Arrays and Matrices

Arrays, Array Operations, Matrices, Multi-Dimensional Arrays

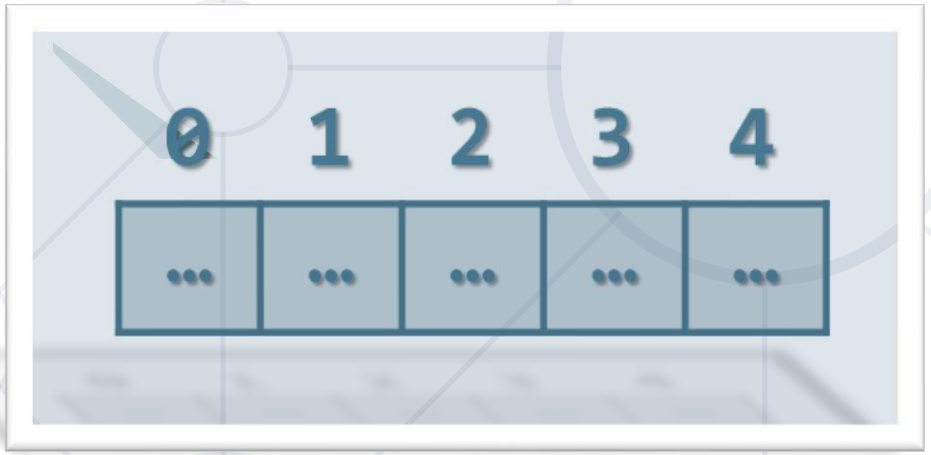

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Table of Contents

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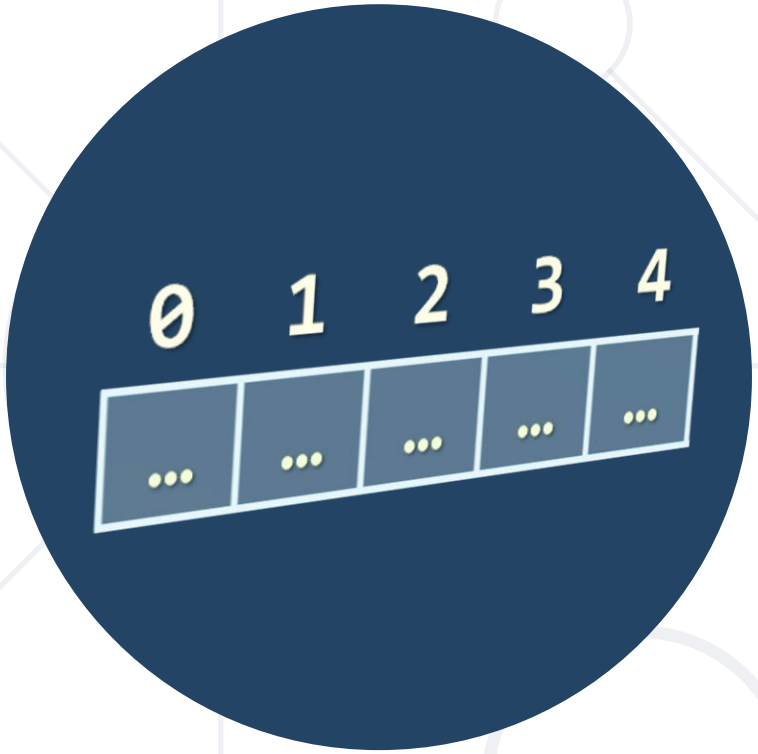

Arrays in JS

Working with Arrays of Elements

What are Arrays?

- In JS **arrays** are ordered sequences of elements

- Elements are **numbered** from **0** to **length-1**
- Arrays hold **key-value pairs**
- **Key** (**0**…**length-1**), **value** of **any type** (e.g. number /string /object)
- Arrays have **variable size** – can be resized (unlike C# / Java / C++)

Arrays – Examples

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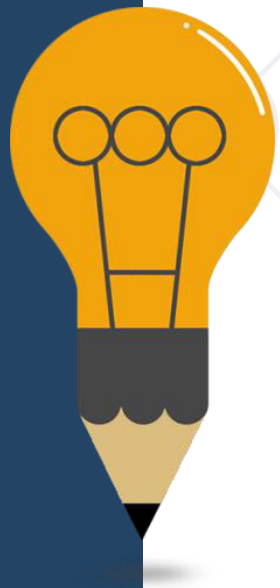
```
let arr = [10, 20, 30];
console.log(arr); // [10, 20, 30]
console.log(arr.length); // 3
console.log(arr[0]); // 10
```



```
arr[0] = 5; // Elements can be modified
console.log(arr); // [5, 20, 30]
```

```
arr.push(500); // Elements are resizable
console.log(arr); // [5, 20, 30, 500]
```

Problem: Sum First and Last Array Elements

- You are given **an array of strings holding numbers**
  - Calculate and print the **sum** of the **first** and the **last elements**

20 30 40	→	60	5 10	→	15	2 → 4

```
function sumFirstAndLast(arr) {
  return Number(arr[0]) + Number(arr[arr.length - 1]);
}
```

```
sumFirstAndLast(['20', '30', '40']) // 60
```

Check your solution here: https://judge.softuni.bg/Contests/311

Processing Arrays Elements

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```
let capitals = ['Sofia', 'Washington', 'London', 'Paris'];
```

```
for (let capital of capitals)
  console.log(capital);
```

for…of works like foreach

```
for (let i in capitals)
  console.log(i + " " + capitals[i]);
```

for…in goes through array indices

```
for (let i = 0; i < capitals.length; i++)
  console.log(capitals[i]);
```

Traditional for-loop

Processing Arrays Elements (2)

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```
let capitals = ['Sofia', 'Washington', 'London', 'Paris'];
```

```
capitals.forEach(capital => console.log(capital));
```

```
capitals.forEach((capital, i) =>
  console.log(i + ' -> ' + capital));
```

```
console.log(capitals.join(', '));
```

```
console.log(JSON.stringify(capitals));
```

Problem: Even Position Elements

- Find the **elements at even positions** in array, space separated

```
function evenPositions(arr) {
  let result = [];
  for (let i in arr)
    if (i % 2 == 0)
      result.push(arr[i]);
  return result.join(' ');
}
```

20 30 40	→	20 40
5 10	→	5
JS	→	JS

Check your solution here: https://judge.softuni.bg/Contests/311

Arrays of Different Types

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```
// Array holding numbers
let numbers = [10, 20, 30, 40, 50];
```

```
// Array holding strings
let weekDays = ['Monday', 'Tuesday', 'Wednesday',
  'Thursday', 'Friday', 'Saturday', 'Sunday'];
```

```
// Array holding mixed data
var mixedArr =
  [20, new Date(), 'hello', {x:5, y:8}];
```

JS Arrays and Invalid Positions

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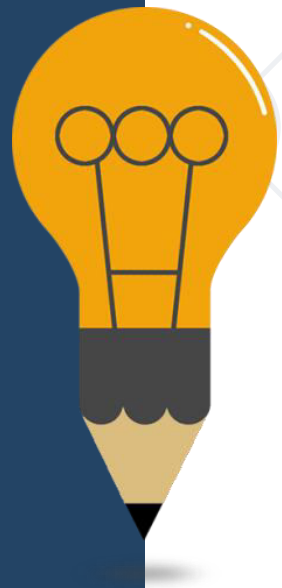
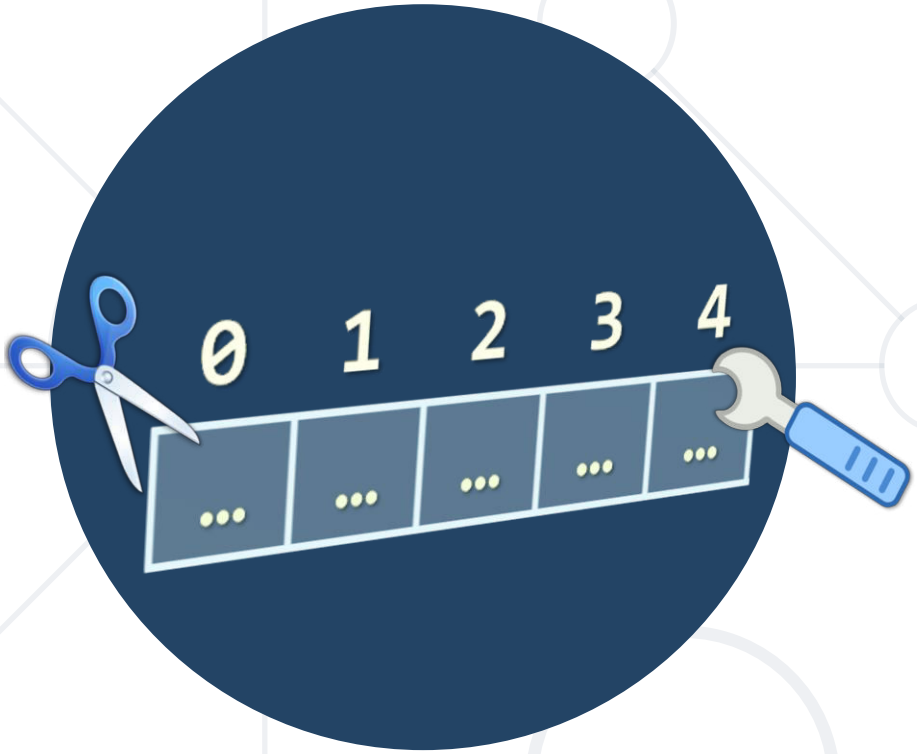
```
let nums = [10, 20, 30];
nums[4] = 50; // Will resize the array
console.log(nums); // [10, 20, 30, ,50]
console.log(nums.length); // 5
console.log(nums[3]); // undefined
```



```
console.log(nums[-5]); // undefined
nums[-5] = -5; // Will not resize the array (invalid
index)!
console.log([nums[-5], nums.length]); // [-5, 5]
```

```
console.log(nums[100]); // undefined
nums[100] = 100; // Will resize the array
console.log([nums[100], nums.length]); // [100, 101]
```



Array Operations

Push, Pop, Shift, Unshift, Slice, Join, …

Add / Remove Elements at Both Ends

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```
let nums = [10, 20, 30];
console.log(nums.join('|')); // 10|20|30
```

```
nums.push(40);
console.log(nums.join('|')); // 10|20|30|40
```

```
let tail = nums.pop();       // tail = 40
console.log(nums.join('|')); // 10|20|30
```

```
nums.unshift(0);
console.log(nums.join('|')); // 0|10|20|30
```

```
let head = nums.shift();     // head = 0
console.log(nums.join('|')); // 10|20|30
```

Problem: Negative / Positive Numbers

- You are given an array of numbers **arr**
  - Process them one by one and produce a new array **result**
    - Prepend each negative element at the front of result
    - Append each positive (or 0) element at the end of result
  - Print the **result** array, each element at separate line

7	→	-2	3	→	-1	-3	→	-1
-2		7	-2		-2	2		-3
8		8	0		3	-1		2
9		9	-1		0	0		0

Solution: Negative / Positive Numbers

```
function negativePositiveNumbers(arr) {
  let result = [];
  for (num of arr)
    if (num < 0)
      result.unshift(num); // Insert at the start
    else
      result.push(num); // Append at the end
  console.log(result.join('\n'));
}
```

Check your solution here: https://judge.softuni.bg/Contests/311

Slicing Arrays

```
let nums = ['one', 'two', 'three', 'four'];
console.log(nums.join('|')); // one|two|three|four
```

```
let firstNums = nums.slice(0, 2); // start, end+1
console.log(firstNums.join('|')); // one|two
```

```
let lastNums = nums.slice(2, 4); // start, end+1
console.log(lastNums.join('|')); // three|four
```

```
let midNums = nums.slice(1, 3); // start, end+1
console.log(midNums.join('|')); // two|three
```

Splice: Cut and Insert Array Elements

```
let nums = [5, 10, 15, 20, 25, 30];
console.log(nums.join('|')); // 5|10|15|20|25|30
```

```
let mid = nums.splice(2, 3); // start, delete-count
console.log(mid.join('|')); // 15|20|25
console.log(nums.join('|')); // 5|10|30
```

```
nums = [5, 10, 15, 20, 25, 30];
nums.splice(3, 2, "twenty", "twenty-five");
console.log(nums.join('|'));
// 5|10|15|twenty|twenty-five|30
```

Problem: First and Last K Numbers

- You are given an **array of numbers**
  - The first element holds an integer **k**
  - Print the **first k** and the **last k** from the other elements in the array (space separated)

```
function firstLastKElements(arr) {
  let k = arr.shift();
  console.log(arr.slice(0, k).join(' '));
  console.log(arr.slice(arr.length-k,
    arr.length).join(' '));
}
```

2 7 8 9	→	7 8 8 9
3 6 7 8 9	→	6 7 8 7 8 9
1 5	→	5 5

Check your solution here: https://judge.softuni.bg/Contests/311

Problem: Sum Last K Numbers Sequence

- Take two integers **n** and **k**
- Generate and print the following **sequence**:
  - The first element is: **1**
  - All other elements = **sum of the previous k** elements
- Example: **n** = 9, **k** = 5
  - 120 = 4 + 8 + 16 + 31 + 61

```
6
3
```

```
Sequence:
1 1 2 4 7 13
```

```
8
2
```

```
Sequence:
1 1 2 3 5 8 13 21
```

```
9
5
```

```
Sequence:
1 1 2 4 8 16 31 61 120
```

+

1 1 2	4 8 16 31 61	120

Check your solution here: https://judge.softuni.bg/Contests/311

Solution: Sum Last K Numbers Sequence

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```
function sumLastKNumbersSequence(n, k) {
  let seq = [1];
  for (let current = 1; current < n; current++) {
    let start = Math.max(0, current - k);
    let end = current - 1;
    let sum = // TODO: sum the values of seq[start … end]
    seq[current] = sum;
  }
  console.log(seq.join(' '));
}
```

Check your solution here: https://judge.softuni.bg/Contests/311

Filtering and Transforming Elements

```
let nums = ['one', 'two', 'three', 'four'];
console.log(nums.join('|')); // one|two|three|four
```

```
let filteredNums =
  nums.filter(x => x.startsWith('t'));
console.log(filteredNums.join('|')); // two|three
```

```
let lengths = nums.map(x => x.length);
console.log(lengths.join('|')); // 3|3|5|4
```

```
let lengths = nums.map(x => [x.length, x[0]]);
console.log(lengths.join('|')); // 3,o|3,t|5,t|4,f
```

More Useful Array Methods

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```
let nums = [1, 2, 3, 4];
let numsSum = nums.reduce((a, b) => a + b);
console.log(numsSum); // 10
```

```
let reversedNums = nums.reverse();
console.log(reversedNums); // [4, 3, 2, 1]
let allNums = nums.concat(reversedNums);
console.log(allNums); // [1, 2, 3, 4, 4, 3, 2, 1]
```

```
let includes = allNums.includes(4);
let index = allNums.indexOf(4);
console.log(includes, index); // true 3
```

Problem: Process Odd Numbers

- You are given an **array of numbers**
  - Print the **odd** numbers, **doubled** and **reversed**

```
function firstLastElements(arr) {
  let result = arr
    .filter((num, i) => i % 2 == 1)
    .map(x => 2*x)
    .reverse();
  return result.join(' ');
}
```

```
10
15
20
25
```

→

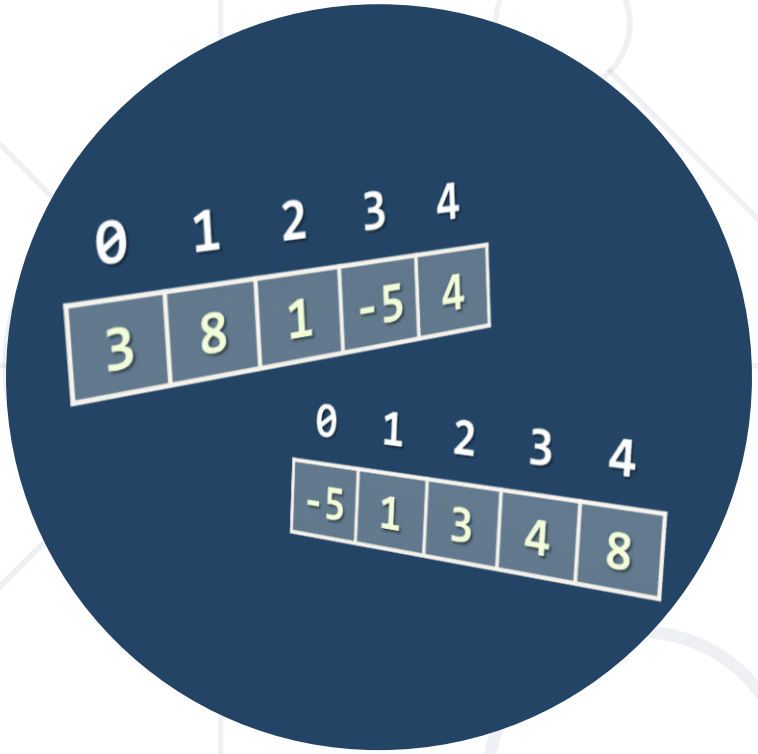
```
50 30
```

```
3
0
10
4
7
3
```

→

```
6 8 0
```

Check your solution here: https://judge.softuni.bg/Contests/311



Sorting Arrays

Arranging Elements in Increasing Order

Sorting Arrays

```
let nums = [20, 40, 10, 30, 100, 5];
console.log(nums.join('|')); // 20|40|10|30|100|5
```

```
nums.sort(); // Works incorrectly on arrays of numbers!!!
console.log(nums.join('|')); // 10|100|20|30|40|5
```

```
nums.sort((a, b) => a-b); // Compare elements as numbers
console.log(nums.join('|')); // 5|10|20|30|40|100
```

Problem: Smallest 2 Numbers

- You are given an **array of numbers**
  - Print the **smallest** two numbers

```
function smallestTwoNumbers(arr) {
  arr.sort((a, b) => a-b);
  let result = arr.slice(0, 2);
  return result.join(' ');
}
```

```
30
15
50
5
```

→

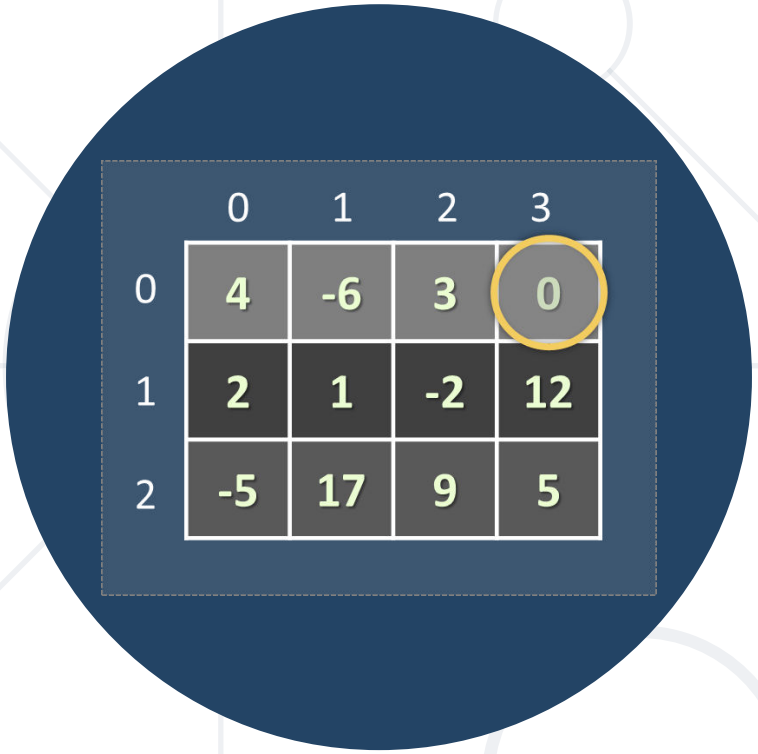
```
5 15
```

```
3
0
10
4
7
3
```

→

```
0 3
```

Check your solution here: https://judge.softuni.bg/Contests/311



Matrices (Tables)

Arrays Holding Arrays

Matrices in JS

- A **matrix** is a **table of values**

Matrix of **4** rows

Element **`matrix[2][0]`** at row **2**, column **0**

	0	1	2	3
0	4	-6	3	0
1	2	1	-2	
2	-5	17		
3	7	3	-9	12

- Represented as **nested arrays** in JavaScript

```
let matrix = [
  [4, -6, 3, 0],
  [2, 1, -2],
  [-5, 17],
  [7, 3, -9, 12]
];
```

Matrix – Example

- Defining a **matrix** (array of arrays)

```
let matrix = [
  ['0,0', '0,1', '0,2'],
  ['1,0', '1,1', '1,2'],
  ['2,0', '2,1', '2,2']
];
```

- Printing a **matrix**

Join the cells in each row by ' ', then join the rows by '\n')

```
console.log(
  matrix.map(row => row.join(' '))
  .join('\n'));
```

```
0,0 0,1 0,2
1,0 1,1 1,2
2,0 2,1 2,2
```

Problem: Biggest Element in Matrix

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- You receive a 2D **matrix of numbers** as an array
  - Each element of the input array is an array of numbers
- Write a JS function to find the **biggest number**

```
3 5 17 12 91 5
-1 7 4 33 6 22
1 8 99 3 10 43
```

↓

```
99
```

```
3 5 7 12
-1 4 33 2
8 3 0 4
```

↓

```
33
```

```
20 50 10
8 33 145
```

↓

```
145
```

Solution: Biggest Element in Matrix

```
function biggestElement(matrix) {

  let biggestNum = Number.NEGATIVE_INFINITY;
  matrix.forEach(
    r => r.forEach(
      c => biggestNum = Math.max(biggestNum, c)));

  return biggestNum;
}
```

```
20 50 10
8 33 145
```

```
biggestElement([[20, 50, 10], [8, 33, 145]]); // 145
```

Check your solution here: https://judge.softuni.bg/Contests/311

Problem: Diagonal Sums

- You receive a 2D matrix of numbers as an array
  - Each element of the input array is an array of numbers
- Find sum at the main and at the secondary diagonals

20	40
10	60

80 50

3	5	17
-1	7	14
1	-8	89

99 25

Solution: Diagonal Sums

```
function diagonalSums(matrix) {

  let mainSum = 0, secondarySum = 0;
  for (let row = 0; row < matrix.length; row++) {
    mainSum += matrix[row][row];
    secondarySum += matrix[row][matrix.length-row-1];
  }
  console.log(mainSum + ' ' + secondarySum);
}
```

3	5	17
-1	7	14
1	-8	89

```
diagonalSums([[20, 40], [10, 60]]); // 80 50
```

Check your solution here: https://judge.softuni.bg/Contests/311

Problem: Equal Neighbors

- You are given a matrix of elements
  - Find the number of equal neighbors

```
2 3 4 7 0
4 0 5 3 4
2 3 5 4 2
9 8 7 5 4
```

1

```
2 2 5 7 4
4 0 5 3 4
2 5 5 4 2
```

5

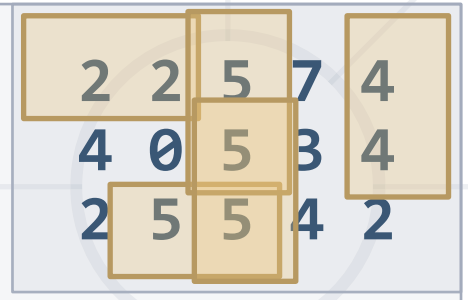
```
test yes yo ho
well done yo 6
not done yet 5
```

2

Problem: Equal Neighbors

```
function equalNeighborsCount(matrix) {

  let neighbors = 0;
  for (let row = 0; row < matrix.length-1; row++)
    for (let col = 0; col < matrix[row].length; col++)
      if (matrix[row][col] === matrix[row + 1][col])
        neighbors++;
  // TODO: check also the horizontal neighbors
  return neighbors;
}
```



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Live Exercises

Summary

- **Arrays** in JS hold sequence of elements

```
let nums = [10, 20, 30, 40];
```

- Elements are accessed by **index**

```
nums[2] = 100;
```

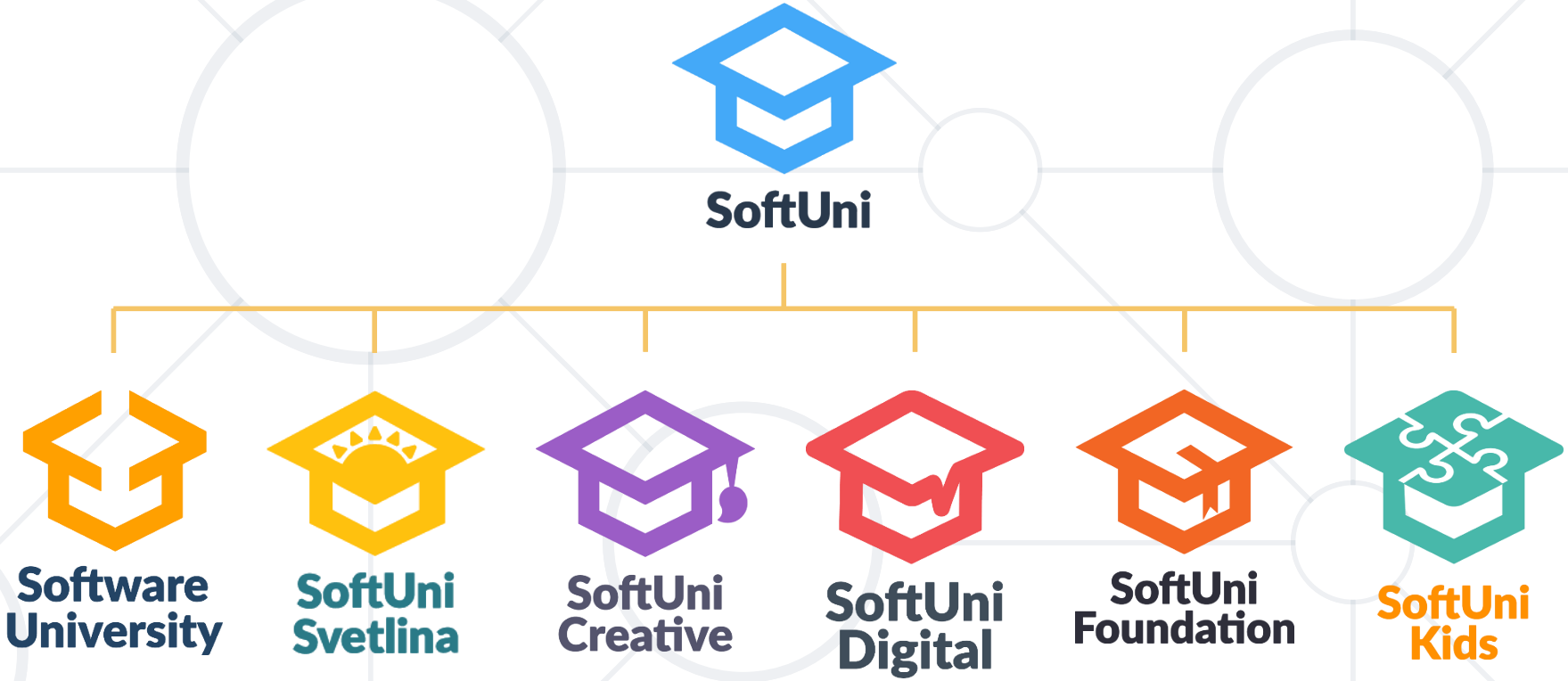
- Behave like **lists** (add / delete elements)

```
nums.push('new element');
```

- **Matrices** are arrays holding arrays

```
let matrix = [[10, 20], [30, 40]];
```

Questions?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