Advanced Functions

Function Context, First-Class Functions, Referential Transparency, Currying, IIFE, Closure

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Execution Context

Execution Context Review

- The **function context** is the object that **owns** the currently executed code
- Function context === `this` object
- Depends on how the function is invoked
  - Global invoke: `func()`
  - Object method: `object.function()`
  - DOM Event: `element.addEventListener()`
  - Using `call()` / `apply()` / `bind()`

Inner Method Context

- `this` variable is accessible only by the outer method

```
const obj = {
  name: 'Peter',
  outer() {
    console.log(this); // Object {name: "Peter"}

    function inner() { console.log(this); }

    inner();
  }
}

obj.outer(); // Window
```

Arrow Function Context

- `this` retains the value of the **enclosing lexical context**

```
const obj = {
  name: 'Peter',
  outer() {
    console.log(this); // Object {name: "Peter"}

    const inner = () => console.log(this);

    inner();
  }
}

obj.outer(); // Object {name: "Peter"}
```

Explicit Binding

- Occurs when `call()`, `apply()`, or `bind()` are used on a function
- **Forces** a **function** call to **use** a particular **object** for this binding

```
function greet() {
  console.log(this.name);
}

let person = { name:'Alex' };
greet.call(person, arg1, arg2, arg3, ...); // Alex
```

Changing the Context: Call

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- Calls a function with a given **this** value and **arguments** provided individually

```
const sharePersonalInfo = function (...activities) {
  let info = `Hello, my name is ${this.name} and`+
           + `I'm a ${this.profession}.\n`;
  info += activities.reduce((acc, curr) => {
      let el  = `--- ${curr}\n`;
      return acc + el;
  }, "My hobbies are:\n").trim();
  return info;
}
// Continues on the next slide…
```

Changing the Context: Call

```
const firstPerson = { name: "Peter", profession: "Fisherman" };
console.log(sharePersonalInfo.call(firstPerson, 'biking',
'swimming','football'));
// Hello, my name is Peter.
// I'm a Fisherman.
// My hobbies are:
// --- biking
// --- swimming
// --- football
```

Changing the Context: Apply

- Calls a function with a **given this value**, and **arguments** provided as an **array**
- **`apply()`** accepts a **single array** of arguments, while **`call()`** accepts an **argument list**
- If the first argument is **undefined** or **null** a similar outcome can be achieved using the array **spread syntax**

Apply() – Example

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```
const firstPerson = {
  name: "Peter",
  prof: "Fisherman",
  shareInfo: function () {
    console.log(`${this.name} works as a ${this.prof}`);
  }
};
const secondPerson = { name: "George", prof: "Manager" };
firstPerson.shareInfo.apply(secondPerson);
// George works as a Manager
```

Changing the Context: Bind

- The `bind()` method creates a **new function**
- Has its `this` keyword **set** to the **provided** value, with a given sequence of arguments preceding any provided when the **new function** is called
- Calling the bound function generally results in the **execution** of its **wrapped function**

Bind – Example

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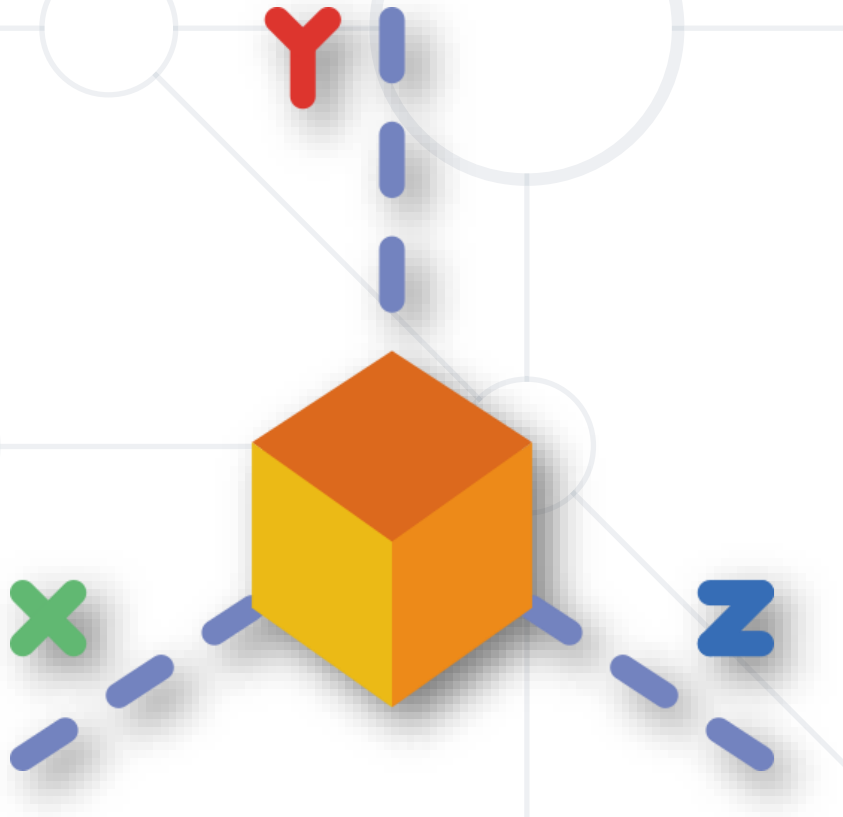
```
const x = 42;
const getX = function () {
  return this.x;
}
const module = {x , getX };
const unboundGetX = module.getX;
console.log(unboundGetX()); // undefined
const boundGetX = unboundGetX.bind(module);
console.log(boundGetX()); // 42
```

Problem: Area and Volume Calculator

- The functions **area** and **vol** are **passed as parameters** to your function

```
function area() {
  return Math.abs(this.x * this.y);
};
```

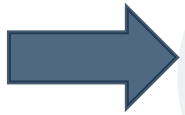
```
function vol() {
  return Math.abs(this.x * this.y *
this.z);
};
```



Problem: Area and Volume Calculator

- Calculate the **area** and the **volume** of figures, which are defined by their coordinates (**x**, **y** and **z**), **using** the **provided functions**

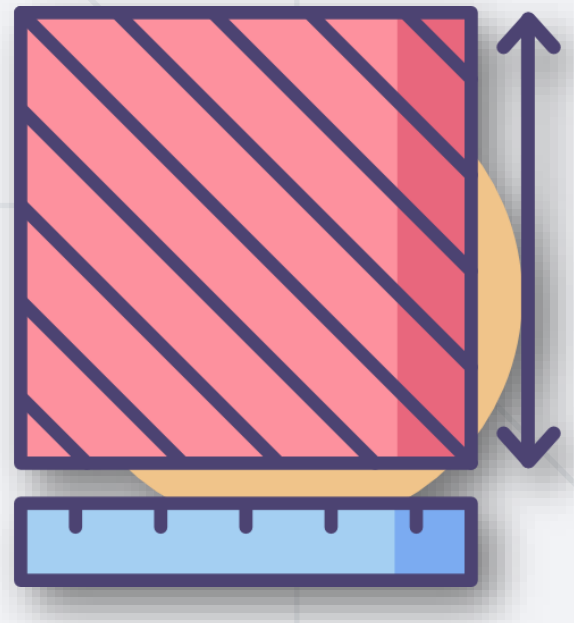
```
`[
{"x":"1","y":"2","z":"10"},
{"x":"7","y":"7","z":"10"},
{"x":"5","y":"2","z":"10"}
]`
```



```
[
  { area: 2, volume: 20 },
  { area: 49, volume: 490 },
  { area: 10, volume: 100 }
]
```

Solution: Area and Volume Calculator

```
function solve(area, vol, input) {
  let objects = JSON.parse(input);
  function calc(obj) {
    let areaObj = Math.abs(area.call(obj));
    let volumeObj = Math.abs(vol.call(obj));
    return { area: areaObj, volume: volumeObj }
  }
  return objects.map(calc);
}
```



Object Methods as Browser Event Handlers

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```
const person = {
  name: "Peter",
  respond() {
    alert(`${this.name} says hello!`);
  }
}
const boundRespond = person.respond.bind(person);

documet.getElementById('callBtn')
       .addEventListener('click', person.respond);

documet.getElementById('callBtn')
       .addEventListener('click', boundRespond);
```

```
<body>
  <button id="callBtn">Call Person</button>
</body>
```

Unwanted result

Works as intended

Functional Programming in JS

First-Class Functions

- **First-class functions** are treated like any other variable
  - Passed as an **argument**
  - **Returned** by another function
  - Assigned as a **value** to a **variable**

> The term "first-class" means that something is just a value. A first-class function is one that can go anywhere that any other value can go - there are few to no restrictions.
>
> *Michael Fogus, Functional Javascript*

First-Class Functions

- Can be passed as an **argument** to another function

```
function sayHello() {
    return "Hello, ";
}
```

```
function greeting(helloMessage, name) {
    return helloMessage() + name;
}
```

```
console.log(greeting(sayHello, "JavaScript!"));
// Hello, JavaScript!
```

First-Class Functions

- Can be **returned** by another function
  - We can do that, because we treated functions in JavaScript as a **value**

```
function sayHello() {
    return function () {
        console.log('Hello!');
    }
}
```

First-Class Functions

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- Can be assigned as a **value** to a **variable**

```
const write = function () {
    return "Hello, world!";
}
```

```
console.log(write());
// Hello, world!
```

Higher-Order Functions

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- Take other **functions** as an **argument** or **return a function** as a result

```
const sayHello = function () {
  return function () {
     console.log("Hello!");
  }
}
```

```
const myFunc = sayHello();
myFunc(); // Hello!
```

Predicates

- Any function that returns a **bool based** on evaluation of the **truth** of an **assertion**
- Predicates are often found in the form of **callbacks**

```
let found = array1.find(isFound);

function isFound(element) {
    return element > 10; // True or false
}

console.log(found); // 12
```

predicate

Built-in Higher Order Functions

- Array.prototype.map
- Array.prototype.filter
- Array.prototype.reduce

```
users = [ { name: 'Tim', age: 25 },
          { name: 'Sam', age: 30 },
          { name: 'Bill', age: 20 } ];

getName = (user) => user.name;
usernames = users.map(getName);
console.log(usernames) // ["Tim", "Sam", "Bill"]
```

Pure Functions

- Returns the **same result** given **same parameters**
- Execution is **independent** of the state of the system

```
// impure function:
let number = 1;
const increment = () => number += 1;
increment(); // 2

// pure function:
const increment = n => n + 1;
increment(1); // 2
```

Referential Transparency

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- An **expression** that can be **replaced** with its corresponding **value** without **changing** the program's behavior
- Expression is **pure** and its evaluation must have no **side effects**

```
function add(a, b) { return a + b };
function mult(a, b) { return a * b};
let x = add(2, mult(3, 4));
// mult(3, 4)) can be replaced with 12
```

Closure

Closure

- One of the most **important features** in JavaScript
- The **scope** of an inner function **includes** the scope of the outer function
- An **inner** function retains **variables** being used from the **outer** function scope even after the parent function has **returned**

Functions Returning Functions

- A **state** is preserved in the outer function (**closure**)

```
const f = (function () {
    let counter = 0;
    return function () {
        console.log(++counter);
    }
})();
```

```
f(); // 1
f(); // 2
f(); // 3
f(); // 4
f(); // 5
f(); // 6
f(); // 7
```

Problem: Command Processor

- Write a program, which:
  - Keeps a string **inside its scope**
  - Can execute different **commands** that modify a string:
    - `append()` - add **str** to the end of the internal string
    - `removeStart()` - **remove** the **first n** characters
    - `removeEnd()` - remove the **last n** characters
    - `print()` - print the stored string

Solution: Command Processor

```
function solution() {
    let str = '';
    return {
        append: (s) => str += s,
        removeStart: (n) => str = str.substring(n),
        removeEnd: (n) => str = str.substring(0, str.length - n),
        print: () => console.log(str)
    }
}
```

Review: DOM Problems

- Attempt to solve problems **Sections**, **Locked Profile** and **Furniture** from **previous exercises**, by using **closures** to store local **state** and **references**

What is IIFE?

- Immediately-Invoked Function Expressions (IIFE)
  - Define anonymous function expression
  - Invoke it immediately after declaration

```
(function () { let name = "Peter"; })();
// Variable name is not accessible from the outside scope
console.log(name); // ReferenceError
```

```
let result = (function () {
    let name = "Peter";
    return name;
})();
// Immediately creates the output:
console.log(result); // Peter
```

Function Decoration

Partial Application

- **Set** some of the **arguments** of a function, **without executing** it
- Pass the **remaining arguments** when a result is needed
  - The partially applied function can be **used multiple times**
  - It will **retain** all fixed arguments, **regardless of context**

```
f = (x, y) => x + y
```

```
g = (x) => f(1, x)
```

```
Math.pow(x,y)
```

```
sqr = (x) => Math.pow(x,2)
```

Problem: Currency Format

- Receive **three primitives** and a **function `formatter`**
  - The **`formatter`** function takes **4 arguments**
  - Use the first **three parameters** of your solution to create and return a **partially applied** function that only takes 1 parameter
- Sample usage:

```
const dollarFormatter =
  createFormatter(',', '$', true, currencyFormatter);
console.log(dollarFormatter(5345));   // $ 5345,00
console.log(dollarFormatter(3.1429)); // $ 3,14
console.log(dollarFormatter(2.709));  // $ 2,71
```

Solution: Currency Format

```
function createFormatter(separator,
                         symbol,
                         symbolFirst,
                         formatter) {
  return (value) => formatter(separator,
                              symbol,
                              symbolFirst,
                              value);
}
```

Partially applied arguments

Currying

- Currying is a technique for **function decomposition**

```
function sum3(a) {
    return (b) => {
        return (c) => {
            return a + b + c;
        }
    }
}
console.log(sum3(5)(6)(8)); // 19
```

- Supply arguments **one at a time**, instead of at once
  - They may come from **different sources**
  - Execution can be **delayed** until it's needed

Currying Usage

- **Function Composition** - Building new function from old function by passing arguments
- **Memoization** - Functions that are called repeatedly with the same set of inputs but whose result is relatively expensive to produce
- **Handle Errors** - Throwing functions and exiting immediately after an error

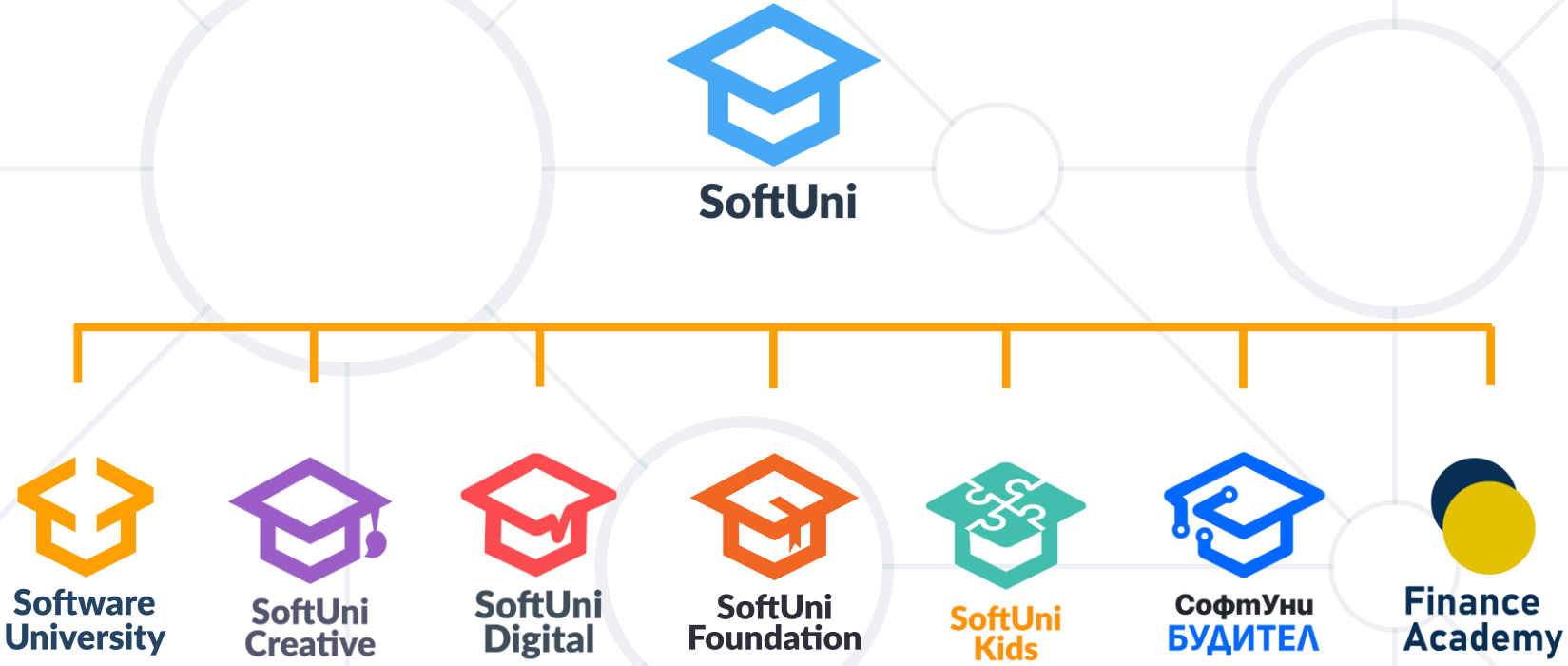
Currying vs Partial Application

- **Currying** always produces nested unary functions
- **Partial** application produces functions of arbitrary number of arguments
- Currying is **NOT** partial application
  - It can be implemented using partial application

Summary

- The execution context of a function can be changed using bind, apply and call
- JavaScript supports many aspects of the functional programming paradigm
- Closures allow a function to maintain state
  - They are powerful and flexible
- Partial application can be used to decorate and compose functions and to delay execution

Questions?



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