Reach Higher with Higher-Order Functions

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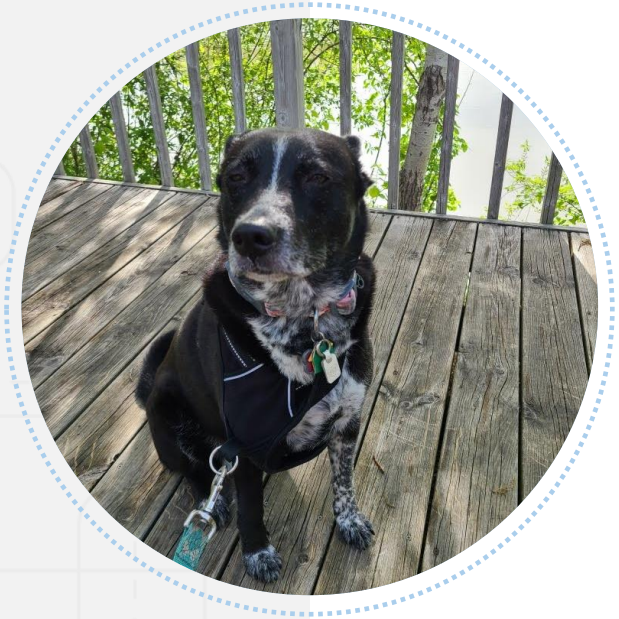

About Me

- Technical Architect with nvisia
- Coding professionally for 10 years
- Live in Milwaukee with my wife and dog
- I love Star Wars

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About nvisia

- Software consulting company
- Chicago, Milwaukee, Madison
- A group of like-minded technologists that love to help build and maintain software at every point in the life-cycle.
- We love being involved in the community.

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Why Do This?

What are We Going to Talk About?

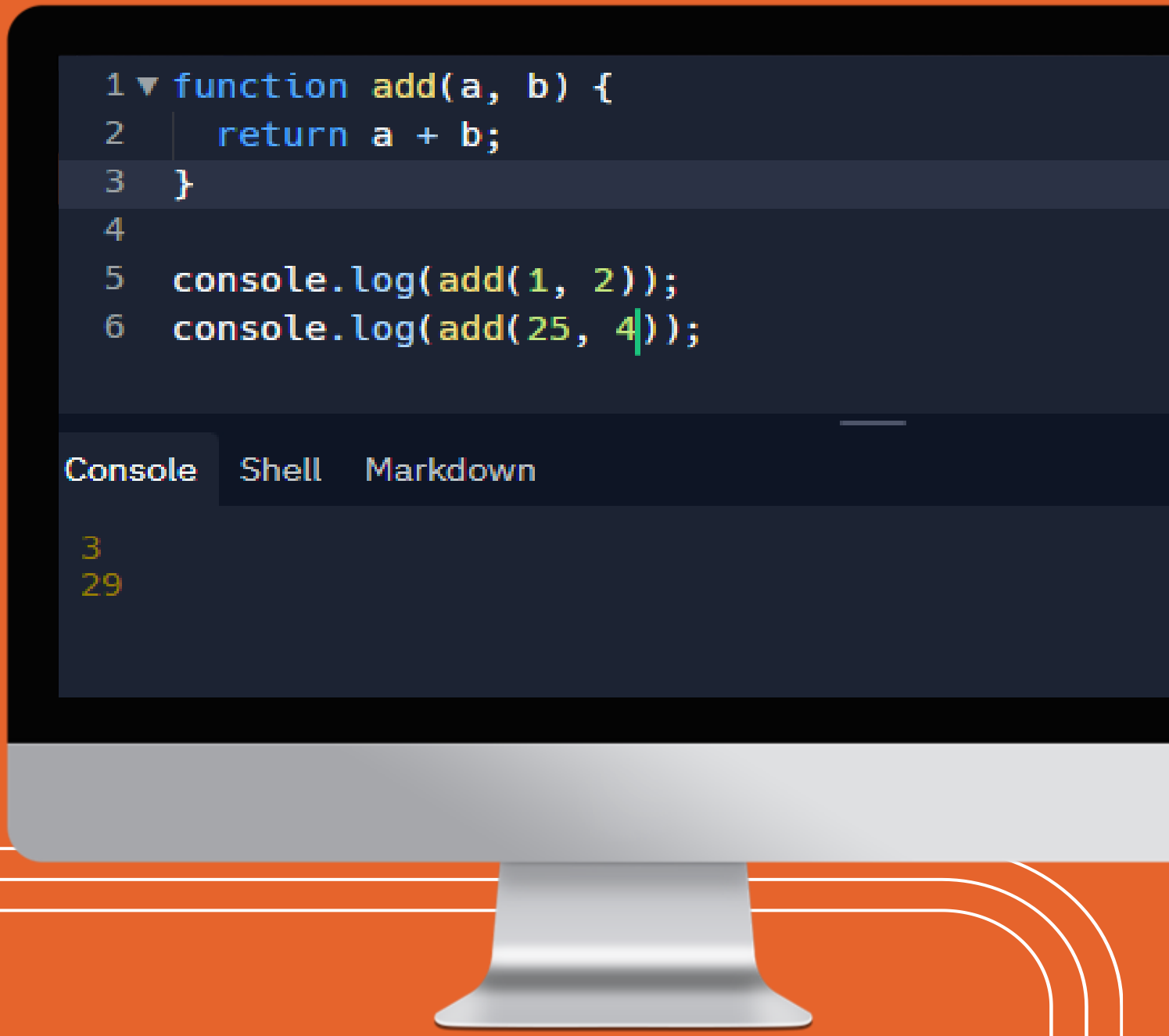
What is a higher-order function?

Why Use Them?

Examples

What is a function?

- A block of code that encapsulates logic
- Invocable multiple times with different inputs
- Breaks down our problems



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First-Order Function

```
1  const num1 = 5;
2  const num2 = 2;
3
4  function add(a, b) {
5    return a + b;
6  }
7
8  console.log(add(num1, num2));
9
10 function subtract(a, b) {
11   return a - b;
12 }
13
14 console.log(subtract(num1, num2));
15
16 function multiply(a, b) {
17   return a * b;
18 }
19
20 console.log(multiply(num1, num2));
21
22 function add5(a) {
23   return a + 5;
24 }
25
26 console.log(add5(num1));
```

Console | Shell | Markdown

```
7
3
10
10
```

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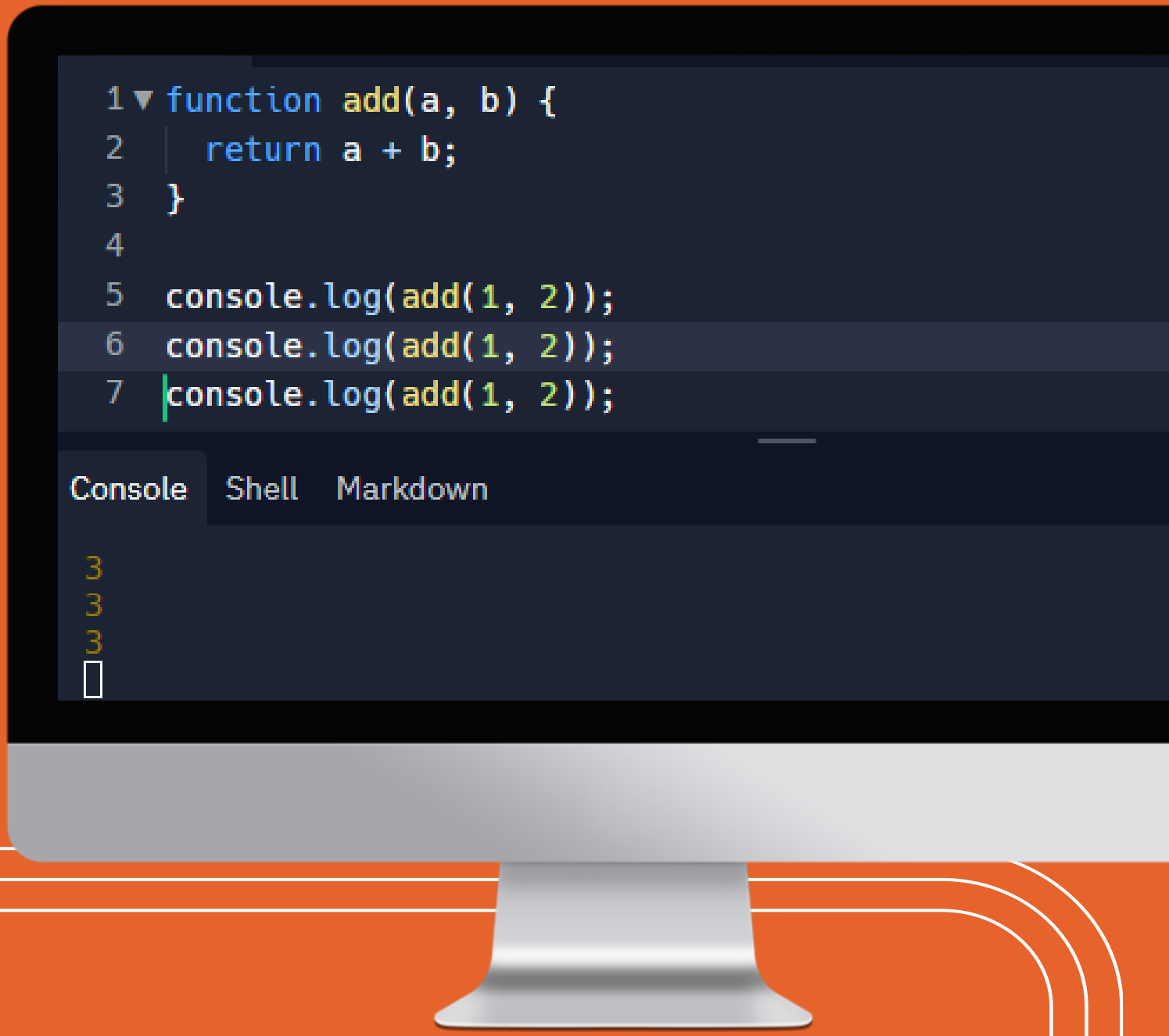
Drive thru: Will that be all?

Me:

Pure Function

Idempotent

- Given a set of arguments the function will always produce the same result.



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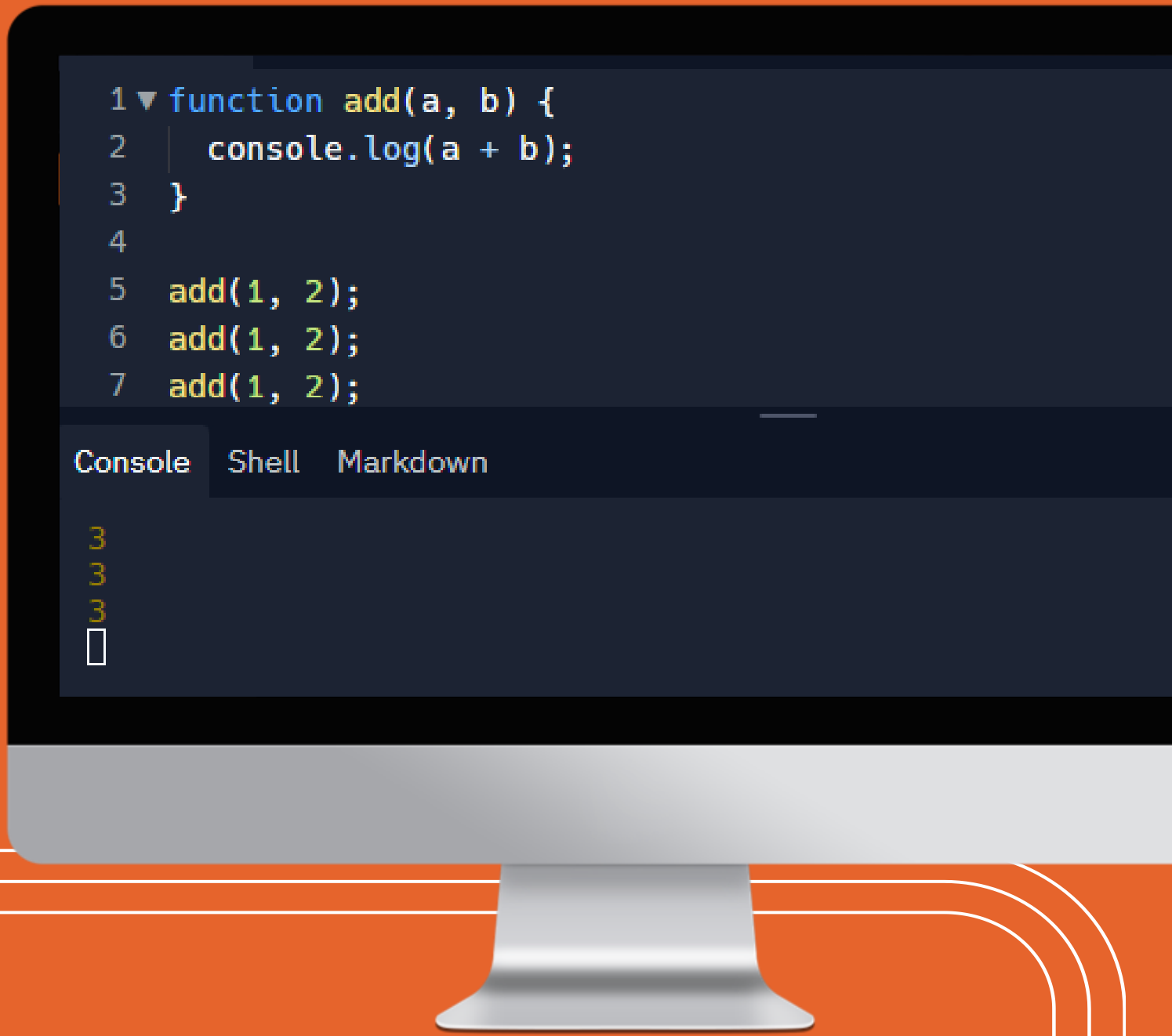
Side-Effects

- References entities outside of the function's scope.
- Pure functions don't have any
- Unavoidable



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First Class

- Like every other variable


```
1 ▼ function add(a, b) {
2       return a + b;
3   }
4
5   const num = 5;
6   const greeting = 'hello';
7
8   console.log(add(num, 2));
9
10  const plus = add; // no parens
11  console.log(plus(num, 2))
12
13  const concat = plus;
14  console.log(concat(greeting, ' world!'))
15
16  console.log(add(num, 2));
```

Console | Shell | Markdown

```
7
7
hello world!
7
```

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What are Higher Order Functions?

Any function that takes a function as an argument or returns a function as its result.

```
1 ▼ function vader() {
2       console.log('I am your Father');
3   }
4
5 ▼ function luke() {
6       console.log('NOOOOOOOO!!!');
7   }
8   vader();
9   luke();
```

Console Shell Markdown

```
I am your Father
NOOOOOOOO!!!
```

```
1 ▼ function luke() {
2       console.log('NOOOOOOOO!!!');
3   }
4
5 ▼ function vader(responseFunc) {
6       console.log('I am your Father');
7       responseFunc();
8   }
9   vader(luke);
```

Console Shell Markdown

```
I am your Father
NOOOOOOOO!!!
```

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```
1 function vaderSpeaks() {
2   console.log('Vader: I am your Father');
3 }
4
5 function lukeSpeaks() {
6   console.log('Luke: NOOOOOOOO!!!');
7 }
8 vaderSpeaks();
9 lukeSpeaks();
```

Console Shell Markdown

```
Vader: I am your Father
Luke: NOOOOOOOO!!!
```

```
1  function actor(name) {
2    return function speak(dialogue) {
3      console.log(`${name}: ${dialogue}`)
4    }
5  }
6
7  const vaderSpeaks = actor('Vader')
8  const lukeSpeaks = actor('Luke');
9
10 vaderSpeaks('Obi-Wan never told you what happened to your
   father.');
11 lukeSpeaks('He told me enough! It was you who killed him.');
12 vaderSpeaks('No. I am your Father');
13 lukeSpeaks('NOOOOOOOO!!!');
14
15 actor('Obi-Wan')('Luke, use the force!');
```

Console Shell Markdown

```
Vader: Obi-Wan never told you what happened to your father.
Luke: He told me enough! It was you who killed him.
Vader: No. I am your Father
Luke: NOOOOOOOO!!!
Obi-Wan: Luke, use the force!
```

Closure

```
1 ▼ function init() {
2     const message = 'Hello There!';
3 ▼   function displayMessage() {
4         console.log(message);
5     }
6     displayMessage();
7 }
8
9 init();
10
11 console.log(message);
```

Console Shell Markdown

```
Hello There!
/home/runner/HOF-Presentation/index.js:11
console.log(message);
            ^

ReferenceError: message is not defined
```

```
1 ▼ function init() {
2     const message = 'Hello There!';
3 ▼   function displayMessage() {
4         console.log(message);
5     }
6     return displayMessage;
7 }
8
9 const initialize = init();
10 initialize();
```

Console Shell Markdown

```
Hello There!
```

Why Use Higher-Order Functions?

Composition

```
function isEven(arg) {
  return (arg % 2) === 0;
}

function greaterThan(val) {
  return function(arg) {
    return arg > val;
  }
}

function and(predA, predB) {
  return function(arg) {
    return predA(arg) && predB(arg);
  }
}
```

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Composition

```
17  const greaterThan2 = greaterThan(2)
18
19  const isEvenAndGreaterThan2 = and(isEven, greaterThan2);
20
21  console.log(isEvenAndGreaterThan2(2));
22  console.log(isEvenAndGreaterThan2(3));
23  console.log(isEvenAndGreaterThan2(4));
24  console.log(isEvenAndGreaterThan2(5));
```

Console Shell Markdown

```
false
false
true
false
```

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Composition

```
26 ▼ function or(predA, predB) {
27 ▼   return function(arg) {
28       return predA(arg) || predB(arg);
29     }
30   }
31
32   const isEvenAndGreaterThan2OrAnyOver10 = or(isEvenAndGreaterThan2,
     greaterThan(10));
33
34   console.log(isEvenAndGreaterThan2OrAnyOver10(2));
35   console.log(isEvenAndGreaterThan2OrAnyOver10(3));
36   console.log(isEvenAndGreaterThan2OrAnyOver10(4));
37   console.log(isEvenAndGreaterThan2OrAnyOver10(5));
38   console.log(isEvenAndGreaterThan2OrAnyOver10(11));
```

Console Shell Markdown

```
false
false
true
false
true
```

Testability

- We can write tests and feel confident!

```
test("test-isEven-odd-arg", async function() {
  expect(index.isEven(3)).toBe(false);
});
test("test-isEven-even-arg", async function() {
  expect(index.isEven(2)).toBe(true);
});
```

```
test("test-and-both-true", async function() {
  function passThrough(val) { return val}
  expect(index.and(passThrough, passThrough)(true))
    .toBe(true);
});
test("test-and-both-false", async function() {
  function passThrough(val) { return val}
  expect(index.and(passThrough, passThrough)(false))
    .toBe(false);
});
test("test-and-first-false", async function() {
  function passThrough(val) { return val}
  function returnFalse() {return false}
  expect(index.and(returnFalse, passThrough)(true))
    .toBe(false);
});
test("test-and-second-false", async function() {
  function passThrough(val) { return val}
  function returnFalse() {return false}
  expect(index.and(passThrough, returnFalse)
(true)).toBe(false);
});
```

Declarative

- This will make your code more declarative. Your code will describe what needs to be done instead of how to do it.

```
or(and(isEven, greaterThan(2)), greaterThan(10));
```

You may already be using them!

- React
- Callbacks - not the best use-case but sometimes necessary
- Promise chains
- array loop methods
- Any lambda in any language

Examples

Array Loop Methods

- .map() – transform each entry
- .filter() – remove entries that don’t meet this condition
- .reduce() – combine all entries to one value

Transform Each Entry

```
1  const arr = [1, 2, 3, 4];
2  const newArr = [];
3  for(let i = 0; i < arr.length; i++) {
4      newArr.push(arr[i] * 2);
5  }
6
7  console.log(newArr);
```

Console Shell Markdown

```
[ 2, 4, 6, 8 ]
```

```
1  const arr = [1, 2, 3, 4];
2
3  function double(x) {
4      return x * 2;
5  }
6
7  const newArr = arr.map(double)
8
9  console.log(newArr);
```

Console Shell Markdown

```
[ 2, 4, 6, 8 ]
```

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Only Bring These Over

```
1  const arr = [1, 2, 3, 4];
2  const newArr = [];
3  for(let i = 0; i < arr.length; i++) {
4    if(arr[i] % 2) newArr.push(arr[i]);
5  }
6
7  console.log(newArr);
```

Console Shell Markdown

```
[ 1, 3 ]
```

```
1  const arr = [1, 2, 3, 4];
2  function isOdd(x) {
3    return x % 2;
4  }
5  const newArr = arr.filter(isOdd);
6
7  console.log(newArr);
8  console.log(arr);
```

Console Shell Markdown

```
[ 1, 3 ]
[ 1, 2, 3, 4 ]
```

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Combine Everything Into One

```
1  const arr = [1, 2, 3, 4];
2  let sum = 0;
3  for(let i = 0; i < arr.length; i++) {
4      sum += arr[i];
5  }
6
7  console.log(sum);
```

Console Shell Markdown

```
10
```

```
1  const arr = [1, 2, 3, 4];
2  function add(a, b) {
3      return a + b;
4  }
5  const sum = arr.reduce(add, 0);
6
7  console.log(sum);
```

Console Shell Markdown

```
10
[ 1, 2, 3, 4 ]
```

```
const sum = arr.reduce(function(currentSum, currentValue){
  return currentSum + currentValue
}, 0);
```

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Disclaimer

- These are my own simplified implementations of these functions
- They could probably use some polish
- Many already exist in libraries

I don’t need those other arguments

```
40  const arr = [11, 5, 9, 17, 25, 3];
41
42  arr.forEach(console.log);
43
```

Console Shell Markdown

```
11 0 [ 11, 5, 9, 17, 25, 3 ]
5 1 [ 11, 5, 9, 17, 25, 3 ]
9 2 [ 11, 5, 9, 17, 25, 3 ]
17 3 [ 11, 5, 9, 17, 25, 3 ]
25 4 [ 11, 5, 9, 17, 25, 3 ]
3 5 [ 11, 5, 9, 17, 25, 3 ]
```

```
40  const arr = [11, 5, 9, 17, 25, 3];
41
42  function unary(func) {
43    return function(firstArg) {
44      return func(firstArg);
45    }
46  }
47
48  arr.forEach(unary(console.log));
```

Console Shell Markdown

```
11
5
9
17
25
3
```

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Not() what I wanted

```
50  const arr = [11, 5, 9, 17, 25, 3];
51
52  arr.filter(function(x){
53    return !greaterThan(10)(x)
54  }).forEach(unary(console.log));
```

Console Shell Markdown

```
5
9
3
```

```
50  const arr = [11, 5, 9, 17, 25, 3];
51
52  function not(pred) {
53    return function(...args) {
54      return !pred(...args);
55    }
56  }
57
58  arr.filter(not(greaterThan(10))).forEach(unary(console.log));
```

Console Shell Markdown

```
5
9
3
```

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Constant Arguments

```
64 function add(a, b) {
65   return a + b;
66 }
67
68 function subtract(a, b) {
69   return a - b;
70 }
71
72 function multiply(a, b) {
73   return a * b;
74 }
75
76 console.log(add(5, 3));
77 console.log(subtract(5, 3));
78 console.log(multiply(5, 3));
79
```

Console Shell Markdown

```
8
2
15
```

```
80 function withArgs(...args) {
81   return function (func) {
82     return func(...args);
83   }
84 }
85
86 const funcs = [add, subtract, multiply];
87
88 funcs.map(withArgs(5, 3)).forEach(unary(console.log));
89
```

Console Shell Markdown

```
8
2
15
```

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Just Constant

```
121 function constant(val) {
122   return function() {
123     return val;
124   }
125 }
126
127 const ten = constant(10);
128
129 console.log(ten(1));
130 console.log(ten(6));
131 console.log(ten(888));
132 console.log(ten('hello'));
133 console.log(ten('hello', 5, 2));
134
```

Console Shell Markdown

```
10
10
10
10
10
```

Only in some cases

```
103  const arr = [11, 5, 9, 17, 25, 3];
104
105  function capAt10(arg) {
106    if(arg > 10) return 10;
107    return arg;
108  }
109
110  arr.map(capAt10).forEach(unary(console.log));
111
```

Console Shell Markdown

```
10
5
9
10
10
3
```

```
103  const arr = [11, 5, 9, 17, 25, 3];
104
105  function conditional(pred, func) {
106    return function(arg) {
107      if(pred(arg)) return func(arg);
108      return arg;
109    }
110  }
111
112  arr.map(conditional(greaterThan(10),
     ten)).forEach(unary(console.log));
113
```

Console Shell Markdown

```
10
5
9
10
10
3
```

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Get a property From an Object

```
114 const records = [
115   { user: { name: {first: 'Luke', last: 'Skywalker' } } },
116   { user: { name: {first: 'Luke', last: 'Warm' } } },
117   { user: { name: {first: 'Luke', last: 'Atmee' } } }
118 ]
119
120 function getLastName(record) {
121   const user = record ? record.user : undefined;
122   const name = user ? user.name : undefined;
123   return name.last;
124 }
125
126 records.map(getLastName).forEach(unary(console.log));
127
```

Console Shell Markdown

```
Skywalker
Warm
Atmee
```

```
128 function getProp(keyPath) {
129   return function(obj) {
130     return keyPath.split('.')
131     .reduce(function(currObj, currKey) {
132       if(currObj) return currObj[currKey];
133     }, obj)
134   }
135 }
136
137 records.map(getProp('user.name.last')).forEach(unary(console.log))
138
```

Console Shell Markdown

```
Skywalker
Warm
Atmee
```

```
139 records.map(getProp('user.name.first'))
140   .forEach(unary(console.log));
141
```

Console Shell Markdown

```
Luke
Luke
Luke
```

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Once

```
180 function once(func) {
181   let hasRun = false;
182   return function(...args) {
183     if (!hasRun) {
184       func(...args);
185       hasRun = true;
186     };
187   }
188 }
189
190 function initApp() {
191   console.log('initialized app');
192 }
193
194 const initialize = once(initApp);
195
196 initialize();
197 initialize();
198 initialize();
```

Console Shell Markdown

```
initialized app
```

Don’t ever let go

```
200 function expensiveApiCall(arg) {
201   console.log('making expensive call for arg: ' + arg);
202   return arg;
203 }
204
205 const cache = {};
206
207 function memoizeExpensiveApiCall(arg) {
208   if (cache[arg]) return cache[arg];
209   const result = expensiveApiCall(arg);
210   cache[arg] = result;
211   return result;
212 }
213
214 console.log(memoizeExpensiveApiCall(5))
215 console.log(memoizeExpensiveApiCall(5))
216 console.log(memoizeExpensiveApiCall(11))
217 console.log(memoizeExpensiveApiCall(11))
218 console.log(memoizeExpensiveApiCall(5))
```

Console Shell Markdown

```
making expensive call for arg: 5
5
5
making expensive call for arg: 11
11
11
5
```

```
220 function memoize(func) {
221   const cache = {};
222   return function(arg) {
223     if (cache[arg]) return cache[arg];
224     const result = func(arg);
225     cache[arg] = result;
226     return result;
227   }
228 }
229
230 const memoizeExpensiveApiCall = memoize(expensiveApiCall);
231
232 console.log(memoizeExpensiveApiCall(5))
233 console.log(memoizeExpensiveApiCall(5))
234 console.log(memoizeExpensiveApiCall(11))
235 console.log(memoizeExpensiveApiCall(11))
236 console.log(memoizeExpensiveApiCall(5))
```

Console Shell Markdown

```
making expensive call for arg: 5
5
5
making expensive call for arg: 11
11
11
5
```

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Tips

1. Try to find pure abstractions
2. Use closures for private scope
3. Be mindful of mutation
4. Keep your naming consistent

Questions?

Thank You!

Libraries:

- Lodash
- Ramda

Books:

- Functional-Light Javascript by Kyle Simpson
- Mastering Javascript Functional Programming by Federico Kereki

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