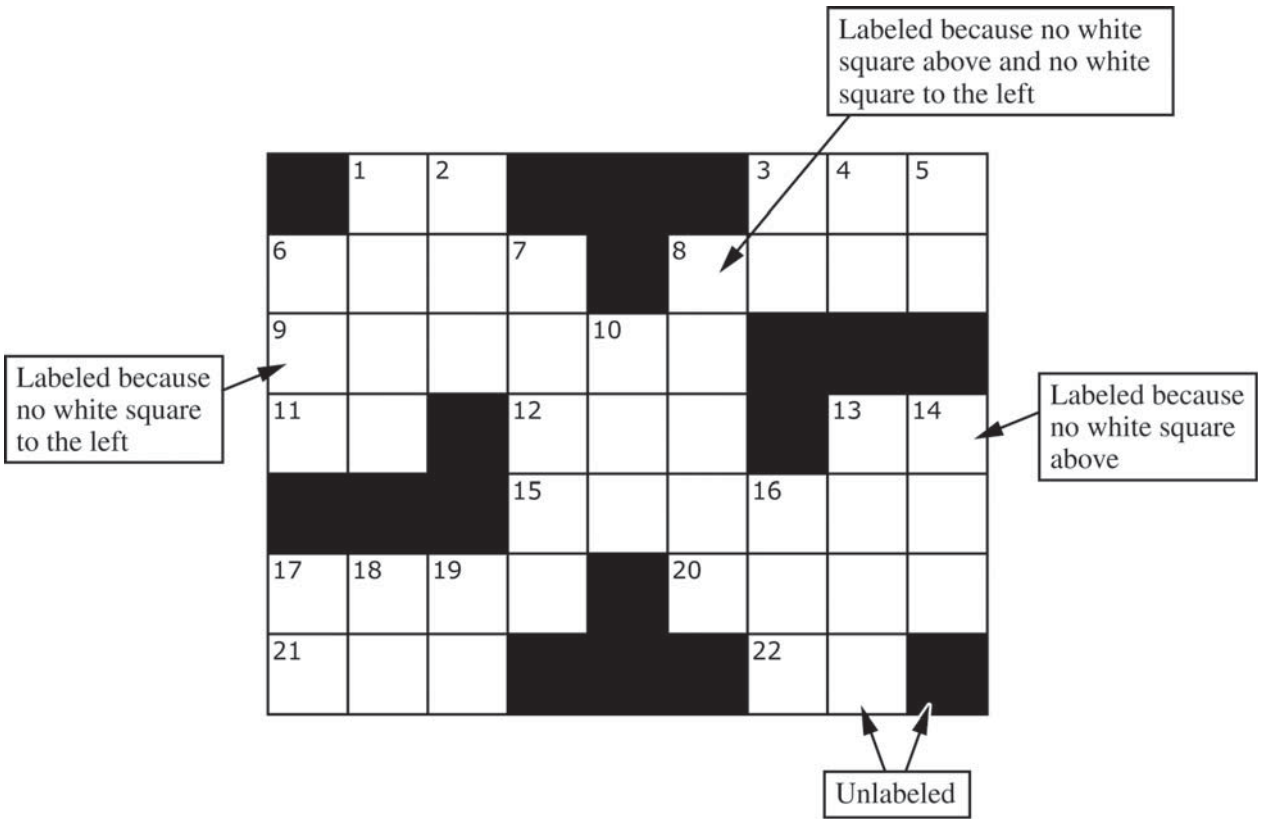
3. A crossword puzzle grid is a two-dimensional rectangular array of black and white squares. Some of the white squares are labeled with a positive number according to the *crossword labeling rule*.

   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.


Labeled because no white square above and no white square to the left
Labeled because no white square to the left
Labeled because no white square above
Unlabeled
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

GO ON TO THE NEXT PAGE.

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.
}
```

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 grid 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.
     */
    private 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.
}
```

Part (a) begins on page 14.

GO ON TO THE NEXT PAGE.

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Question 3: Crossword

Part (a)	`toBeLabeled`	**3 points**

Intent: *Return a* `boolean` *value indicating whether a crossword grid square should be labeled with a positive number*

+1 Checks `blackSquares[r][c]`

+1 Checks for black square/border above and black square/border to the left (*no bounds errors*)

+1 Returns `true` if square should be labeled with positive number; returns `false` otherwise

Part (b)	`Crossword` constructor	**6 points**

Intent: *Initialize each square in a crossword puzzle grid to have a color* `(boolean)` *and an integer label*

+1 `puzzle = new Square[blackSquares.length][blackSquares[0].length];` (*or equivalent*)

+1 Accesses all locations in `puzzle` (*no bounds errors*)

+1 Calls `toBeLabeled` with appropriate parameters

+1 Creates and assigns new `Square` to location in `puzzle`

+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*)

Question-Specific Penalties

-2 (p) Consistently uses incorrect name instead of `puzzle`

-1 (q) Uses *array*`[].length` instead of *array*`[`*num*`].length`

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2016 CANONICAL SOLUTIONS

Question 3: Crossword

Part (a):

```
private boolean toBeLabeled(int r, int c, boolean[][] blackSquares)
{
     return (!(blackSquares[r][c]) &&
           (r == 0 || c == 0 || blackSquares[r - 1][c] ||
            blackSquares[r][c - 1]));
}
```

Part (b):

```
public Crossword(boolean[][] blackSquares)
{
     puzzle = new Square[blackSquares.length][blackSquares[0].length];
     int num = 1;

     for (int r = 0; r < blackSquares.length; r++)
     {
          for (int c = 0; c < blackSquares[0].length; c++)
          {
               if (blackSquares[r][c])
               {
                    puzzle[r][c] = new Square(true, 0);
               }
               else
               {
                    if (toBeLabeled(r, c, blackSquares))
                    {
                         puzzle[r][c] = new Square(false, num);
                         num++;
                    }
                    else
                    {
                         puzzle[r][c] = new Square(false, 0);
                    }
               }
          }
     }
}
```