Array Plotter
Plotting Pictures in a 2D Grid

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Introduction

In this lab you will implement methods for drawing in a two-dimensional grid by changing the elements in a 2D array of `boolean` values. This will give you practice with developing algorithms for two-dimensional arrays.

You will manage a 2D array of `boolean` values named `colorArray`. This array will be used to color a two-dimensional grid of colors. If an element of `colorArray` has the value `true`, then the corresponding grid cell color will be the "drawing color". If it has the value `false`, then the corresponding grid cell color will be the "background color". See the example below in which the grid on the right is filled in with colors based on the `colorArray` array on the left. In this example, the "drawing color" is red and the "background color" is white.

	0	1	2	3
	false	false	false	**true**
1	false	**true**	false	false
2	false	false	**true**	false
3	**true**	false	false	false
4	false	false	false	false

	0	1	2	3
				🟥
1		🟥		
2			🟥	
3	🟥			
4				

Getting Started

1. Copy the **ArrayPlotter Student** folder to your network drive. It contains a JCreator project which includes **ArrayPlotter.java**, the only file you will be changing in this lab. The project also contains a **class** file (**ArrayPlotterGUI.class**) and a **`jar`** file (**`gridgridworld.jar`**). These are used to create and display the *Graphical User Interface* (GUI) that you will use to see the grid of colors. The GUI also has buttons which are used to call the methods that manipulate the grid.

   First you will add the code in the `ArrayPlotter` class that is necessary to create an Array Plotter object and to create and display the GUI.

a. Locate the two private instance variables in `ArrayPlotter`. **These are the only two instance variables that you will need, do not add any more.** Read the comments so that you understand their purpose.

b. Complete the constructor to initialize the instance variables as follows:

   i. Construct a new `ArrayPlotterGUI` object. Its constructor takes one parameter, the current `ArrayPlotter` object (`this`). Assign the reference to that `ArrayPlotterGUI` object to the appropriate instance variable.

   ii. Assign `null` to the 2D array instance variable. You'll create or re-create a 2D array object in response to GUI button clicks.

   iii. Compile your project.

c. Complete the `initializeColorArray` method. This method must create and assign a new 2D array of the given dimensions to the `colorArray` instance variable. Compile your project.

d. Complete the `main` method. All that's required is to create a new `ArrayPlotter` object, no additional code is required in `main`. This is an event driven program. You execute methods in `ArrayPlotter` by clicking buttons in the Graphical User Interface (GUI).

   Compile and run your project. You should see the GUI, experiment with it. When you click the **New Grid** button, your `initializeColorArray` method is called. Clicking this button also makes the **ClearGrid** and **RowMajorFill** buttons available for use. These two buttons execute your `onClearGridButtonClick` and `onRowMajorFillButtonClick` methods respectively. Currently, clicking either of these buttons causes a pop-up message indicating that you have not yet implemented the corresponding method.

2. Replace the body of the `onRowMajorFillButtonClick` method with an appropriate implementation. This method uses a nested loop to traverse `colorArray` in *row-major* (left-to-right, top-down) order. **Use descriptive names for your loop control variables.** I suggest naming them `r` and `c`, or `row` and `col`. The <u>body of the inner loop</u> needs to set the appropriate element of `colorArray` to `true` and then call the `update` method of the GUI with the statement `gui.update(colorArray);`

   Compile and run your program. Create a new grid and click on the **rowMajorFill** drawing button; you should see colors filling the locations of the grid in row-major (top-down, left-to-right) order. Note that the drawing pauses between coloring each cell. Experiment with the **Adjust Speed** slider while your program is filling the grid.

3. Replace the body of the `onClearGridButtonClick` method. First it must assign `false` to all of the elements of `colorArray`. Then it must update the GUI. Only call `update` after the iteration is complete, don't call it inside a loop. This will result in the grid being cleared all at once instead of pausing for each cell. Also delete the import for `JOptionPane`. Compile and run your program.

Adding Additional Drawing Methods

Now it's time to write the remaining drawing methods on your own. Pay attention to the following important requirements as you write and test each of these methods.

- **Each method must fill in the grid in the order specified.**
- The `update()` method must be called once for each `colorArray` element value change.
- Except for the `onXFillButtonClick` method, a method may not set a `colorArray` element to `true` and update the GUI more than once. This will cause a pause in the filling of the grid. Do not update the GUI for `false` elements.
- Compile and test each method as you go along.
- Buttons for new correctly written drawing methods will magically appear in the GUI. `ArrayPlotterGUI` accomplishes this by using Java Reflection. Google "Java reflection" if you want to know more.
- The methods must work properly for all different grid dimensions. You should test each method on grids of the following sizes: 5 x 5, 4 x 8, 8 x 4, 1 x 1, 1 x 10, and 10 x 1.

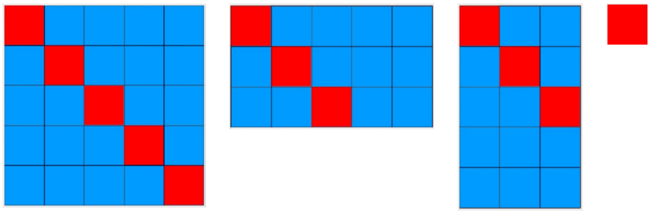
4. Write the `onColMajorFillButtonClick` method, using the `onRowMajorFillButtonClick` method as a guide. The cells must be traversed in column-major order. A column-major order is column-by-column from left-to-right, going down each column. It first visits all the locations in column 0 top-to-bottom, then all the locations in column 1, and so on.

5. Write an `onReverseRowMajorFillButtonClick` method, using the `onRowMajorFillButtonClick` method as a guide. This algorithm must fill in cells bottom-up, going left-to-right across each row. In other words, the row order is reversed, but the column order is not.

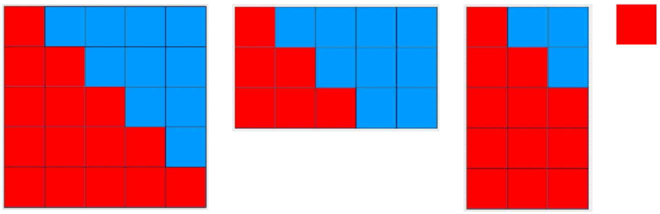
6. Write an `onReverseColMajorFillButtonClick` method, using the `onColMajorFillButtonClick` method as a guide. This algorithm must fill in cells right-to-left, going up each column from the bottom. In other words, both the row and column orders must be the reverse of `onColMajorFillButtonClick`.

7. Write an `onMainDiagonalFillButtonClick` method. This algorithm must fill in cells along the diagonal from the upper-left corner towards the lower-right corner. It will end up in the lower-right corner only if the grid is square. If it is not square, the algorithm steps down and to the right until it comes to the last column or the last row, depending on whether

the grid is taller than it is wide or wider than it is tall. The diagrams below show the result for a 5 x 5 grid, a 3 x 5 grid, a 5 x 3 grid, and a 1 x 1 grid.



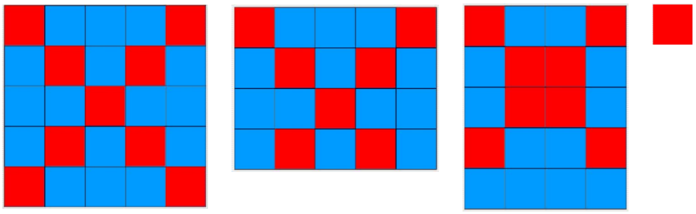
8. Write an `onMainTriangleFillButtonClick` method. This algorithm must fill in all the cells on and below the main diagonal. **It must fill in these cells in row-major order.** The diagrams below show the behavior for 5 x 5, 3 x 5, 5 x 3 grid, and 1 x 1 grids.



9. Write an `onOtherDiagonalFillButtonClick` method. This algorithm must fill in cells along the other diagonal from the upper-right corner towards the lower-left corner. It will end up in the lower-left corner only if the grid is square. If it is not square, the algorithm steps down and to the right until it comes to the last column or the last row, depending on whether the grid is taller than it is wide or wider than it is tall.

10. Write an `onOtherTriangleFillButtonClick` method similar to the first triangle fill method, but going from the upper-right corner towards the lower-left corner. (Again, whether it actually reaches the lower-left corner depends on whether or not the grid is square.) It must fill all the cells on and below the diagonal in row-major order.

11. Write an `onXFillButtonClick` method that draws an 'X' in the grid. **Reuse existing methods as appropriate.** Your implementation must consist of two statements, with no explicit loops. If the two diagonals share a common cell, then the corresponding `colorArray` element should be set to `true` and the GUI should be updated twice. This will appear to cause a pause in the drawing when it draws the overlap. The diagrams below show the results for 5 x 5, 4 x 5, 5 x 4, and 1 x 1 grids.



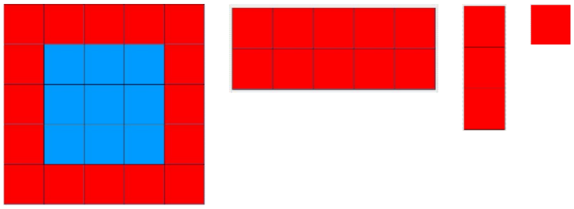
12. Your next drawing method will utilize two private helper methods. Proceed as follows:

    a. Write a `private void fillRowLeftToRight(boolean[] row)` method that traverses the `row` array from left to right. For each element in `row`, it must set that element to `true` and call the GUI update method with the `colorArray` parameter.

    b. Write a similar `fillRowRightToLeft` method that traverses the `row` from right to left.

    c. Write an `onSerpentineFillButtonClick` method that traverses each row from top to bottom. Even indexed rows (0, 2, …) are traversed from left to right, and odd indexed rows (1, 3, …) are traversed from right to left. This method must utilize your two helper methods and must only have one loop.

13. Write an `onBorderFillButtonClick` method that draws a border around the grid's perimeter. Your drawing must start in the upper-left corner and proceed in a clockwise fashion. You code must not reimplement and code that is already available in the methods you have written. Your method will consist of two private helper method calls and two loops. Make sure that the GUI doesn't pause unnecessarily as it fills the grid. The diagrams below show the results for 5 x 5, 2 x 5, 3 x 1, and 1 x 1 grids.



This lab was inspired by the Dots program by Richard Rasala of Northeastern University.