to pick a flavor from the 5 preset choices for ordering each pizza until receiving the response 'n' from the user for the question "Do you want more pizzas (y/n)?". Here, your program should also accept user input that is uppercase or probably with leading or trailing spaces. The return values from `select_menu()` are the flavor string and the custom ingredient id's list (if the user chose "Custom" flavor) which are used to construct a `Pizza` object, which is then appended to the `pizza_list` of the current `PizzaOrder` object.

(d) Define a static method `select_menu()`, which prints the flavor choice menu and prompts the user to enter a choice between 1 and 5. If the user picks 5 (i.e. Custom) as the choice, then it prints the ingredients choice list. The user should enter a space-separated list of numbers between 1 and 15 to indicate the ingredients desired for making the pizza. As said above, this method returns two values to the caller: (1) the flavor string, which is then used to map for the ingredient list from the ingredients dictionary; (2) the custom ingredient ids list, which is None if the user has picked any choice between 1 and 4, or a list of user input choices of ingredient id's if 5 ("Custom") was selected.

(e) Override the `__str__()` method of `PizzaOrder` which should return a string agreeing with the sample run as shown below.

Sample Client Code

Please put this under an `if __name__ == '__main__':` block of your script.

```
PizzaOrder.total_orders = 0
for i in range(3):  # placing 3 pizza orders
    po = PizzaOrder()
    print(po)
```

Sample Output

```
Pizza order 1:
1. Hawaiian
2. Garden Feast
3. Meat Festival
4. Carbonara
5. Custom
Select a flavor: 1↵
Do you want more pizzas (y/n)? y↵
1. Hawaiian
2. Garden Feast
3. Meat Festival
4. Carbonara
5. Custom
Select a flavor: 3↵
Do you want more pizzas (y/n)? n↵
```

```
Pizza order 1's summary:
1. Hawaiian (Ham, Pineapple)
2. Meat Festival (Sausage, Bacon, Beef, Meatball)

Pizza order 2:
1. Hawaiian
2. Garden Feast
3. Meat Festival
4. Carbonara
5. Custom
Select a flavor: 4↵
Do you want more pizzas (y/n)? y↵
1. Hawaiian
2. Garden Feast
3. Meat Festival
4. Carbonara
5. Custom
Select a flavor: 5↵
1: Ham, 2: Sausage, 3: Bacon, 4: Beef, 5: Meatball
6: Spinach, 7: Olive, 8: Mushroom, 9: Tomato, 10: Eggplant
11: Garlic, 12: Cheese, 13: Pineapple, 14: Onion, 15: Caper
Select id's of ingredients: 3 5 7 10 12 15↵
Do you want more pizzas (y/n)? y↵
1. Hawaiian
2. Garden Feast
3. Meat Festival
4. Carbonara
5. Custom
Select a flavor: 5↵
1: Ham, 2: Sausage, 3: Bacon, 4: Beef, 5: Meatball
6: Spinach, 7: Olive, 8: Mushroom, 9: Tomato, 10: Eggplant
11: Garlic, 12: Cheese, 13: Pineapple, 14: Onion, 15: Caper
Select id's of ingredients: 4 6 8 9 11 13↵
Do you want more pizzas (y/n)? n↵
Pizza order 2's summary:
1. Carbonara (Bacon, Cheese)
2. Custom (Bacon, Meatball, Olive, Eggplant, Cheese, Caper)
3. Custom (Beef, Spinach, Mushroom, Tomato, Garlic, Pineapple)

Pizza order 3:
1. Hawaiian
2. Garden Feast
3. Meat Festival
4. Carbonara
5. Custom
Select a flavor: 2↵
Do you want more pizzas (y/n)? n↵
Pizza order 3's summary:
1. Garden Feast (Spinach, Olive, Mushroom, Tomato, Eggplant)
```

Question 2 – The Gekitai Board Game (80%)

Write a Python module `gekitai.py` to implement a two-player board game called *Gekitai* (a Japanese word which means "repel" or "push away"). Here is the game description from the designer (we rephrased a little bit): Gekitai is a 3-in-a-row game played on a 6x6 grid. Each player has eight colored pieces and takes turns placing them anywhere on any open space on the board. When placed, a piece pushes all adjacent pieces outwards one space if there is an open space for it to move to (or off the board). Pieces shoved off the board are returned to the player. If there is not an open space on the opposite side of the pushed piece, it does not push (a newly played piece cannot push two or more other lined-up pieces). The first player who either (1) lines up three of their color in a row (horizontal or vertical or diagonal) at the end of their turn (after pushing), or (2) has all eight of their pieces on the board (also after pushing), is declared the winner. To quickly understand how to play this game, you may also watch this game review video or play this online game implementing Gekitai.

The key idea of this game is the "repel" effect when placing a piece onto the board. For example, refer to Figure 1 below. Suppose that the player (Red) of the current turn is to put a piece at location B2. Then all the three pieces (both the player's and opponent's) adjacent to B2 will be pushed away by one square outward. So, the black piece originally at A1 is shoved off the board and recycled to the player (Black) for making future turns whereas the pieces at C2 and B3 will be repelled to new positions D2 and B4 respectively.

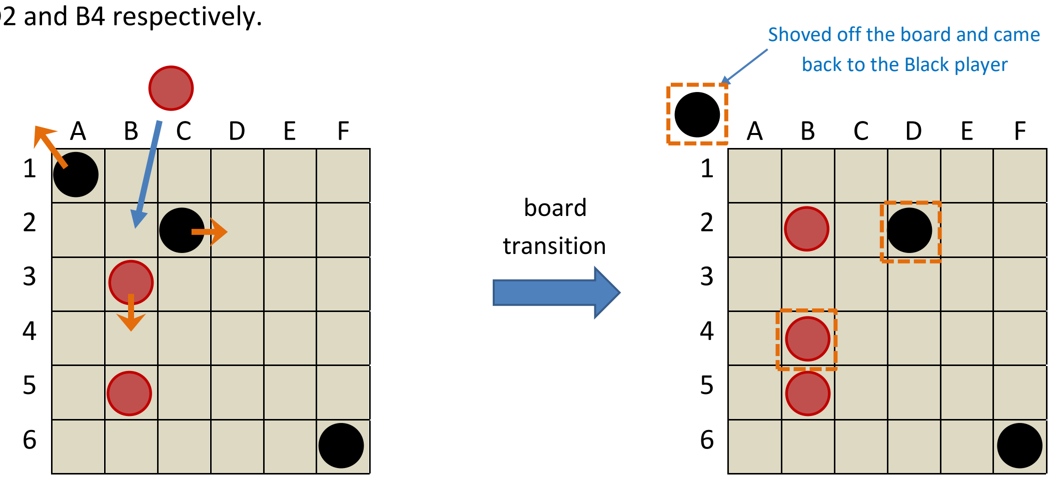


Figure 1: An example move on the game board and its effect on the adjacent pieces

However, remember (from the above description) that a move cannot push away a piece which has another adjacent piece (both the player's and opponent's) occupying the square it is being pushed onto. For example, look at Figure 2 below. If the player (Black) puts a piece at B3, it won't repel the piece at B4 downward because there is no open space (B5 is already occupied), and only the piece at B2 will be pushed upward to position B1.

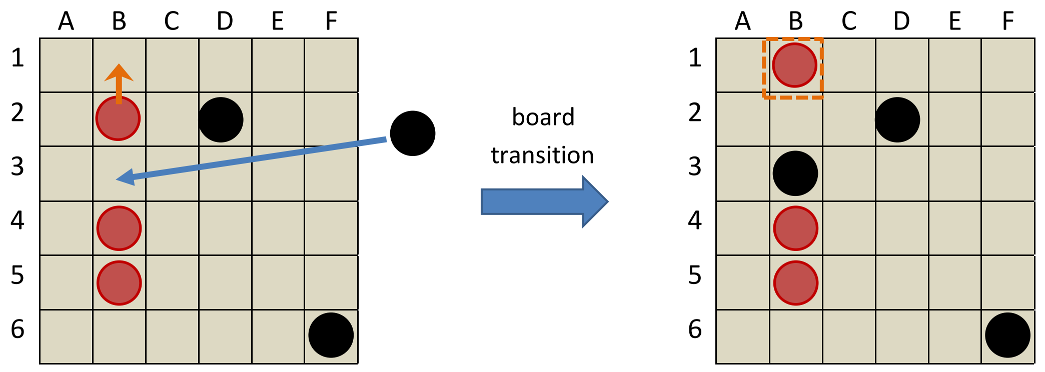


Figure 2: Another example move on the game board and its effect on the adjacent pieces

The last move made by Black was indeed a bad one – if Red puts a piece at B6 now, Red will win the game because three red pieces have formed a vertical line (see Figure 3).

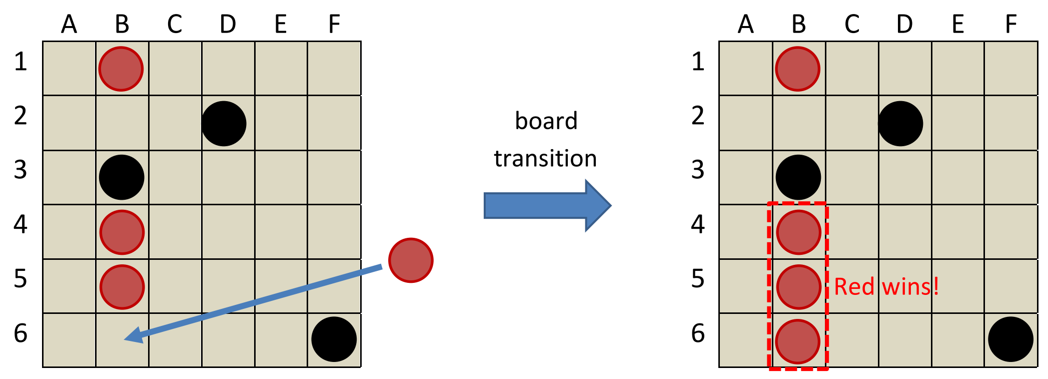


Figure 3: A move that lets Red win the game

To achieve the repelling effect, your program may need to scan all the eight directions (N, NE, E, SE, S, SW, W, NW) around the target position for a piece placement. For example, to put a piece at D3 in Figure 4, it should check if there exist any piece(s) at all the blue cells, and if any, it should check if the corresponding purple cell(s) are empty before moving the pieces outward into the purple cells.

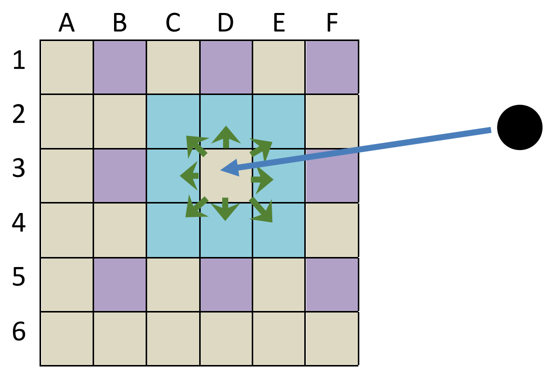


Figure 4: Positions to check to repel pieces adjacent to a target cell

Figure 5 below shows other possible winning conditions. Recall that a line can be formed horizontally, vertically, and diagonally, and that there is another winning condition: if all the eight pieces of the same color are placed on the board, the player of that color will win.

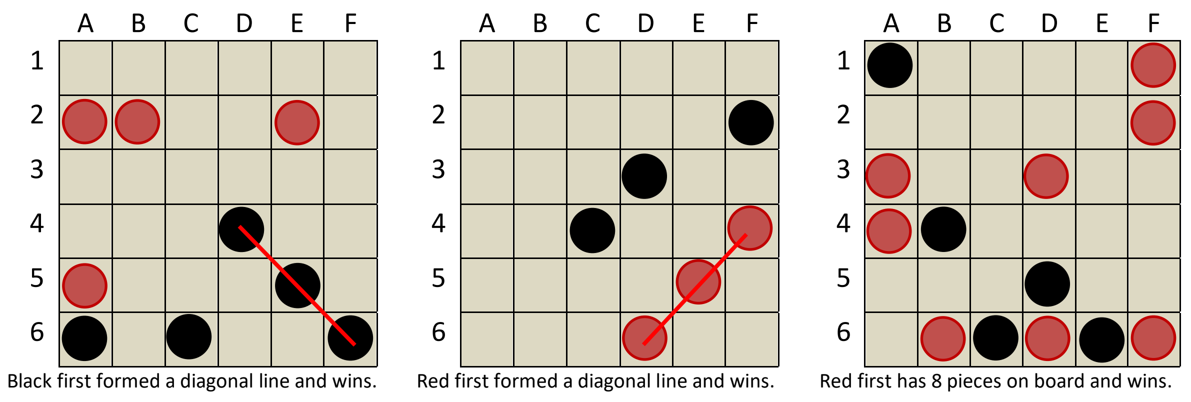

A
B
C
D
E
F
1
2
3
4
5
6
Black first formed a diagonal line and wins.
Red first formed a diagonal line and wins.
Red first has 8 pieces on board and wins.

Figure 5: Other winning conditions

Game Board Representation

We are going to implement this game as a console-based program and the game board will be represented by characters arranged in Figure 6 below:

```
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 | X |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   | O | X |   | X |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   | O |   |   |   |   |
  +---+---+---+---+---+---+
6 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
```

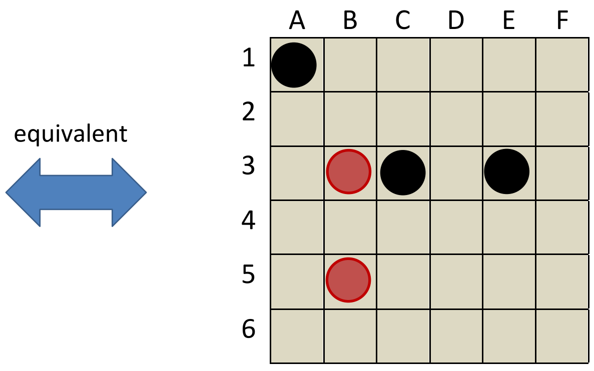


Figure 6: An example game board in the console

In the beginning, all cells on the board are empty. Pieces of player 1 (Black) and player 2 (Red) are denoted by 'X' and 'O' symbols, respectively.

Program Flow

1. The program starts the game with an empty board. Player 1 (X) takes the first turn.
2. Then, prompt the current player to enter a cell address to put a piece onto the board.
3. A piece cannot be placed onto the board if the target cell is not empty or if the position is outside the board's boundaries. In case it is not placeable, display a warning message "Invalid move!" and go back to Step 2.
4. Update the board by putting the input piece to the target position and repelling existing adjacent pieces away if there exists open space. (Recycle any off-the-board pieces to their owning players)
5. Swap player to take the next turn.
6. Repeat steps 2–5 until a player wins (forming a line of L pieces or having all P pieces put on the board). If both players satisfy either of the winning conditions concurrently, the moving player (i.e., the one taking the current turn) is regarded the winner.
7. When a game finishes, display the message *"Player X wins!"* or *"Player O wins!"* accordingly.

Assumptions

- The board is always a square, i.e., number of rows = number of columns.
- There are three basic configuration parameters for this game:
  - N = 6 is the board size (N^2 = number of cells);
  - P = 8 is the number of pieces per player;
  - L = 3 is the number of pieces required to form a line.
- To check if your program is scalable on these parameters instead of hardcoding, we may have a few test cases that vary theirs values although this may affect the original game rules. To support our testing, the constructor of your `Gekitai` class must follow this method signature:

  ```
  __init__(self, N: int = 6, P: int = 8, L: int = 3)
  ```

  Then we can create game objects for different test cases such as:

```
g1 = Gekitai()
g2 = Gekitai(7, 9, 4)
g3 = Gekitai(P=6)
```

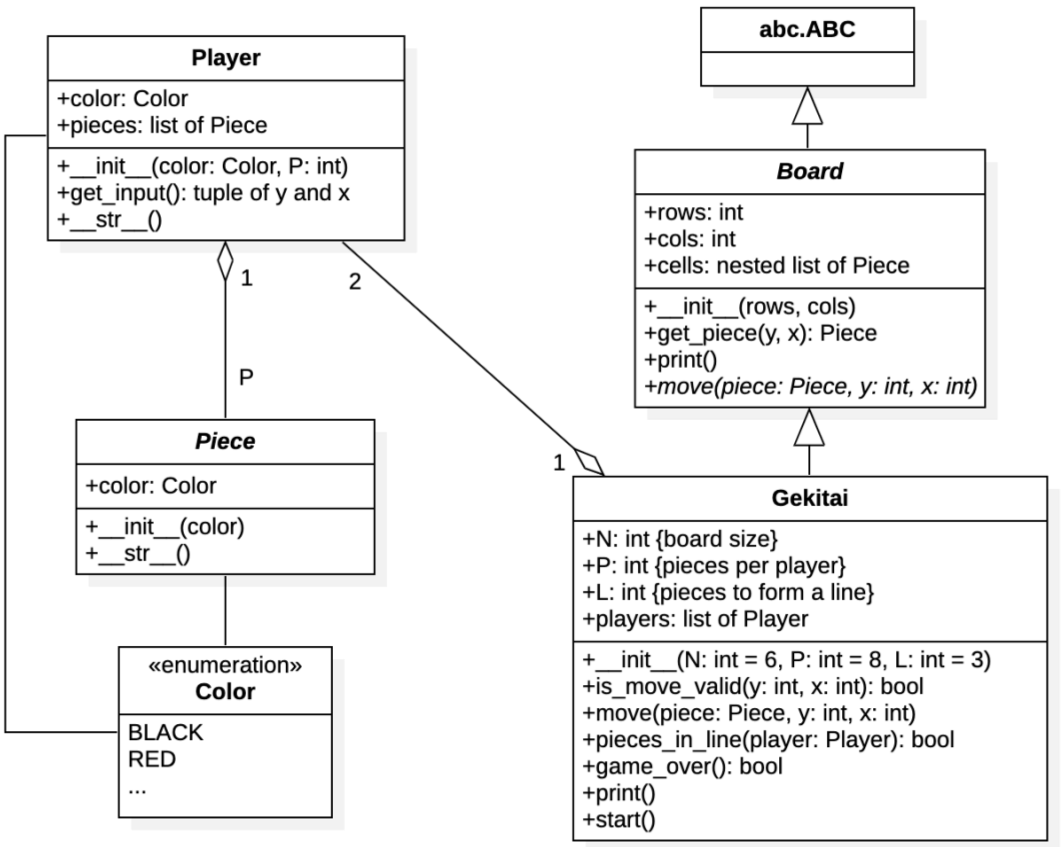
- You may assume the range for N is between 6 and 8, P between 6 and 12, and L between 3 and the minimum of N and P. Validation on these parameters is not strictly necessary as we will not test your program with values that are out of range, but you are welcome to add the following assertion when constructing the `Gekitai` object:

  ```
  assert 6 <= N <= 8 and 6 <= P <= 12 and 3 <= L <= min(N, P)
  ```

- We assume that cell address inputs always follow the Excel-like format of one letter (A-Z or a-z) plus one integer (1-26). Uppercase or lowercase inputs like "A1", "c6", or even having some spaces in the string like " b 5 " will be accepted as normal. Use exception handling techniques to avoid program crash due to weird inputs like "AA1", "A01", "abc", "A3.14", "#a2", … for cell addresses, which may raise `ValueError` when getting the user input.
- There is no draw game based on the official game rules. Due to the repelling effect, it is possible that a move may cause both players to form a line of L pieces at the same time. In this case, the official game rules regard the moving player as the winner. The same applies to the case that the moving player putting his/her last piece on the board but causing the opponent to form a line.

OO Design for this Game

You must use OOP to develop this program. Please take reference of the UML class diagram below which is our suggested OO design for this problem.


Player
+color: Color
+pieces: list of Piece
+__init__(color: Color, P: int)
+get_input(): tuple of y and x
+__str__()
1
2
P
Piece
+color: Color
+__init__(color)
+__str__()
«enumeration»
Color
BLACK
RED
...
abc.ABC
Board
+rows: int
+cols: int
+cells: nested list of Piece
+__init__(rows, cols)
+get_piece(y, x): Piece
+print()
+move(piece: Piece, y: int, x: int)
1
Gekitai
+N: int {board size}
+P: int {pieces per player}
+L: int {pieces to form a line}
+players: list of Player
+__init__(N: int = 6, P: int = 8, L: int = 3)
+is_move_valid(y: int, x: int): bool
+move(piece: Piece, y: int, x: int)
+pieces_in_line(player: Player): bool
+game_over(): bool
+print()
+start()
Figure 7: UML class diagram for the game program design

Note: For the operations or methods in the UML diagram, we omit the `self` parameter which is Python-specific and not meaningful in UML which is independent of the OOP language being used.

This question aims at testing your implementation skills rather than your OO design skills. Therefore, whenever possible, just follow our given design in your submitted code (while you are encouraged to try other designs in your own separate code versions that need not be submitted). Having that said, we allow some leeway to differ from this suggested design as long as your program generates the correct output. In fact, the above diagram is only a baseline design and some details (at attribute or operation level) are omitted. **During your coding, please feel free to add new attributes or methods when you see it fit.**

Some points to assist your understanding of the UML diagram and coding:

- A player holds P pieces. In OO terms, one `Player` object aggregates P `Piece` objects.
- Gekitai is a two-player board game. So, one `Gekitai` object aggregates 2 `Player` objects.
- In coding, we usually use an array or list to realize an aggregation relationship, e.g., for the `Player` class, define an instance variable which is a list of P `Piece` objects.
- The *Board* class is shown in italic in the diagram. This notation is a UML syntax to mean that the class is *abstract*. It is an abstract class (or ABC) as it contains an abstract method `move()`, again in italic, whose implementation is not yet known until we know what game the board represents. The `Gekitai` class (representing a specific board game) should override this abstract method by its own version of how to move a piece to reflect its game rules, e.g., repelling adjacent pieces.
- While the Board class is abstract, it does contain some methods that are concrete and reusable. For example, the method to print the board and the method to get a piece from a target position (y, x), which means row y column x on the board, are common for most board games. We prefer implementing these methods at the parent class level for better generalization and code reuse.

Color Enum Class

Pieces and players should have a color attribute for identification purpose. Regarding this, a simple way can be adding an integer 0 or 1 to the objects to distinguish black from red. But we recommend using an enumeration class to define a new type for color. Check out the enum module in Python. For example, you can define the following `Color` class by extending `Enum`:

```python
from enum import Enum
class Color(Enum):
    BLACK = 'X'
    RED = 'O'

c = Color.RED
```

Then you can get the name string 'RED' via `c.name` and the value string 'O' via `c.value`.

Piece Class

Attributes:

- `color`: the color identifying which player this piece belongs to

Methods:

This class may have no methods. But depending on your implementation choice, you may choose to override the `__str__()` method to print the `Piece` object as some more meaningful string like the 'X' or 'O' symbol than the object's type and memory address. (Doing so or not is optional.)

`Player` Class

Attributes:

- `color`: the color identifying the player
- `pieces`: a list of `Piece` objects which represent game pieces that are with the player, i.e., pending to be put onto the game board.

Methods:

`get_input(self) -> tuple[int, int]`

Get the input cell address (Excel-format) from the user (current player) and return a tuple `(y, x)` where y and x (zero-based indexes) refer to the target cell at row y and column x.

Again, depending on your implementation choice, you may override the `__str__()` method to print the `Player` object as some string reflecting the 'X' or 'O' symbol if this brings convenience.

`Board` Class

Attributes:

- `cells`: a nested list (2D array) implementing the game board. Each element (representing a cell) is storing either a `Piece` object or something such as None that represents an empty cell.
- `rows`: the number of rows for the `cells` array
- `cols`: the number of columns for the `cells` array

Methods:

`get_piece(self, y, x) -> Piece`

Return the element `cells[y][x]` which is either a `Piece` object or something like None that represents an empty cell. (Note: think about how to handle cases that y and x are beyond the dimensions of the `cells` array.)

`print(self)`

Print the game board in the format as shown in Figure 6.

`move(self, piece: Piece, y: int, x: int)`

(An abstract method that is being overridden by a subclass)

`Gekitai` Class

It is a subclass of the `Board` abstract class.

Attributes:

- `N`: board size
- `P`: the total number of pieces given to each player
- `L`: the number of pieces required to form a line
- `players`: a list or tuple of the two `Player` objects

Methods:

`is_move_valid(self, y: int, int x: int) -> bool`

Return `True` if it is valid to move a piece onto the board at row y and column x (zero-based indexes), i.e., if the element `cells[y][x]` is an empty cell. Otherwise, it returns `False`. (Note that depending on your design, if x and y are beyond the board’s boundaries, it can also return `False`.)

`move(self, piece: Piece, y: int, x: int)`

This function carries out updates of the `cells` array to actualize the effects of moving a piece of the current player into the cell at row `y` and column `x` (zero-based indexes). This includes setting the element `cells[y][x]` to `piece` and moving its adjacent pieces (the 8 possible cells surrounding `cells[y][x]`) outward by one square if there is open space for them to move into.

`pieces_in_line(self, player: Player) -> bool`

Return `True` if it can find L consecutive pieces in a line on the board that belong to the specified `player`, and `False` otherwise. Calling this method will be useful to assist determining whether the game is over. When it returns `True`, that means the specified `player` has won.

`game_over(self) -> bool`

Return `True` if it finds any player has satisfied any of the winning conditions, i.e., L pieces in one line (horizontal, vertical or diagonal) or P pieces arrived on the board.

`print(self)`

This overrides Board's `print()` method. Besides printing the game board, it also prints the list of pieces that are still with each player, i.e., those that are not yet on the board. (See our provided sample output to know more).

`start(self)`

This method implements the main loop of the game, prompting players to make moves in turns by calling the `get_input()` method of each `Player` object.

Final Remarks

- You should avoid using global variables whenever possible (except for those that are read-only).
- Your program should include suitable comments as documentation. Each class must have a "doc string" to describe what it is (our sample program has purposely omitted them so that you cannot copy and need to write them up in your own words). You are also highly encouraged to do the same at method level. Missing class-level doc strings will invite some mark deduction.

Sample Runs

```
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O', 'O', 'O']
Player X's turn: H3↵
Invalid move!
Player X's turn: A-1↵
Invalid move!
Player X's turn: @# \ 789↵
Invalid move!
Player X's turn: A 1↵
```

```
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 | X |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O', 'O', 'O']
Player O's turn: a6↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 | X |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 | O |   |   |   |   |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O', 'O']
Player X's turn: a6↵
Invalid move!
Player X's turn: c3↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 | X |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   | X |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 | O |   |   |   |   |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O', 'O']
Player O's turn: d4↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 | X |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   | X |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   | O |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 | O |   |   |   |   |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O']
Player X's turn: c3↵
```

```
Game over:
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 | X |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   | X |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   | X |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   | O |   |
  +---+---+---+---+---+---+
6 | O |   |   |   |   |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O']
Player X wins!
```

Another example run in which both players formed a line of 3 pieces simultaneously:

```
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O', 'O', 'O']
Player X's turn: e6↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O', 'O', 'O']
Player O's turn: a2↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 | O |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X', 'X']
```

```
O: ['O', 'O', 'O', 'O', 'O', 'O', 'O']
Player X's turn: e4↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 | O |   |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O', 'O']
Player O's turn: c2↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 | O |   | O |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
5 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
6 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O']
Player X's turn: e3↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 | O |   | O |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
5 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
6 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O', 'O']
Player O's turn: d2↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 | O | O |   | O |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   | X |
  +---+---+---+---+---+---+
5 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
6 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O']
Player X's turn: c5↵
```

```
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
2 | O | O |   | O |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   | X |
  +---+---+---+---+---+---+
5 |   |   | X |   | X |   |
  +---+---+---+---+---+---+
6 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O', 'O']
Player O's turn: e1↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   | O |   |
  +---+---+---+---+---+---+
2 | O | O |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   | O |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   |   |   | X |
  +---+---+---+---+---+---+
5 |   |   | X |   | X |   |
  +---+---+---+---+---+---+
6 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X', 'X']
O: ['O', 'O', 'O', 'O']
Player X's turn: b6↵
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   | O |   |
  +---+---+---+---+---+---+
2 | O | O |   |   |   |   |
  +---+---+---+---+---+---+
3 |   |   | O |   |   |   |
  +---+---+---+---+---+---+
4 |   |   |   | X |   | X |
  +---+---+---+---+---+---+
5 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
6 |   | X |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X']
O: ['O', 'O', 'O', 'O']
Player O's turn: c4↵
Game over:
    A   B   C   D   E   F
  +---+---+---+---+---+---+
1 |   |   |   |   | O |   |
  +---+---+---+---+---+---+
2 | O | O | O |   |   |   |
  +---+---+---+---+---+---+
3 |   |   |   |   |   |   |
  +---+---+---+---+---+---+
4 |   |   | O |   | X | X |
  +---+---+---+---+---+---+
5 |   |   |   |   | X |   |
  +---+---+---+---+---+---+
6 |   | X |   |   | X |   |
  +---+---+---+---+---+---+
X: ['X', 'X', 'X']
O: ['O', 'O', 'O']
Player O wins!
```

Sample Executable

For more sample runs, you can execute our provided modules in binary format:

- `gekitai.so` (for macOS)
- `gekitai.pyd` (for Windows)

Put the corresponding binary file in your current directory. Start a Python shell and type the following to start a game using the default configuration for N, P and L.

```python
from gekitai import Gekitai
game = Gekitai()
game.start()
```

If you want to customize any of N, P and L, it is just a matter of passing valid arguments when constructing the game object. For example,

```python
from gekitai import Gekitai
game = Gekitai(7, 9, 4)
game.start()
```