CSE 121 Lesson 14:

2D Arrays

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Summer 2024

sli.do #cse121

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Announcements, Reminders

- **Quiz 2 tomorrow!**
  - Quiz 1 grades released on Monday, see details on Ed
  - Study lecture examples in the past two weeks! You may see one show up on the quiz :)
- R5 due tomorrow, R6 released tomorrow
- Programming Assignment 3 releasing later today – last assignment!
- Final Exam: **Friday, 8/16 from 12:00-1:00 in PCAR 290**
  - **See Ed post for more information**
- Final Reflection feedback deadline this Friday!

Final Exam Details (1/2)

- Final Exam: **Friday, 8/16 from 12:00-1:00 in PCAR 290**
- In-person, on paper, completed individually
- **Please bring ID – we will be taking attendance**
- Open Note, Open Book
  - We will provide you one "reference sheet", and
  - You may as many paper notes as you wish
- Will have 3 problems worth 2 grades each, all similar in style to the quizzes
- Focus is on behavior (not code style) – minor syntax errors are allowed

Final Exam Details (2/2)

- Next week will be focused on Final Exam review and preparation
- Many resources will be available, including:
  - dedicated section time for final exam review!
  - multiple previous actual finals + practice finals
  - **online final exam review session** (Wednesday 8/14 from 4:30 – 6 PM)
- More details on course website

(PCM) 2D Arrays (1/3)

```
int[][] a = new int[4][3];
```

type name array creation code

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[][]
```

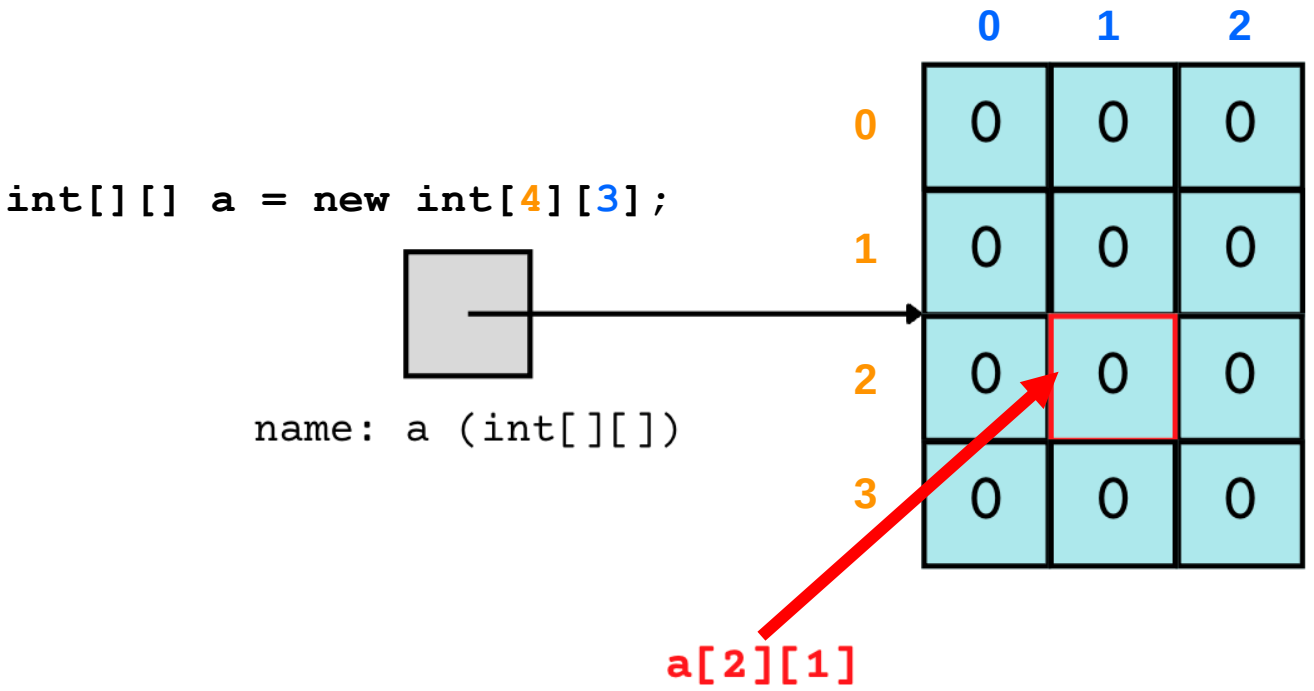
```
boolean[][]
```

```
char[][]
```

(PCM) 2D Arrays (2/3)

An array of arrays!

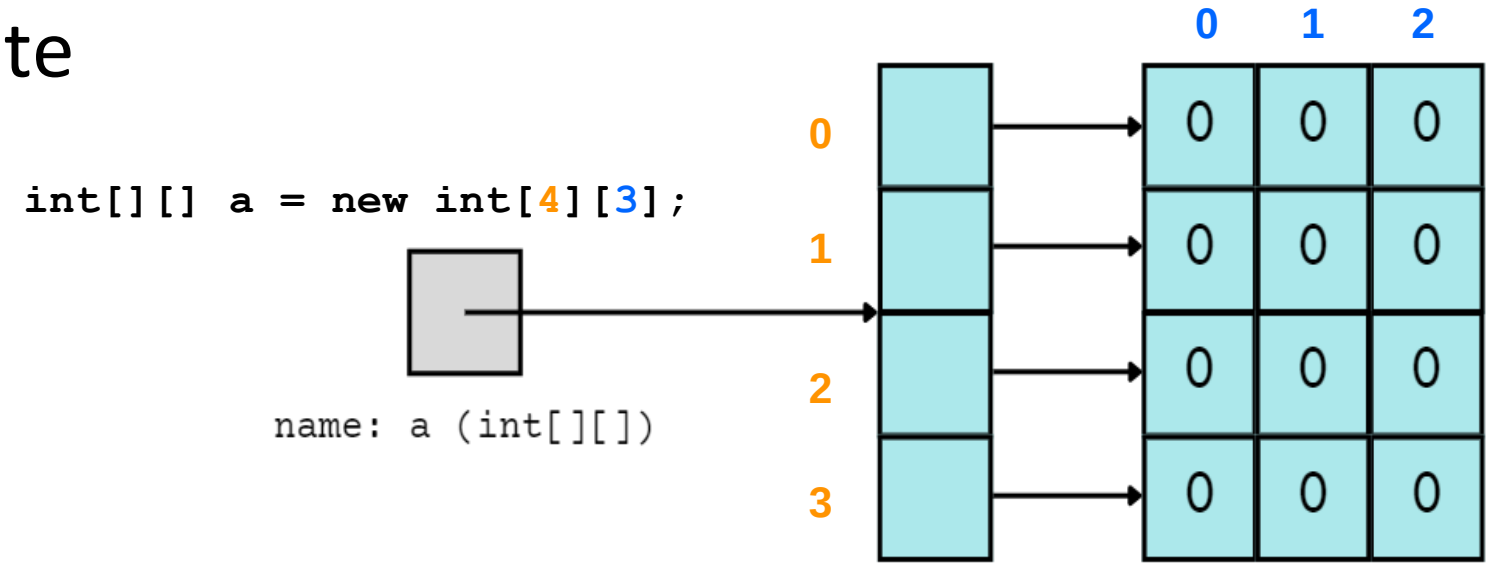
The two dimensions are "rows" and "columns"



(PCM) 2D Arrays (3/3)

A slightly more accurate view…

reference semantics



(PCM) 2D Array Traversals

for each row…

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

for each element within a row…

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.

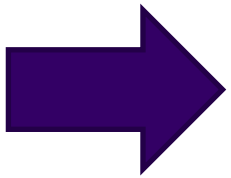
Applications of 2D Arrays

- **Matrices**
  - Useful in various applications requiring complex math!
  - Fundamental to machine learning & AI
  - P3 is a real-life application of this!
- Board games
  - e.g., chess/checkerboard, tic tac toe, sudoku
- Representing information in a grid or table
  - e.g., scorekeeping, gradebook, census data
- Image processing

matrixAdd

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

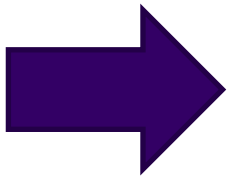
70	73	66	79	39
91	75	73	99	47
27	64	21	34	1



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

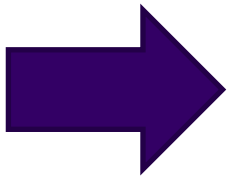


```
i: 0
j: 0
```


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
```

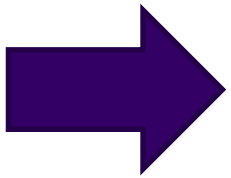
93				

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
```



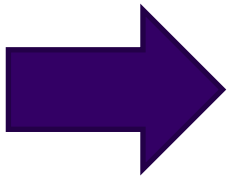
93	169			

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
```



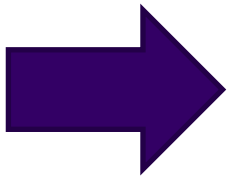
93	169	84		

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
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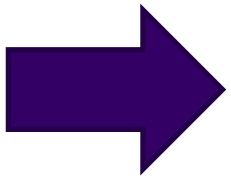


```
i: 0
j: 4
```

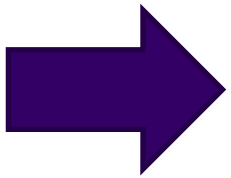
93	169	84	83	103

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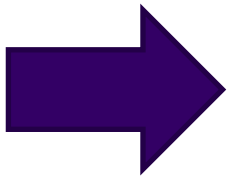
70	73	66	79	39
91	75	73	99	47
27	64	21	34	1

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

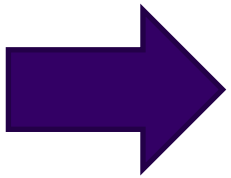


93	169	84	83	103
136	115			

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
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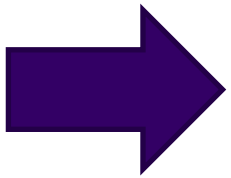
92	13	77	71	12

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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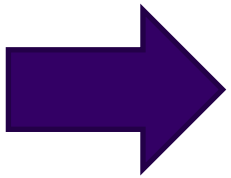


```
i: 1
j: 4
```

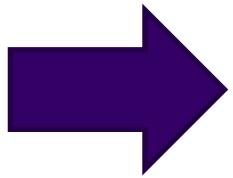
93	169	84	83	103
136	115	91	143	81

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
136	115	91	143	81
119				

matrixAdd

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```
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```

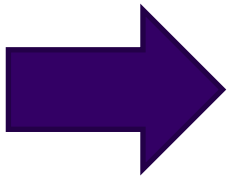

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119	77			

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70	73	66	79	39
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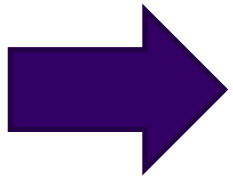
```
i: 2
j: 2
```



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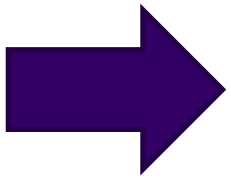

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136	115	91	143	81
119	77	98	105	

matrixAdd

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j: 4
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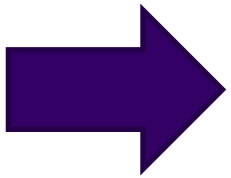

93	169	84	83	103
136	115	91	143	81
119	77	98	105	13

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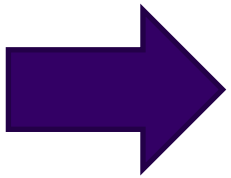

93	169	84	83	103
136	115	91	143	81
119	77	98	105	13

(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
  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	
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