

Advanced Functions

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



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#js-advanced

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this

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
```



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

```
const sharePersonalInfo = function (...activities) {  
  let info = `Hello, my name is ${this.name}.\n` +  
    `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

```
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
```

- 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

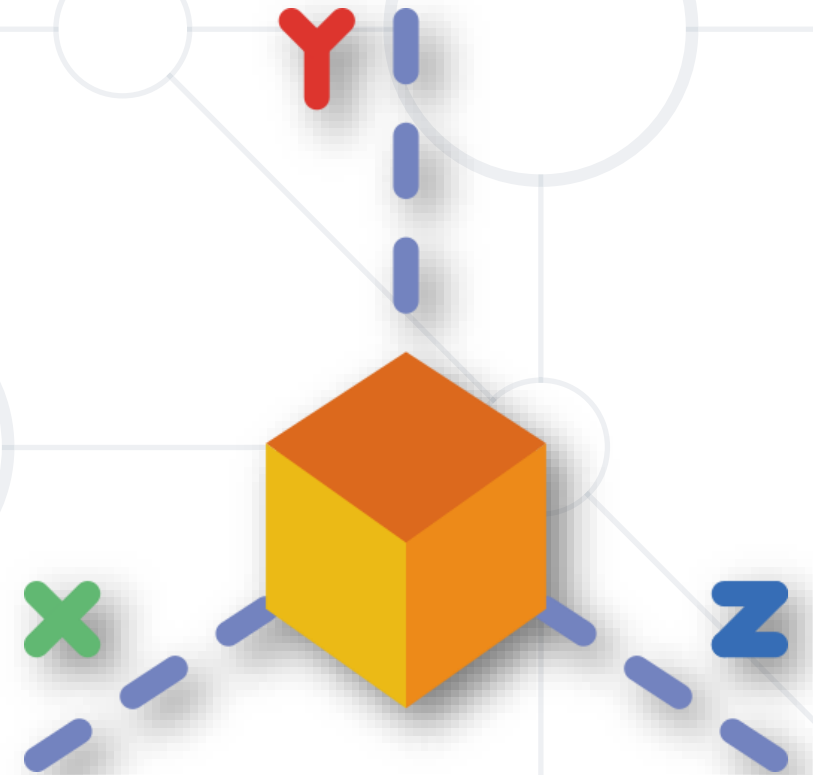
```
const x = 42;
const getX = function () {
  return this.x;
}
const module = {x , getX };
const unboundGetX = module.getX;
console.log(unboundGetX()); // undefined
const boundGetX = unboundGetX.bind(module);
console.log(boundGetX()); // 42
```

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**

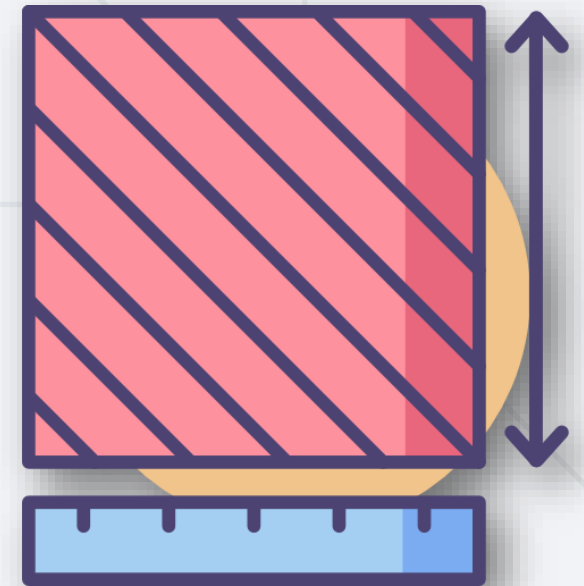
```
`[  
  {"x": "1", "y": "2", "z": "10"},  
  {"x": "7", "y": "7", "z": "10"},  
  {"x": "5", "y": "2", "z": "10"}  
]`
```



```
[  
  { 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

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

```
const boundRespond = person.respond.bind(person);  
document.getElementById('callBtn')  
  .addEventListener('click', person.respond);  
document.getElementById('callBtn')  
  .addEventListener('click', boundRespond);
```

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

Unwanted
result


Works as
intended



$f(x)$

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

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


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

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



Higher-Order Functions

- 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

- 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)  
  }  
}
```

- 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

- **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**

$$f = (x, y) \Rightarrow x + y$$

$$g = (x) \Rightarrow f(1, x)$$
$$\text{Math.pow}(x, y)$$

$$\text{sqr} = (x) \Rightarrow \text{Math.pow}(x, 2)$$

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

- **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

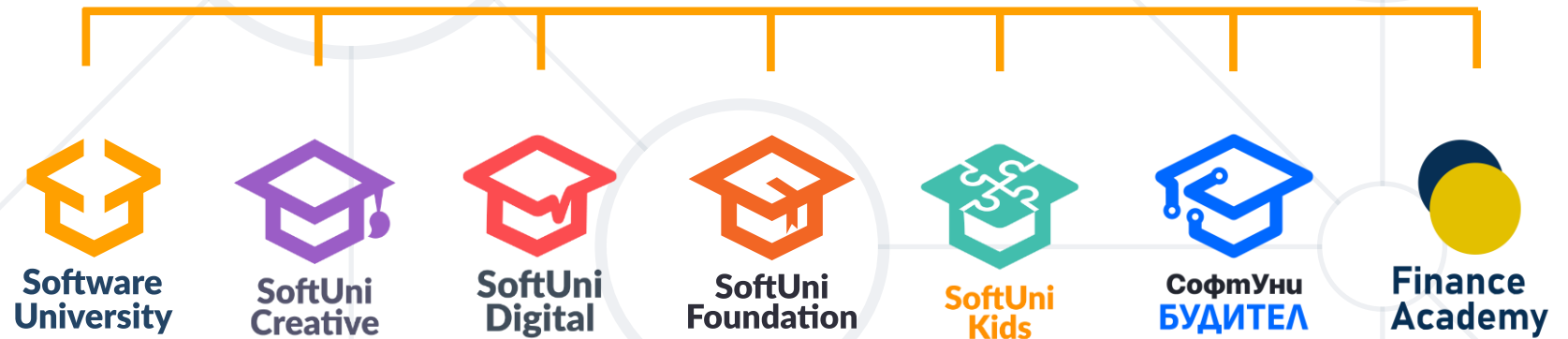
Currying vs Partial Application

- **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

- 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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