Week 11: Computer Science 1

Multidimensionality continued & Software Libraries

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We have been using the Java **Standard Library** since the beginning of the semester. What is a **Software Library**?

A **Software Library** is a collection of pre-written code that can be used to perform common tasks.

Java has a vast **Standard Library** that is included with the Java Development Kit (JDK). It includes the Math class, the Scanner class, the String class, and many more.

Along with the **Standard Library**, there are many other libraries that can be used to perform more specialized tasks. These libraries are often open-source and can be found on the internet.

One such Java Library is called **Processing**. Processing is a flexible software sketchbook and a language for learning how to code within the context of the visual arts.

Processing is a Java library that simplifies the process of creating visual programs. It is used by developers, artists, designers, and students to create visual programs.

Here is a link to the Processing website: Processing

You can download the Processing IDE (Integrated Development Environment) from the Processing website. You won't be able to run the Processing code the same way you run Java code in VS Code.

In Processing we can declare variables and arrays just like we do in Java. We can also use loops and conditionals to control the flow of our programs.

```
int x = 100;
int y = 100;
double speed = 2.5;

for (int i = 0; i < 10; i++) {
  x += speed;
  y += speed;
  ellipse(x, y, 50, 50);
}
```

We can also create methods similar to Java. The only difference is that we don't need to include `public static` in front of the method declaration.

```
void drawCircle(int x, int y, int diameter) {
  ellipse(x, y, diameter, diameter);
}
```

Here is an example of a simple Processing program that draws a circle on the screen:

```
void setup() {
  size(500, 500);
}

void draw() {
  rect(200, 200, 100, 100);
}
```

This program creates a window that is 500 pixels by 500 pixels and draws a circle at the coordinates (200, 200) with a diameter of 100 pixels. It's a simple program, close to the Hello World of programming visuals.

setup() is a special function in Processing that is called once when the program starts. draw() is another special function that is called repeatedly to update the screen, it's a loop that runs continuously.

Now we can combine what we know in Java with Processing. Let's add a variable to the previous program to make the rect move across the screen.

```
int x = 0;

void setup() {
  size(500, 500);
}

void draw() {
  background(255);
  rect(x, 200, 100, 100);
  x += 1;
}
```

The concepts we are learning in this class can be applied to other programming languages and libraries. The syntax may be different, but the underlying concepts are the same.

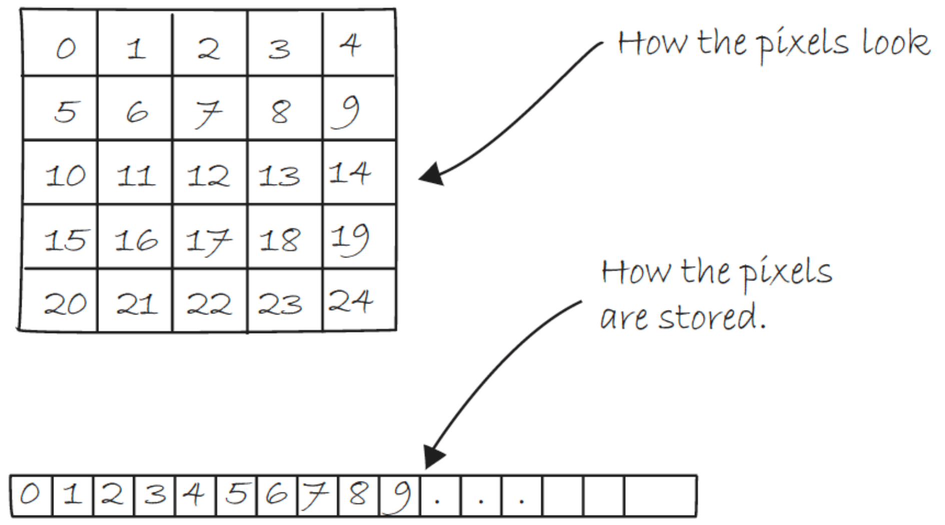
We can use loops, conditionals, and arrays to manipulate data in Processing just like we do in Java. All other programming languages have similar concepts.

If you want to explore Processing further, you can download it from the Processing website and start creating visual programs.

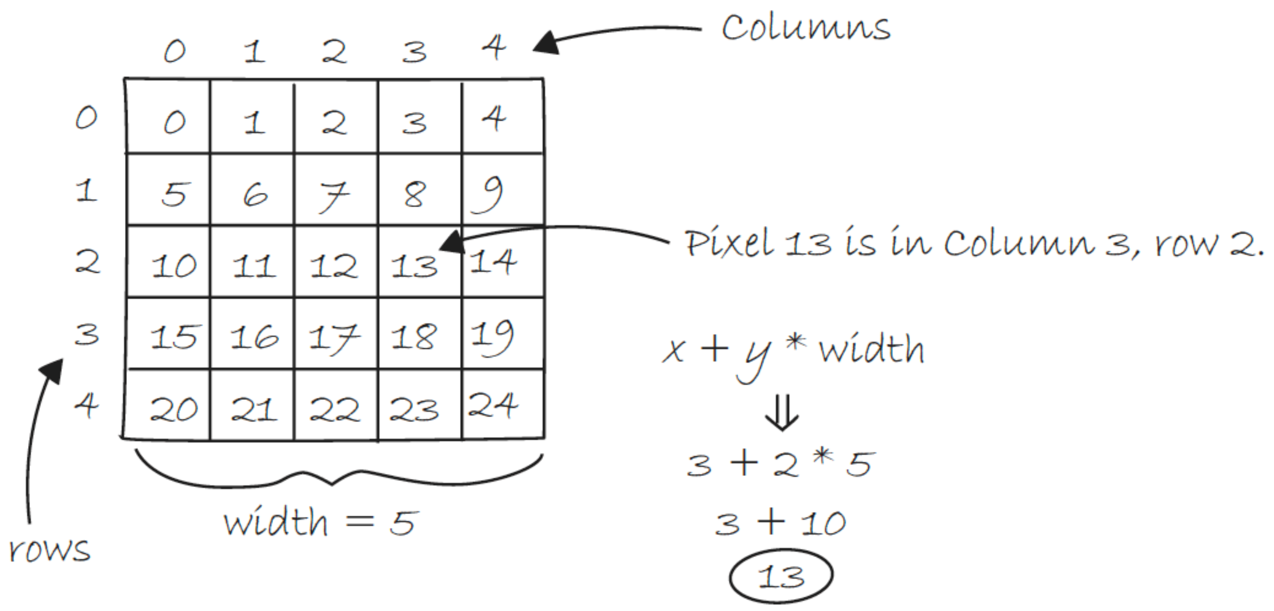
We'll use Processing today to continue our study of 2D arrays and nested loops.

First, let's talk about **Multidimensionality** in reference to visual programming.

In visual programming, we are manipulating the color values of the pixels on your screen. The screen is a 2D grid of pixels, and we can manipulate the color values of each pixel to create images.



Remember that 2D array is logically represented in a grid. Actually, it is stored in memory as sequential blocks of memory. We use the formaula `row * width + column` to access the elements of a 2D array.



```java
int[][] canvas;
int pixelSize = 20; // Size of each pixel
int cols, rows;

void setup() {
  size(400, 400);
  cols = width / pixelSize;
  rows = height / pixelSize;
  canvas = new int[rows][cols];
  initializeCanvas();
}

void draw() {
  background(255);
  displayCanvas();
}

void mouseDragged() {
  int col = mouseX / pixelSize;
  int row = mouseY / pixelSize;
  if (col >= 0 && col < cols && row >= 0 && row < rows) {
    canvas[row][col] = 0;
  }
}

void initializeCanvas() {
  for (int i = 0; i < rows; i++) { // Iterate over rows first
    for (int j = 0; j < cols; j++) { // Then iterate over cols
      canvas[i][j] = 255; // Set all pixels to white initially
    }
  }
}

void displayCanvas() {
  for (int i = 0; i < rows; i++) { // Iterate over rows first
    for (int j = 0; j < cols; j++) { // Then iterate over cols
      fill(canvas[i][j]);
      noStroke();
      rect(j * pixelSize, i * pixelSize, pixelSize, pixelSize);
    }
  }
}
```