

FRQ – class Crossword

1. A crossword puzzle grid is a two-dimensional rectangular array of black and white squares. Some of the white squares are labeled with a positive number according to the crossword labeling rule.

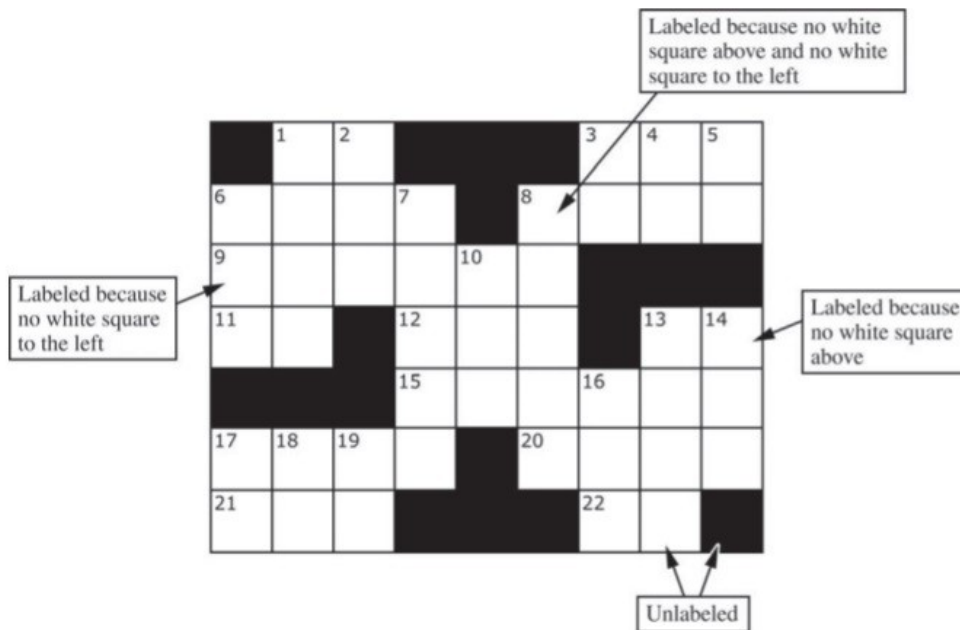
The crossword labeling rule identifies squares to be labeled with a positive number as follows.

A square is labeled with a positive number if and only if

- the square is white and
- the square does not have a white square immediately above it, or it does not have a white square immediately to its left, or both.

The squares identified by these criteria are labeled with consecutive numbers in row-major order, starting at 1.

The following diagram shows a crossword puzzle grid and the labeling of the squares according to the crossword labeling rule.



This question uses two classes, a `Square` class that represents an individual square in the puzzle and a `Crossword` class that represents a crossword puzzle grid. A partial declaration of the `Square` class is shown below.

```
public class Square {
    /** Constructs one square of a crossword puzzle grid.
     * Postcondition:
     * - the square is black if and only if "isBlack" is true
     * - the square has number "num"
     */
    public Square(boolean isBlack, int num) {
        /* implementation not shown */
    }

    // There may be instance variables, constructors, and methods
    // that are not shown.
}
```

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A partial declaration of the Crossword class is shown below. You will implement one method and the constructor in the Crossword class.

```
public class Crossword {
    /** Each element is a Square object with a color
     * (black or white) and a number.
     * puzzle[r][c] represents the square in row r, column c.
     * There is at least one row in the puzzle;
     */
    private Square[][] puzzle;

    /** Constructs a crossword puzzle grid.
     * Precondition: There is at least one row in blackSquares.
     * Postcondition:
     * - the crossword puzzle grid has the same dimensions as
     *   blackSquares.
     * - the Square object at row r, column c in the crossword
     *   puzzle is black if and only if blackSquares[r][c] is true;
     * - the squares in the puzzle are labeled according to the
     *   crossword labeling rule
     */
    public Crossword(boolean[][] blackSquares) {
        /* to be implemented in part (b) */
    }

    /**
     * Returns "true" if the square at row "r", column "c" should be
     * labeled with a positive number; false otherwise
     * The square at row "r", column "c" is black if and only if
     * "blackSquares[r][c]" is "true".
     * Precondition: "r" and "c" are valid indexes in "blackSquares".
     */
    public boolean toBeLabeled(int r, int c, boolean[][] blackSquares)
    {
        /* to be implemented in part (a) */
    }

    // There may be instance variables, constructors, and methods
    // that are not shown.
}
```

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- a) Write the `Crossword` method `toBeLabeled`. The method returns `true` if the square indexed by row `r`, column `c` in a crossword puzzle grid should be labeled with a positive number according to the crossword labeling rule; otherwise it returns `false`. The parameter `blackSquares` indicates which squares in the crossword puzzle grid are black.

Class information for this question:

```
public class Square  
public class Square(boolean isBlack, int num)  
  
public class Crossword  
  
private Square[][] puzzle  
  
public Crossword(boolean[][] blackSquares)  
private boolean toBeLabeled(int r, int c, boolean[][] blackSquares)
```

Complete method `toBeLabeled` below.

```
/**  
 * Returns "true" if the square at row "r", column "c" should be  
 * labeled with a positive number; false otherwise  
 * The square at row "r", column "c" is black if and only if  
 * "blackSquares[r][c]" is "true".  
 * Precondition: "r" and "c" are valid indexes in "blackSquares".  
 */  
private boolean toBeLabeled(int r, int c, boolean[][] blackSquares)
```

/* 3 marks */

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- b) Write the `Crossword` constructor. The constructor should initialize the crossword puzzle grid to have the same dimensions as the parameter `blackSquares`. Each element of the puzzle grid should be initialized with a reference to a `Square` object with the appropriate color and number. The number is positive if the square is labeled and 0 if the square is not labeled.

Assume that `toBeLabeled` works as specified, regardless of what you wrote in part (a). You must use `toBeLabeled` appropriately to receive full credit.

Complete the `Crossword` constructor below.

```
/** Constructs a crossword puzzle grid.
 * Precondition: There is at least one row in blackSquares.
 * Postcondition:
 * - the crossword puzzle grid has the same dimensions as blackSquares.
 * - the Square object at row r, column c in the crossword puzzle is
 *   black if and only if blackSquares[r][c] is true;
 * - the squares in the puzzle are labeled according to the crossword
 *   labeling rule
 */
public Crossword(boolean[][] blackSquares)
```

/* 6 marks */