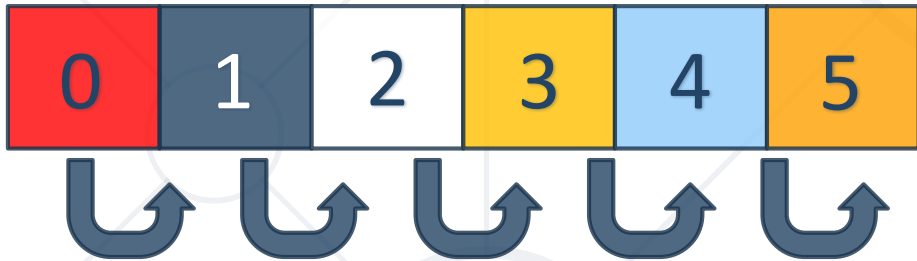


Arrays and Nested Arrays

Definitions and Manipulations



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Working with Arrays of Elements

Arrays in JavaScript

What is an Array?

- Arrays are **list-like objects**
- Arrays are a **reference type**, the variable points to an address in memory



Array of 5 elements

0 1 2 3 4

Element **index**

... ..

Array **element**

- Elements are **numbered** from **0** to **length - 1**
- Creating an array using **an array literal**

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

What is an Array?

- Neither the **length** of a JavaScript array **or** the **types** of its elements are **fixed**
- An array's **length can be changed** at any time
- Data can be stored at non-contiguous locations in the array
- JavaScript arrays are not guaranteed to be dense



Arrays of Different Types



```
// 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 (not a good practice)
```

```
let mixedArr = [20, new Date(), 'hello', {x:5, y:8}];
```



Accessing Array Elements

Accessing Elements

- Array elements are accessed using their **index**

```
let cars = ['BMW', 'Audi', 'Opel'];  
let firstCar = cars[0];    // BMW  
let lastCar = cars[cars.length - 1];    // Opel
```

- Accessing indexes that do not exist in the array returns **undefined**

```
console.log(cars[3]);    // undefined  
console.log(cars[-1]);    // undefined
```

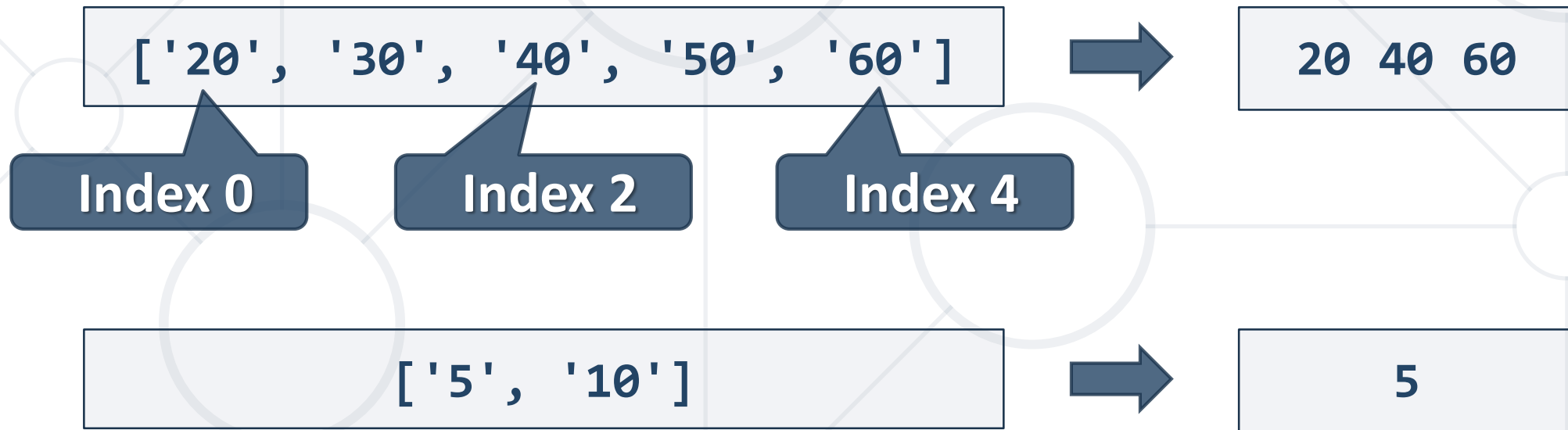
- Arrays can be **iterated** using **for-of** loop

```
for (let car of cars) { ... }
```



Problem: Even Position Element

- Find every element at **even index** in input array
- Print** them on the console, separated by space



Solution: Even Position Element

```
function solve(arr) {  
  let result = '';  
  
  for (let i = 0; i < arr.length; i+=2) {  
    result += arr[i];  
    result += ' ';  
  }  
  
  console.log(result);  
}
```

Arrays Indexation

- Setting values via **non-integers** using **bracket notation** (or dot notation) creates **object properties** instead of array elements (will be discussed in later lesson)



```
let arr = [];  
arr[3.4] = 'Oranges';  
arr[-1] = 'Apples';  
console.log(arr.length);           // 0  
console.log(arr.hasOwnProperty(3.4)); // true  
  
arr["1"] = 'Grapes';  
console.log(arr.length);           // 2  
console.log(arr); // [ <1 empty item>, 'Grapes',  
  '3.4': 'Oranges', '-1': 'Apples' ]
```

Destructuring Syntax

- Expression that **unpacks values** from **arrays** or **objects**, into distinct **variables**

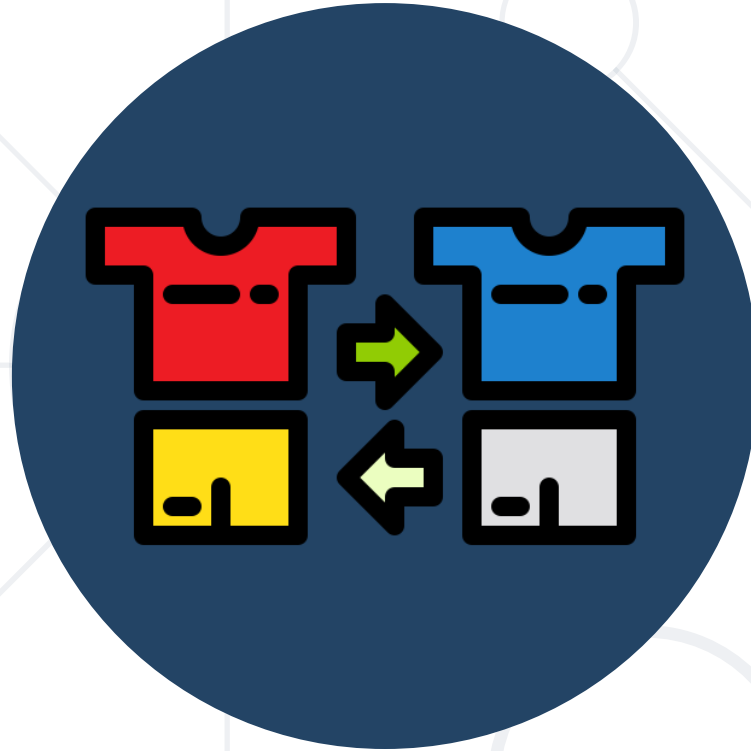
```
let numbers = [10, 20, 30, 40, 50];  
let [a, b, ...elems] = numbers;
```

Rest operator

```
console.log(a) // 10  
console.log(b) // 20  
console.log(elems) // [30, 40, 50]
```

- The **rest operator** can also be used to collect function parameters into an array





Mutator Methods

Modify the Array

Pop


- Removes the **last element** from an array and returns that element
- This method **changes** the **length** of the array



```
let nums = [10, 20, 30, 40, 50, 60, 70];  
console.log(nums.length); // 7  
console.log(nums.pop());  // 70  
console.log(nums.length); // 6  
console.log(nums);        // [ 10, 20, 30, 40, 50, 60 ]
```

Push


- The **push()** method **adds one or more** elements to the **end** of an array and **returns** the new **length** of the array



```
let nums = [10, 20, 30, 40, 50, 60, 70];  
console.log(nums.length); // 7  
console.log(nums.push(80)); // 8 (nums.Length)  
console.log(nums); // [ 10, 20, 30, 40, 50, 60, 70, 80 ]
```


Shift

- The `shift()` method removes the first element from an array and returns that removed element
- This method changes the length of the array



```
let nums = [10, 20, 30, 40, 50, 60, 70];  
console.log(nums.length); // 7  
console.log(nums.shift()); // 10 (removed element)  
console.log(nums); // [ 20, 30, 40, 50, 60, 70 ]
```

Unshift

- The **unshift()** method **adds one or more** elements to the **beginning** of an array and **returns** the new **length** of the array



```
let nums = [40, 50, 60];  
console.log(nums.length);           // 3  
console.log(nums.unshift(30));      // 4 (nums.Length)  
console.log(nums.unshift(10,20));  // 6 (nums.Length)  
console.log(nums);                  // [ 10, 20, 30, 40, 50, 60 ]
```

Problem: Sum First and Last

- Receive an **array of strings** as **input**
- Calculate the **sum** of the **first** and **last** elements
- **Return** the value at the end of your function



Solution: Sum First and Last

```
function firstSolution(arr) {  
  const first = Number(arr[0]);  
  const last = Number(arr[arr.length - 1]);  
  
  return first + last;  
}
```

```
function secondSolution(arr) {  
  return Number(arr.pop()) + Number(arr.shift());  
}
```

Problem: Negative / Positive Numbers

- Create a **new array** from the input array
 - **Prepend** negative elements at the front of the result
 - **Append** non-negative elements at the end of the result
- **Print** each resulting value on a new line




Solution: Negative / Positive Numbers

```
function solve(arr) {  
  const result =[];  
  
  for (let num of arr) {  
    if (num < 0) { result.unshift(num); }  
    else { result.push(num); }  
  }  
  
  for (let num of result) {  
    console.log(num);  
  }  
}
```

Splice

- Changes the contents of an array by **removing** or **replacing** existing **elements** and/or **adding new** elements



```
let nums = [1, 3, 4, 5, 6];
nums.splice(1, 0, 2); // inserts at index 1
console.log(nums); // [ 1, 2, 3, 4, 5, 6 ]
nums.splice(4, 1, 19); // replaces 1 element at index 4
console.log(nums); // [ 1, 2, 3, 4, 19, 6 ]
let e1 = nums.splice(2, 1); // removes 1 element at index 2
console.log(nums); // [ 1, 2, 4, 19, 6 ]
console.log(e1); // [ 3 ]
```

Fill

- Fills all the elements of an array from a **start index** to an **end index** with a **static value**

```
let arr = [1, 2, 3, 4];  
// fill with 0 from position 2 until position 4  
console.log(arr.fill(0, 2, 4)); // [1, 2, 0, 0]  
// fill with 5 from position 1  
console.log(arr.fill(5, 1)); // [1, 5, 5, 5]  
console.log(arr.fill(6)); // [6, 6, 6, 6]
```



Reverse

- Reverses the array
 - The **first** array **element becomes** the **last**, and the last array element becomes the first

```
let arr = [1, 2, 3, 4];  
arr.reverse();  
console.log(arr); // [ 4, 3, 2, 1 ]
```





Sorting Arrays

Default Behavior and Compare Functions

Sorting Arrays

- The **sort()** method sorts the items of an array
- Depending on the provided **compare function**, sorting can be **alphabetic** or **numeric**, and either **ascending (up)** or **descending (down)**
- By default, the **sort()** function sorts the values as strings in **alphabetical** and **ascending** order
- If you want to sort numbers or other values, you need to provide the correct **compare function**!



Sorting Arrays – Example

```
let names = ["Peter", "George", "Mary"];  
names.sort(); // Default behaviour – alphabetical order  
console.log(names); // ["George", "Mary", "Peter"]
```

```
let numbers = [20, 40, 10, 30, 100, 5];  
numbers.sort(); // Unexpected result on arrays of numbers!  
console.log(numbers); // [10, 100, 20, 30, 40, 5]
```

Compare Functions

- A **function** receiving **two parameters**, e.g. **a** and **b**
 - **Returns** either a **positive** number, a **negative** number, or **zero**
 - If **result** < 0 , a is sorted **before** b
 - If **result** > 0 , a is sorted **after** b
 - If **result** $= 0$, a and b are **equal** (no change)



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

Sorting String Arrays

- The **localeCompare()** method is used to compare any two characters without regard for the case used
 - It's a string method so it can't be used directly on an array
 - Pass **localeCompare()** as the comparison function



```
let words = ['nest', 'Eggs', 'bite', 'Grip', 'jAw'];  
words.sort((a, b) => a.localeCompare(b));  
// ['bite', 'Eggs', 'Grip', 'jAw', 'nest']
```

Problem: Bigger Half

- **Sort** an input array of **numbers** in **ascending** order
- Create a **new array** from the **second half** of the input array
 - If there are an **odd number** of elements, take the **bigger half**
- **Return** the resulting array

[4, 7, 2, 5]



[5, 7]

[3, 19, 14, 7, 2, 19, 6]



[7, 14, 19, 19]

Solution: Bigger Half

```
function solve(arr) {  
  arr.sort((a, b) => a - b);  
  const middle = Math.floor(arr.length / 2);  
  const result = arr.slice(middle);  
  
  return result;  
}
```




Accessor Methods

Join


- Creates and returns a **new string** by **concatenating** all of the elements in an array (or an array-like object), **separated** by commas or a **specified separator** string

```
let elements = ['Fire', 'Air', 'Water'];  
console.log(elements.join()); // "Fire,Air,Water"  
console.log(elements.join('')); // "FireAirWater"  
console.log(elements.join('-')); // "Fire-Air-Water"  
console.log(['Fire'].join(".")); // Fire
```



Concat

- The **concat()** method is used to **merge** two or more arrays
- This method **does not change** the **existing arrays**, but instead returns a new array



```
const num1 = [1, 2, 3];  
const num2 = [4, 5, 6];  
const num3 = [7, 8, 9];  
const numbers = num1.concat(num2, num3);  
console.log(numbers); // [1, 2, 3, 4, 5, 6, 7, 8, 9]
```

Slice

- The **slice()** method **returns** a shallow **copy** of a **portion** of an array into a **new array** object selected from begin to end (end not included)
- The **original array** will **not** be **modified**



```
let fruits = ['Banana', 'Orange', 'Lemon', 'Apple', 'Mango'];  
let citrus = fruits.slice(1, 3);  
let fruitsCopy = fruits.slice();  
// fruits contains ['Banana', 'Orange', 'Lemon', 'Apple',  
  'Mango']  
// citrus contains ['Orange', 'Lemon']
```

Includes

- Determines whether an array contains a certain element, returning **true** or **false** as appropriate

```
// array length is 3
// fromIndex is -100
// computed index is 3 + (-100) = -97
let arr = ['a', 'b', 'c'];
arr.includes('a', -100); // true
arr.includes('b', -100); // true
arr.includes('c', -100); // true
arr.includes('a', -2); // false
```



IndexOf

- The `indexOf()` method returns the first index at which a given element can be found in the array
 - Output is `-1` if element is not present

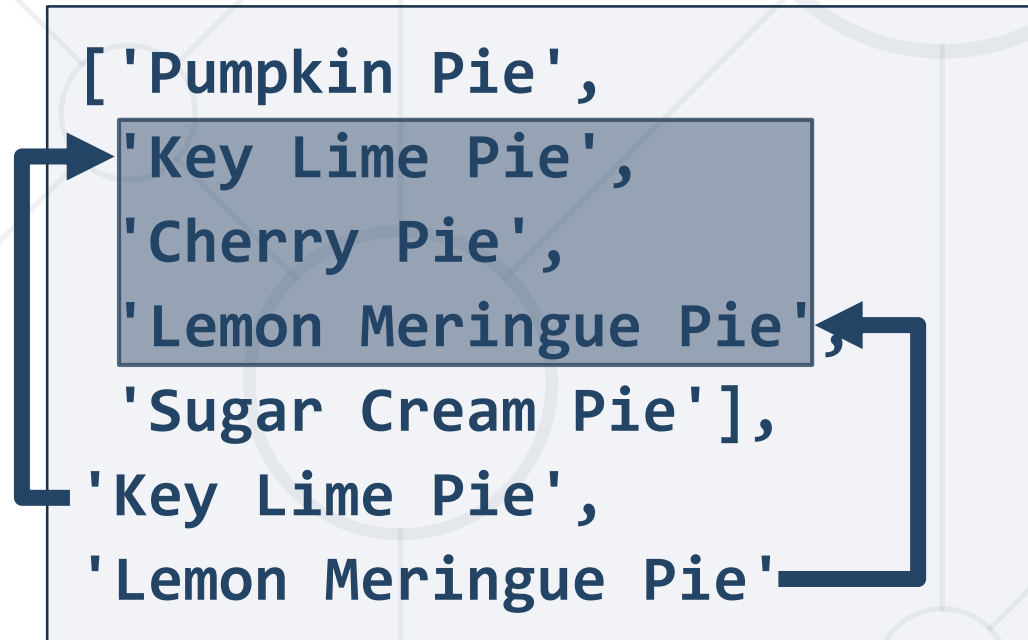


```
const beasts = ['ant', 'bison', 'camel', 'duck', 'bison'];

console.log(beasts.indexOf('bison')); // 1
// start from index 2
console.log(beasts.indexOf('bison', 2)); // 4
console.log(beasts.indexOf('giraffe')); // -1
```

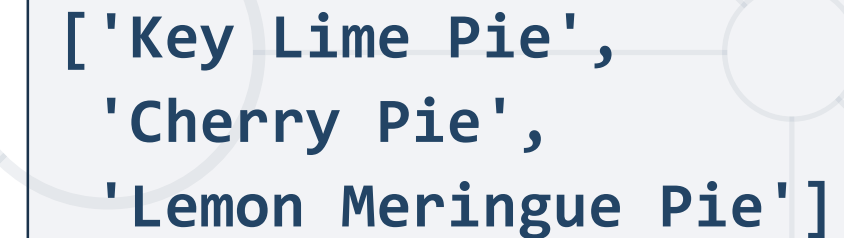
Problem: Piece of Pie

- Receive **three parameters** – an **array of pies** and two **strings**
- Take all pie flavors **between** and **including** the two strings
- **Return** the result as an **array of strings**



The diagram shows a large light blue box containing a list of pie flavors: ['Pumpkin Pie', 'Key Lime Pie', 'Cherry Pie', 'Lemon Meringue Pie', 'Sugar Cream Pie'], followed by 'Key Lime Pie' and 'Lemon Meringue Pie' on a new line. A smaller, darker blue box highlights the sub-range from 'Key Lime Pie' to 'Lemon Meringue Pie'. A thick blue arrow points from the start of this sub-range to the start of the final result box on the right. Another thick blue arrow points from the end of this sub-range to the end of the final result box on the right.

```
['Pumpkin Pie',  
'Key Lime Pie',  
'Cherry Pie',  
'Lemon Meringue Pie',  
'Sugar Cream Pie'],  
'Key Lime Pie',  
'Lemon Meringue Pie']
```



The diagram shows a light blue box containing the resulting array of strings: ['Key Lime Pie', 'Cherry Pie', 'Lemon Meringue Pie']. A thick blue arrow points from the large box on the left to this box.

```
['Key Lime Pie',  
'Cherry Pie',  
'Lemon Meringue Pie']
```

```
function solve(pies, startFlavor, endFlavor) {  
  const start = pies.indexOf(startFlavor);  
  const end = pies.indexOf(endFlavor) + 1;  
  
  const result = pies.slice(start, end);  
  
  return result;  
}
```




Iteration Methods

ForEach

- The **forEach()** method **executes a provided function** once for each array element
- Converting a for loop to forEach

```
const items = ['item1', 'item2', 'item3'];  
const copy = [];
```

```
// For Loop
```

```
for (let i = 0; i < items.length; i++) {  
  copy.push(items[i]);  
}
```

```
// ForEach
```

```
items.forEach(item => { copy.push(item); });
```



Map


- **Creates a new array** with the results of calling a **provided function** on every element in the calling array

```
let numbers = [1, 4, 9];  
let roots = numbers.map(function(num, i, arr) {  
  return Math.sqrt(num)  
});  
// roots is now [1, 2, 3]  
// numbers is still [1, 4, 9]
```



Some

- The **some()** method **tests** whether **at least one** element in the array passes the test implemented by the **provided function**
- It returns a **Boolean** value



```
let array = [1, 2, 3, 4, 5];
let isEven = function(element) {
  // checks whether an element is even
  return element % 2 === 0;
};
console.log(array.some(isEven)); //true
```

Find


- Returns the **first found value** in the array, if an **element** in the array **satisfies** the **provided** testing **function** or **undefined** if not found

```
let array1 = [5, 12, 8, 130, 44];  
let found = array1.find(function(element) {  
    return element > 10;  
});  
console.log(found); // 12
```



Filter

- Creates a **new array** with **filtered elements only**
- Calls a **provided** callback **function** once for each element in an array
- **Does not mutate** the **array** on which it is called



```
let fruits = ['apple', 'banana', 'grapes', 'mango', 'orange'];  
// Filter array items based on search criteria (query)  
function filterItems(arr, query) {  
  return arr.filter(function(el) {  
    return el.toLowerCase().indexOf(query.toLowerCase()) !== -1;  
  });  
};  
console.log(filterItems(fruits, 'ap')); // ['apple', 'grapes']
```

Problem: Process Odd Positions

You are given **array of numbers**

- Find all elements at **odd** positions (indexes)
- **Multiply** them by 2
- **Reverse** them
- Return the elements separated with a single space

[10, 15, 20, 25]



50 30

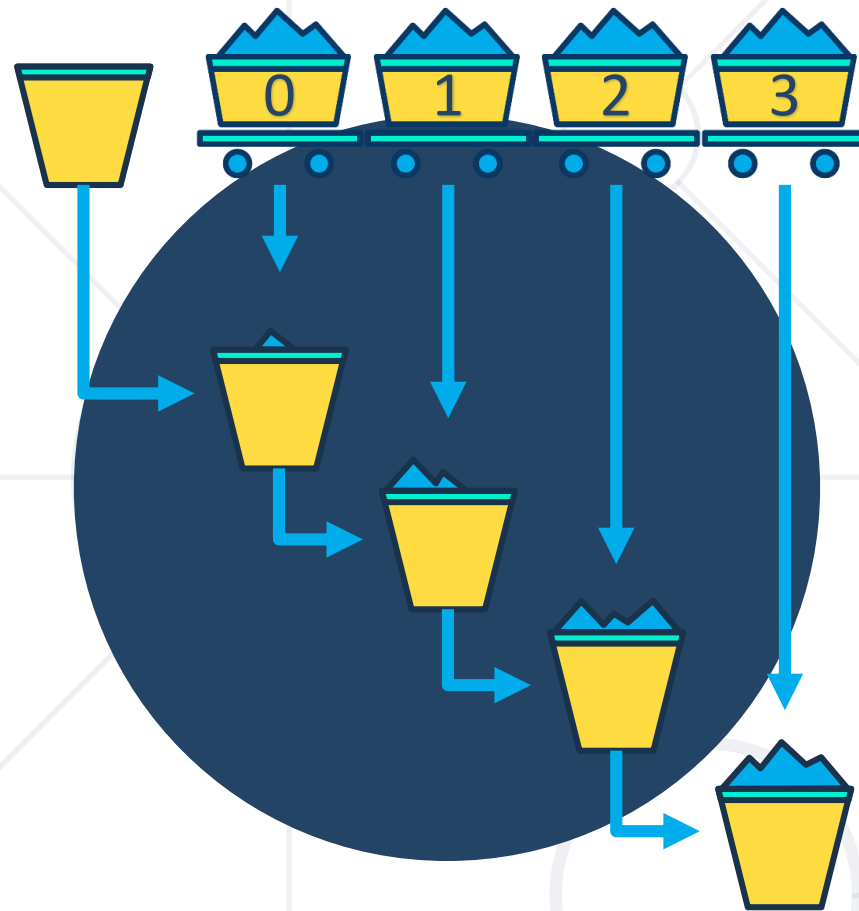
[3, 0, 10, 4, 7, 3]



6 8 0

Solution: Process Odd Positions

```
function solve(arr) {  
  return arr.filter((a, i) => i % 2 !== 0)  
    .map(x => x * 2)  
    .reverse()  
    .join(' ');  
}
```

Reducing Arrays

Reduce

- The **reduce()** method executes a reducer function on each element of the array, resulting in a **single output value**

```
const array1 = [1, 2, 3, 4];  
const reducer =  
  (accumulator, currentValue) => accumulator + currentValue;  
console.log(array1.reduce(reducer)); // 10  
console.log(array1.reduce(reducer, 5)); // 15
```



Reducer Function

- The reducer function takes **four** arguments:
 - Accumulator
 - Current Value
 - Current Index (Optional)
 - Source Array (Optional)
- Your **reducer function's** returned value is **assigned** to the **accumulator**
- **Accumulator's value** - the **final, single** resulting **value**



Examples

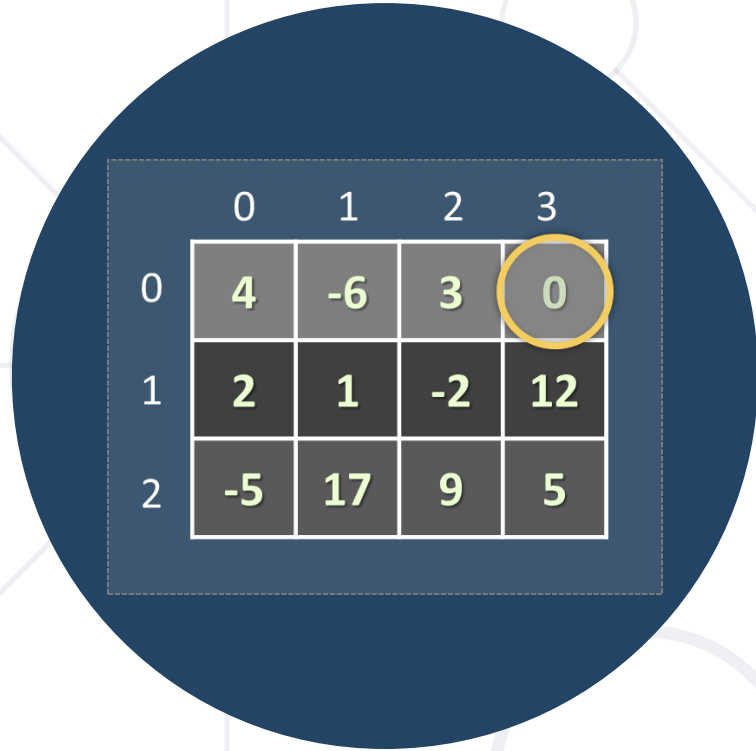
- Sum all values

```
let sum = [0, 1, 2, 3].reduce(function (acc, curr) {  
    return acc + curr;  
}, 0);  
console.log(sum); // 6
```

- Finding an average with reduce

```
const numbersArr= [30, 50, 40, 10, 70];  
const average =  
    numbersArr.reduce((total, number, index, array) => {  
        total += number;  
        if( index === array.length-1) {  
            return total/array.length;  
        } else { return total; }  
    });  
console.log(average) // 40
```





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

Array of Arrays

Nested Arrays

Nested Arrays in JS



Array of 4
arrays


Element
arr[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

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

Looping Through a Nested Array

```
let arr = [[4, 5, 6],  
           [6, 5, 4],  
           [5, 5, 5]];
```



```
arr.forEach(printRow);  
function printRow(row){  
  console.log(row);  
  row.forEach(printNumber);  
}  
function printNumber(num){  
  console.log(num);  
};
```

Prints each row of the array on a separate line

Prints each element of the array on a separate line

Problem: Diagonal Sums

- You are given an **array of arrays**, containing number elements
 - Find what is the **sum** at the **main** diagonal
 - Find what is the **sum** at the **secondary** diagonal
 - Print the diagonal sums separated by **space**

3	5	17
-1	7	14
1	-8	89



Solution: Diagonal Sums

```
function diagonalSums(input) {  
  let firstDiagonal = 0;  
  let secondDiagonal = 0;  
  let firstIndex = 0;  
  let secondIndex = input[0].length - 1;  
  input.forEach(array => {  
    firstDiagonal += array[firstIndex++];  
    secondDiagonal += array[secondIndex--];  
  });  
  console.log(firstDiagonal + ' ' + secondDiagonal);  
}
```

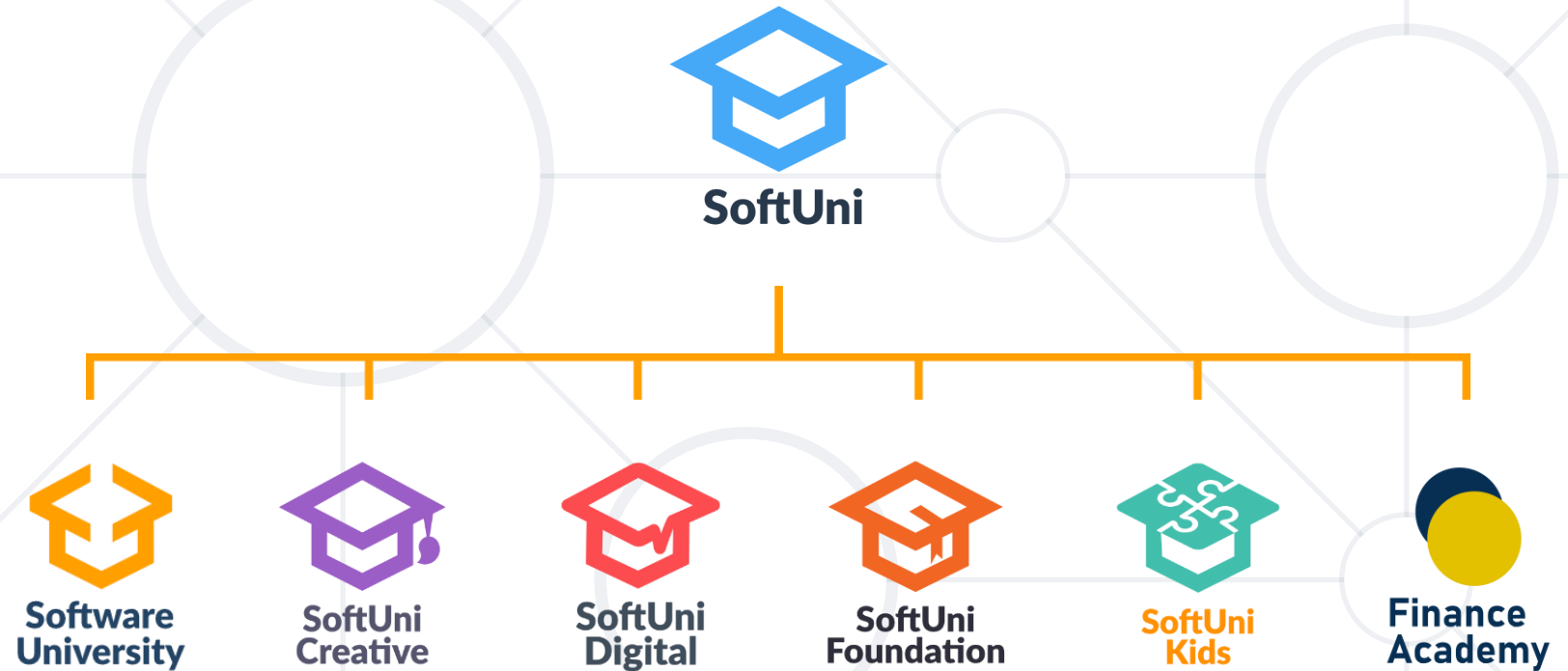


Live Exercises

- Arrays are **list-like objects**
- Elements are **accessed** using their **index**
- **Mutator** methods **change** the original **array**
- **Accessor** methods return a **new array**
- Arrays can be **reduced** to a single value
- An array of arrays is called a **matrix**
- Matrices can have **more** than 2 **dimensions**



Questions?



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