LEC 06

CSE 122

2D Arrays

Questions during Class?

Raise hand or send here

sli.do #cse122

BEFORE WE START

Talk to your neighbors:

Share your favorite color — the other person has to name 3 things they see in the room that are that color.

Instructor Melissa Lin

TAs Poojitha Arangam, Darel Gunawan, Colton Harris, Atharva Kashyap, Eesha Kunisetty, Audrey Lin, Di Mao, Steven Nguyen, Ben Wang, Jaylyn Zhang

Lecture Outline

- Announcements
- 2D Arrays Review
- Images
- Images with 2D Arrays!

Announcements

- Congratulations on completing Quiz 0!
  - Grades will be released next week
- Programming Assignment 1 is due tomorrow
- Creative Project 1 released this Friday (image editing)

Lecture Outline

- Announcements
- **2D Arrays Review**
- Images
- Images with 2D Arrays!

(PCM) Arrays

- The type of an array is *ElementType*[]
  - *ElementType* can be any type!
- Can store multiple elements *of the same type*
- Need to specify length of array and type of elements it will store at creation

```
int[] arr = new int[4];
```

type name array creation code

```
int[]
```

```
double[]
```

```
String[]
```

```
boolean[]
```

```
char[]
```

(PCM) Arrays

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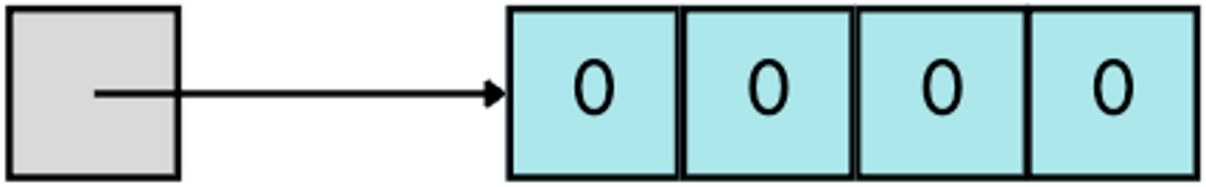


name: arr (int[])

(PCM) 2D Arrays

An array of arrays!

- The *ElementType* of the array is another array itself!
  - Your first example of "nested data structures"
    - There will be more!


```
int[][]
```

```
double[][]
```

```
String[][]
```

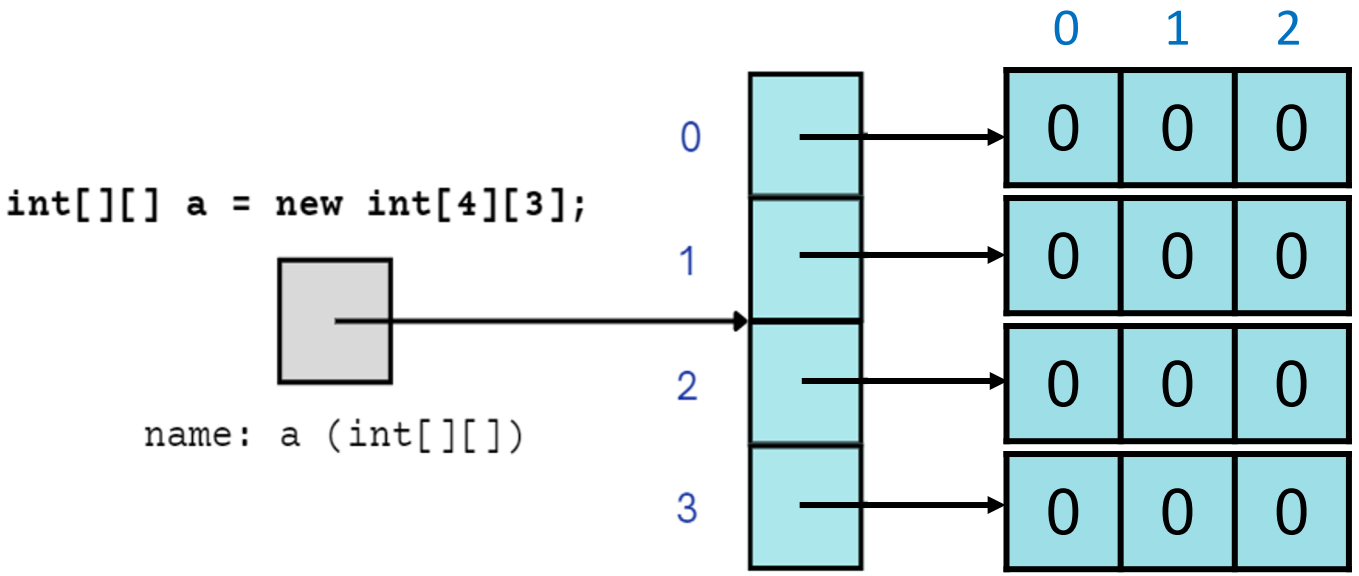
```
boolean[][]
```

```
char[][]
```

(PCM) 2D Arrays

An array whose elements are arrays

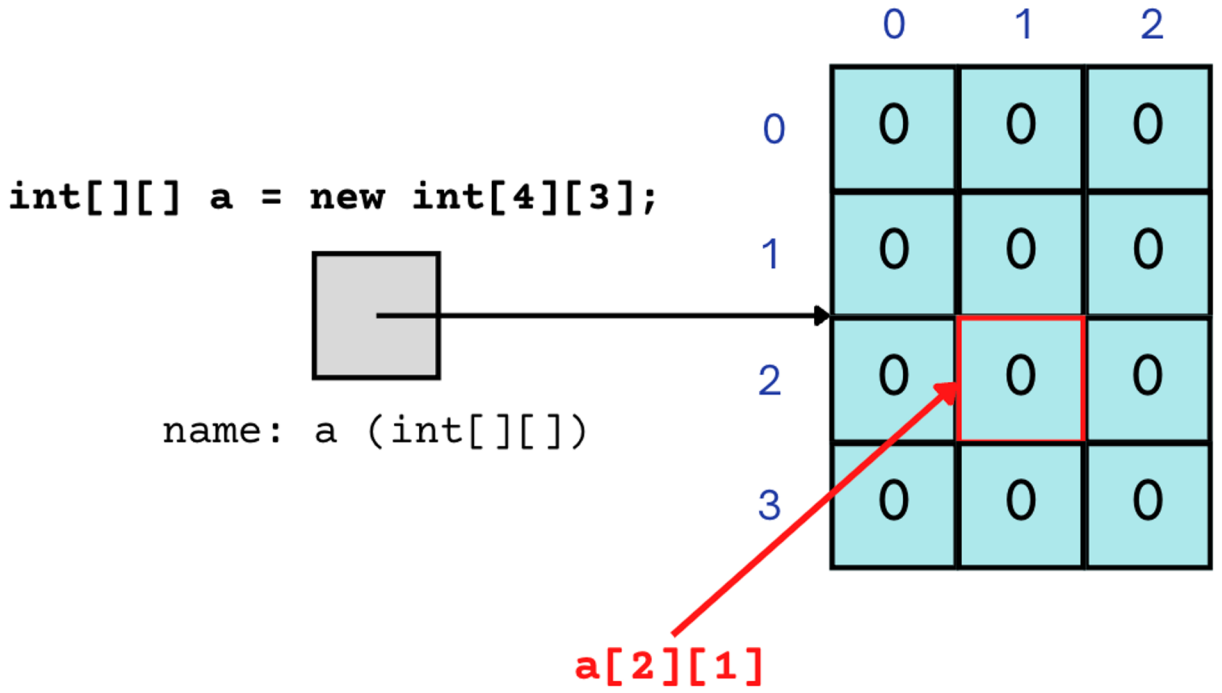
reference semantics!



(PCM) 2D Arrays

An array of arrays!

… a slightly more condensed (but less accurate) view…



(PCM) 2D Array Traversals

```
for (int i = 0; i < list.length; i++) {
    for (int j = 0; j < list[i].length; j++) {
        // do something with list[i][j]
    }
}
```

Arrays Utility Class

Method	Description
`Arrays.toString(array);`	Returns a `String` representing the array, such as `"[10, 30, -25, 17]"`
`Arrays.fill(array, value);`	Sets every element to the given value
`Arrays.equals(array1, array2);`	Returns `true` if the two arrays contain the same elements in the same order
`Arrays.deepToString(array);`	Returns a `String` representing the array; if the array contains other arrays as elements, the `String` represents their contents, and so on. For example, `"[[99, 151], [30, 5]]"`
`Arrays.deepEquals(array1, array2);`	Returns `true` if the two arrays contain the same elements in the same order; if the array(s) contain other arrays as elements, their contents are tested for equality, and so on.

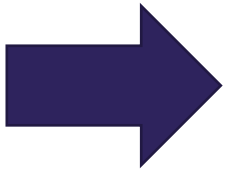
Applications of 2D Arrays

- Matrices
  - Useful in various applications requiring complex math!
- Board games
  - (e.g., chess/checkerboard, tic tac toe, sudoku)
- Representing information in a grid or table
  - (e.g., scorekeeping, gradebook)
- Image processing

matrixAdd

23	96	18	4	64
45	40	18	44	34
92	13	77	71	12

70	73	66	79	39
91	75	73	99	47
27	64	21	34	1



matrixAdd

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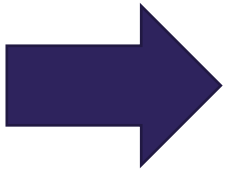

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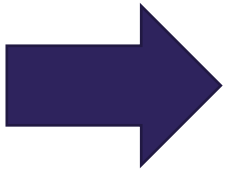

93				

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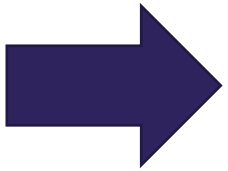

93	169			

matrixAdd

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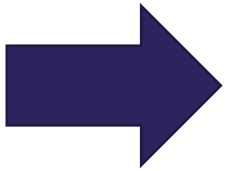

93	169	84		

matrixAdd

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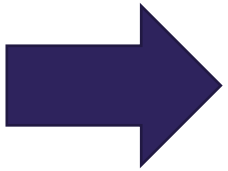

93	169	84	83	

matrixAdd

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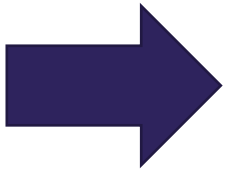

93	169	84	83	103

matrixAdd

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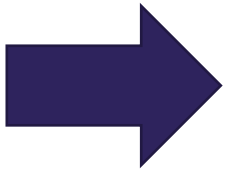

93	169	84	83	103
136				

matrixAdd

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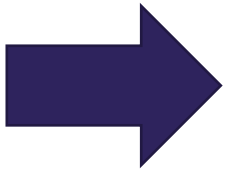

93	169	84	83	103
136	115			

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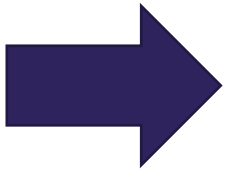

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136	115	91		

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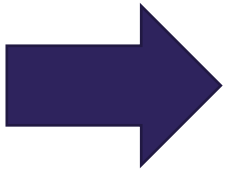

93	169	84	83	103
136	115	91	143	

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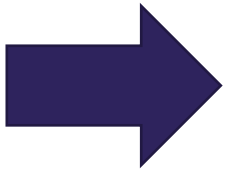

93	169	84	83	103
136	115	91	143	81

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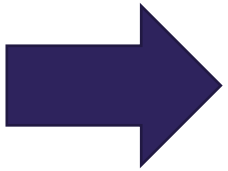

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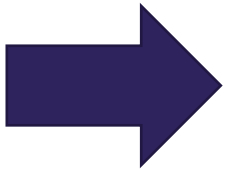

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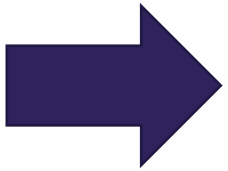

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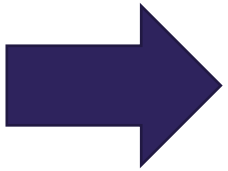

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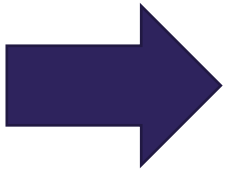

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119	77	98	105	13

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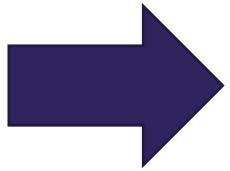

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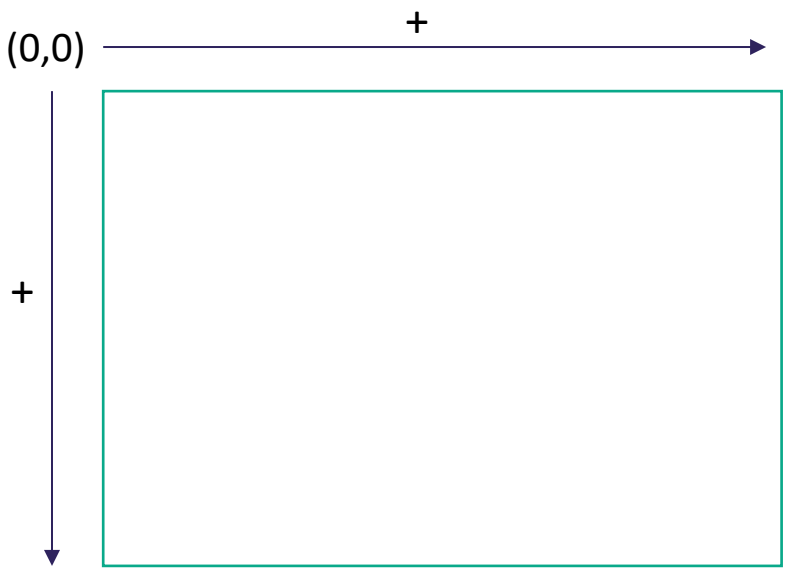
Lecture Outline

- Announcements
- 2D Arrays Review
- Images
- Images with 2D Arrays!

Images

From the computer's perspective, images are just a big grid of values called **pixels**.

Each pixel shows a different color based on a specified value.



Images

If images are just grids of pixels, and we can think of 2D arrays as grids,

We can represent images as 2D arrays of pixels!

Further, since each pixel is shown as a specific color,

We can represent images as 2D arrays of colors!

Images in Java

- `Picture.java`
  - Represents the idea of a picture in your program

- `Color.java`
  - Represents colors in your program!
  - Uses the RGB color scheme where each color is made up of some amount (0-255) of **r**ed, **g**reen, and **b**lue

Images in Java: `Picture.java`

```
Picture pic = new Picture("image.png");
```

Methods	Descriptions
`pic.getPixels();`	Returns a `Color[][]` representing the colors in the grid of pixels.
`pic.setPixels(colorArray);`	Sets the grid of pixels in the picture based on the given `colorArray`.
`pic.save(fileName);`	Saves the current picture to a file with the given `fileName`.
`pic.show();`	Shows the current picture in a window on the screen.*

* This functionality doesn't work perfectly on Ed, it's probably easier to use the save() method!

Images in Java: `Color.java`

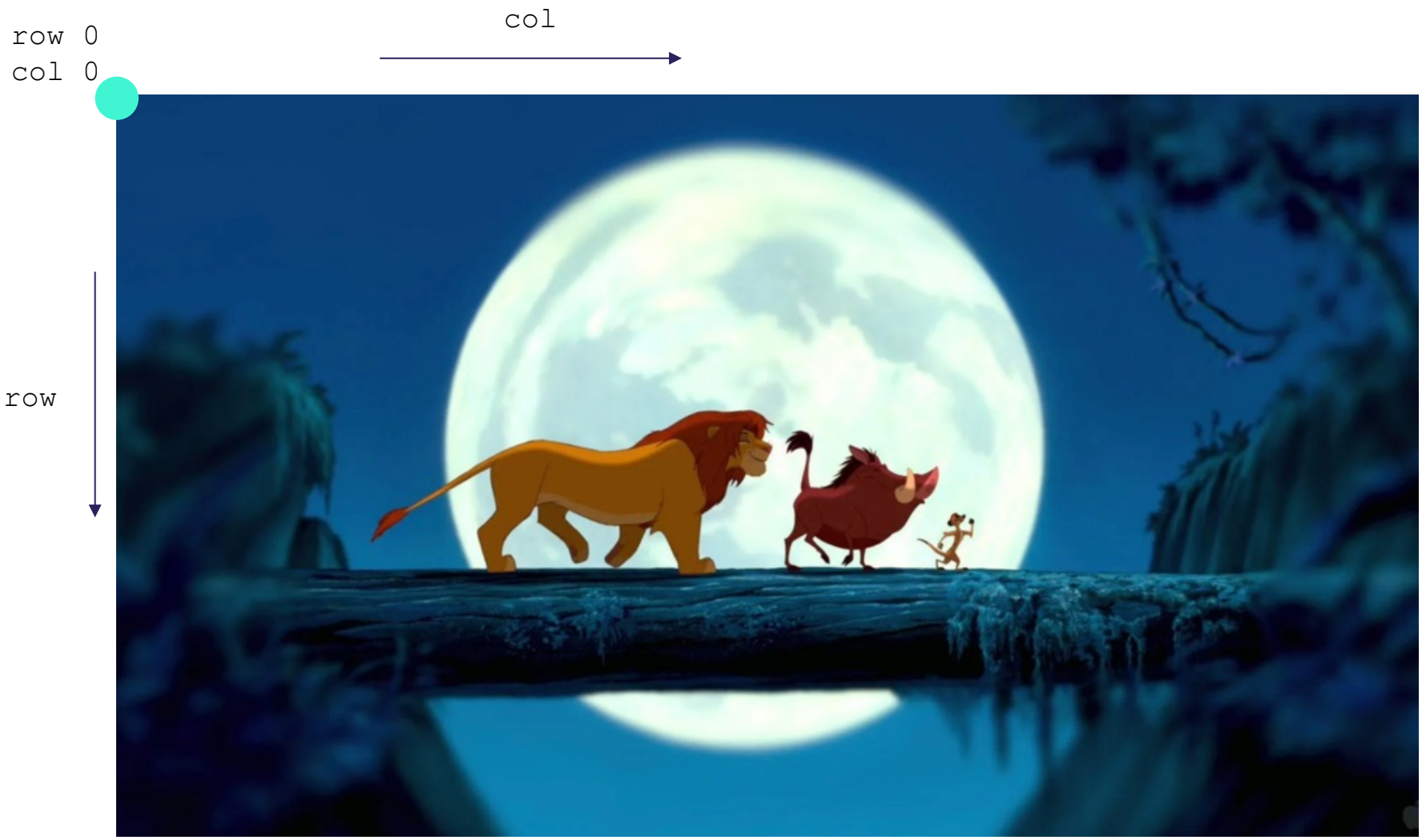
```
Color color = new Color(redVal, greenVal, blueVal);
```

Methods	Descriptions
`color.getRed();`	Returns the color amount for red.
`color.getGreen();`	Returns the color amount for green.
`color.getBlue();`	Returns the color amount for blue.

Lecture Outline

- Announcements
- 2D Arrays Review
- Images
- **Images with 2D Arrays!** 

Example



Practice : Think

sli.do #cse-122

What loop bounds will create the desired rectangle?

Draw a blue rectangle with **top-left at row 200, column 400**.
With **width of 100** and **height of 20**

```
for (int row = ??; row < ??; row++) {
    for (int col = ?? ; col < ?? ; col++) {
```

A)
```
for (int row = 400; row < 420; row++) {
    for (int col = 200; col < 300; col++) {
```

B)
```
for (int row = 200; row < 220; row++) {
    for (int col = 400; col < 500; col++) {
```

C)
```
for (int row = 200; row < 100; row++) {
    for (int col = 400; col < 20; col++) {
```

Practice : Pair

sli.do #cse-122

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Draw a blue rectangle with **top-left at row 200, column 400**.
With **width of 100** and **height of 20**

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B)
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for (int row = 200; row < 220; row++) {
    for (int col = 400; col < 500; col++) {
```

C)
```
for (int row = 200; row < 100; row++) {
    for (int col = 400; col < 20; col++) {
```