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.

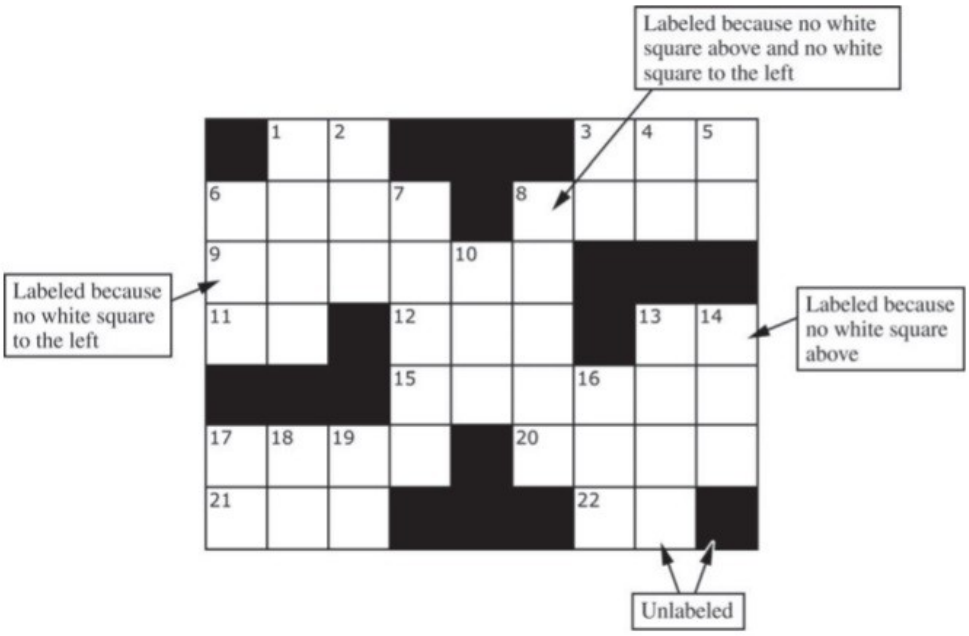
   The crossword labeling rule identifies squares to be labeled with a positive number as follows.

   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.
```

FRQ – class Crossword

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.
```

FRQ – class Crossword

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)
{
   if(blackSquares[r][c]) {
      return false;
   }
   if(r == 0 || blackSquares[r-1][c] ||
      c == 0 || blackSquares[r][c-1])
   {
      return true;
   }
   return false;
}
```

+1 Checks `blackSquares[r][c]`
+1 Checks for black square/border to the left/above (no bounds errors)
+1 Returns `true` if square should be labeled with positive number; returns `false` otherwise

/* 3 marks */

FRQ – class Crossword

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)
{
   final int rows = blackSquares.length;
   final int cols = blackSquares[0].length;
   puzzle = new Square[rows][cols];

   int num = 1;
   for(int row = 0; row < puzzle.length; row++) {
      for(int col = 0; col< puzzle[row].length; col++) {
         boolean isBlack = blackSquares[row][col];
         if(toBeLabeled(row, col, blackSquares)) {
            puzzle[row][col] = new Square(false, num);
            num++;
         } else {
            puzzle[row][col] = new Square(isBlack, 0);
         }
      }
   }
}
```

Scoring

+1 create a new array appropriately, for example:
`puzzle = new Square[blackSquares.length][blackSquares[0].length];`
+1 accesses all locations in puzzle (no bounds errors)
+1 calls to toBeLabeled with appropriate parameters
+1 Creates and assigns new Square to location in puzzle.length
+1 Numbers identified squares consecutively, in row-major order, starting at 1
+1 On exit: all squares in puzzle have correct color and number (*minor errors covered in previous points ok*)
-2 (p) Consistently uses incorrect name instead of `puzzle`
-1 (q) Uses `array[].length` instead of `array[num].length`

/* 6 marks */