CSE 121 – Lesson 15

Miya Natsuhara

Autumn 2023

Music: 121 23au Lecture Tunes

sli.do #cse121

TAs:					
	Trey	Christina	Sahej	Vinay	Kriti
	Sebastian	Colton	Anju	Maria	Minh
	Annie	Janvi	Jonus	Shreya	Vivian
	Jasmine	Arkita	Lydia	Andy	Nicole
	Christian	Vidhi	Luke	Nicolas	Simon
	Lucas	Ritesh	Andras	Shayna	Jessie
	Logan	Hibbah	Archit	Hannah	Lydia
	Jacob	Julia	Ayesha	Aishah	Yijia

Announcements, Reminders

- P3 released later today – last assignment!
  - Focused on 2D arrays!
  - No dedicated resubmission cycle
    (Feedback will not be released the following Tuesday)
  - Extending P3's planned deadline to **Thursday** next week (12/7)…
    so you have an additional 2 days to work on it!
- Gumball (& friends) Visit on Monday, December 11 1:00pm-3:00pm
- Final Exam: **Wednesday, Dec 13 12:30pm-2:20pm**
  - Left-Handed Seating Requests Form, closes end-of-day Monday, Dec 4.

Final Exam Details

- Final Exam: **Wednesday, December 13 12:30pm-2:20pm**
- In-person, on paper, with assigned seating
- No collaboration – should be completed individually
- You may bring in **one 8.5x11-inch** sheet of notes, handwritten or typed, double-sided
- Focused on behavior (not style)
- You should make every attempt to write correct Java syntax
- Next week will be focused on Final Exam review and preparation
  - We are also planning a Final Exam Review Session on Tuesday of finals week (12/12)
- More details on course website

Poll in with your answer!

```
public static void main(String[] args) {
    int x = 0;
    int[] a = new int[4];
    x++;

    mystery(x, a);
    System.out.println(x + " " + Arrays.toString(a));

    x++;
    mystery(x, a);
    System.out.println(x + " " + Arrays.toString(a));
}

public static void mystery(int x, int[] a) {
    x++;
    a[x]++;
    System.out.println(x + " " + Arrays.toString(a));
}
```

Four lines of output would be produced by this code. What would those four lines be?

Poll in with your answer!

```
public static void main(String[] args) {
    int x = 0;
    int[] a = new int[4];
    x++;

    mystery(x, a);
    System.out.println(x + " " + Arrays.toString(a));

    x++;
    mystery(x, a);
    System.out.println(x + " " + Arrays.toString(a));
}

public static void mystery(int x, int[] a) {
    x++;
    a[x]++;
    System.out.println(x + " " + Arrays.toString(a));
}
```

(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 in CSE 122!

`int[][]`

`double[][]`

`String[][]`

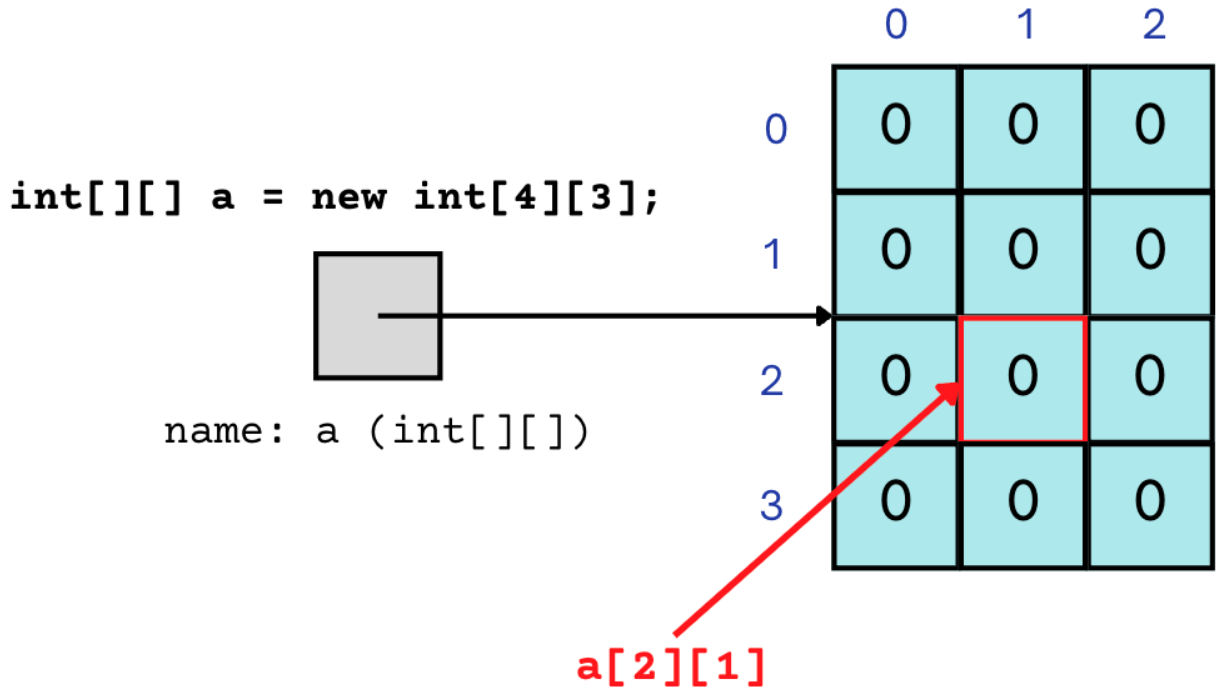
`boolean[][]`

`char[][]`

(PCM) 2D Arrays

An array of arrays!

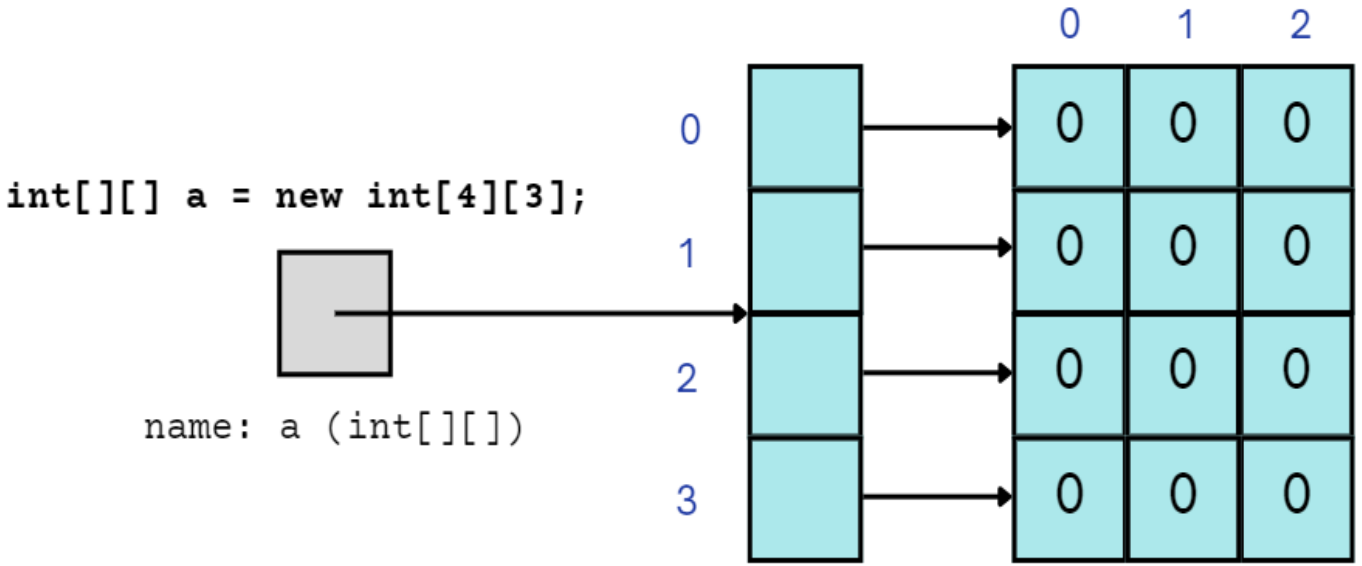
The two dimensions are "rows" and "columns"



(PCM) 2D Arrays

A slightly more accurate view…

reference semantics



(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.

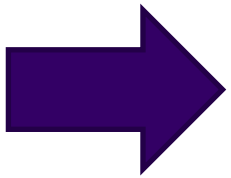
Applications of 2D Arrays

- 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

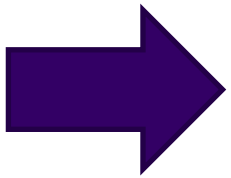
70	73	66	79	39
91	75	73	99	47
27	64	21	34	1



matrixAdd

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

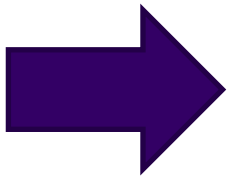


```
i: 0
j: 0
```


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



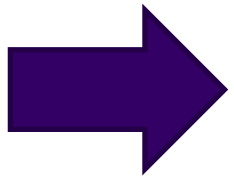
```
i: 0
j: 0
```

93				

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



```
i: 0
j: 1
```

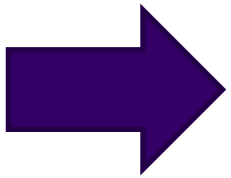
93	169			

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

```
i: 0
j: 2
```



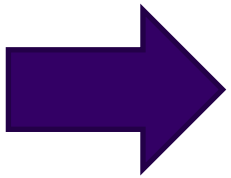
93	169	84		

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

```
i: 0
j: 3
```



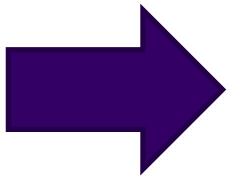
93	169	84	83	

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

```
i: 0
j: 4
```



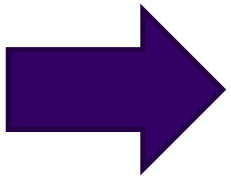
93	169	84	83	103

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

```
i: 1
j: 0
```



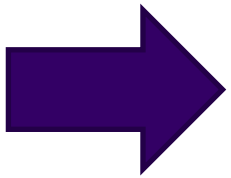
93	169	84	83	103
136				

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

```
i: 1
j: 1
```

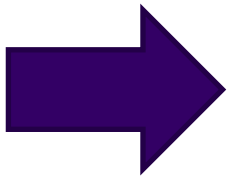


93	169	84	83	103
136	115			

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



```
i: 1
j: 2
```

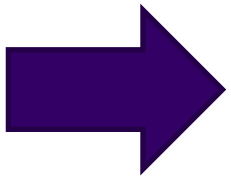
93	169	84	83	103
136	115	91		

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

```
i: 1
j: 3
```



93	169	84	83	103
136	115	91	143	

matrixAdd

23	96	18	4	64
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92	13	77	71	12

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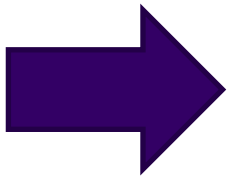


```
i: 1
j: 4
```

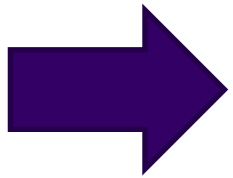
93	169	84	83	103
136	115	91	143	81

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

```
i: 2
j: 0
```



93	169	84	83	103
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119				

matrixAdd

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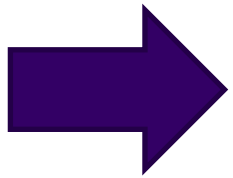

```
i: 2
j: 1
```

93	169	84	83	103
136	115	91	143	81
119	77			

matrixAdd

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92	13	77	71	12

70	73	66	79	39
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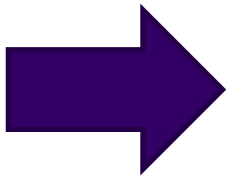
27	64	21	34	1

```
i: 2
j: 2
```



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matrixAdd

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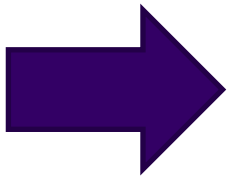
i: 2

j: 3



93	169	84	83	103
136	115	91	143	81
119	77	98	105	

matrixAdd

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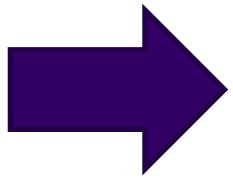
i: 2
j: 4
```



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136	115	91	143	81
119	77	98	105	13

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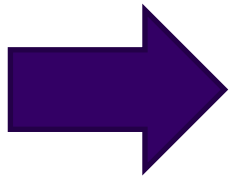

93	169	84	83	103
136	115	91	143	81
119	77	98	105	13

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	43
2	42	40	44
3	42	41	43

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44		
2			
3			

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
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  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	
2			
3			

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	43
2			
3			

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	43
2	42		
3			

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	43
2	42	40	
3			

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	43
2	42	40	44
3			

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	43
2	42	40	44
3	42		

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	43
2	42	40	44
3	42	41	

(2D)ays Above Average: `readData()`

```
How many days' data would you like to input? 3
Next day's data:
  Temperature in Seattle? 44
  Temperature in Tacoma? 40
  Temperature in Bothell? 43
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 40
  Temperature in Bothell? 44
Next day's data:
  Temperature in Seattle? 42
  Temperature in Tacoma? 41
  Temperature in Bothell? 43
…
```

	Seattle	Tacoma	Bothell
1	44	40	43
2	42	40	44
3	42	41	43

(2D)ays Above Average: `computeAverages()`

```
How many days' data would you like to input? 3
…
The average values for each location were
  [42.666666666666664, 40.333333333333336,
  43.333333333333336]
```

	Seattle	Tacoma	Bothell
1	44	40	43
2	42	40	44
3	42	41	43

42.667	40.333	43.333

Average of Seattle temperatures
(44 + 42 + 42) / 3