Object Composition

Closures, Revealing Module Pattern, Object Inheritance, Prototypes

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#JSCORE

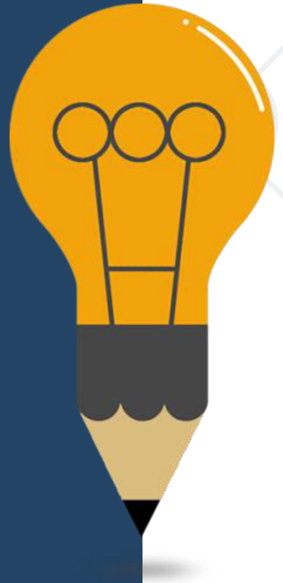
Object Composition

Objects Holding Other Objects

What is Object Composition?

- **Object composition** == combining simple objects or data types into more complex ones

```
let student = {
  firstName: 'Maria',
  lastName: 'Green',
  age: 22,
  location: { lat: 42.698, lng: 23.322 }
}
console.log(student);
console.log(student.location.lat);
```



Composing Objects

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```
let name = "Sofia";
let population = 1325744;
let country = "Bulgaria";
let town = { name, population, country };
console.log(town); // Object {name: "Sofia", population: 1325744, country: "Bulgaria"}
```

Combine variables into object

```
town.location = { lat: 42.698, lng: 23.322 };
console.log(town); // Object {…, location: Object}
```

Combining Data with Functions

```
let rect = {
  width: 10,
  height: 4,
  grow: function(w, h) {
    this.width += w; this.height += h;
  },
  print: function() {
    console.log(`[${this.width} x ${this.height}]`);
  }
};
rect.grow(2, 3);
rect.print(); // [12 x 7]
```

Printing Objects: toString() Function

```
let rect = {
  width: 10,
  height: 4,
  toString: function() {
    return `rect[${this.width} x ${this.height}]`;
  }
};
console.log(rect); // Object {width: 10, height: 4}
// This will invoke toString() to convert the object to String
console.log('' + rect); // rect[12 x 7]
```

Problem: Order Rectangles by Size

- You are given a set of rectangles (**width** x **height**) as nested arrays
- **Order** them by their **area**, then by **width** (descending)

```
[3, 4], [5, 3], [3, 4], [3, 5], [12, 1]
```

```
[5, 3], [3, 5], [12, 1], [3, 4], [3, 4]
```

```
[2, 2.5], [2.5, 2]
```

```
[2.5, 2], [2, 2.5]
```

Solution: Order Rectangles by Size

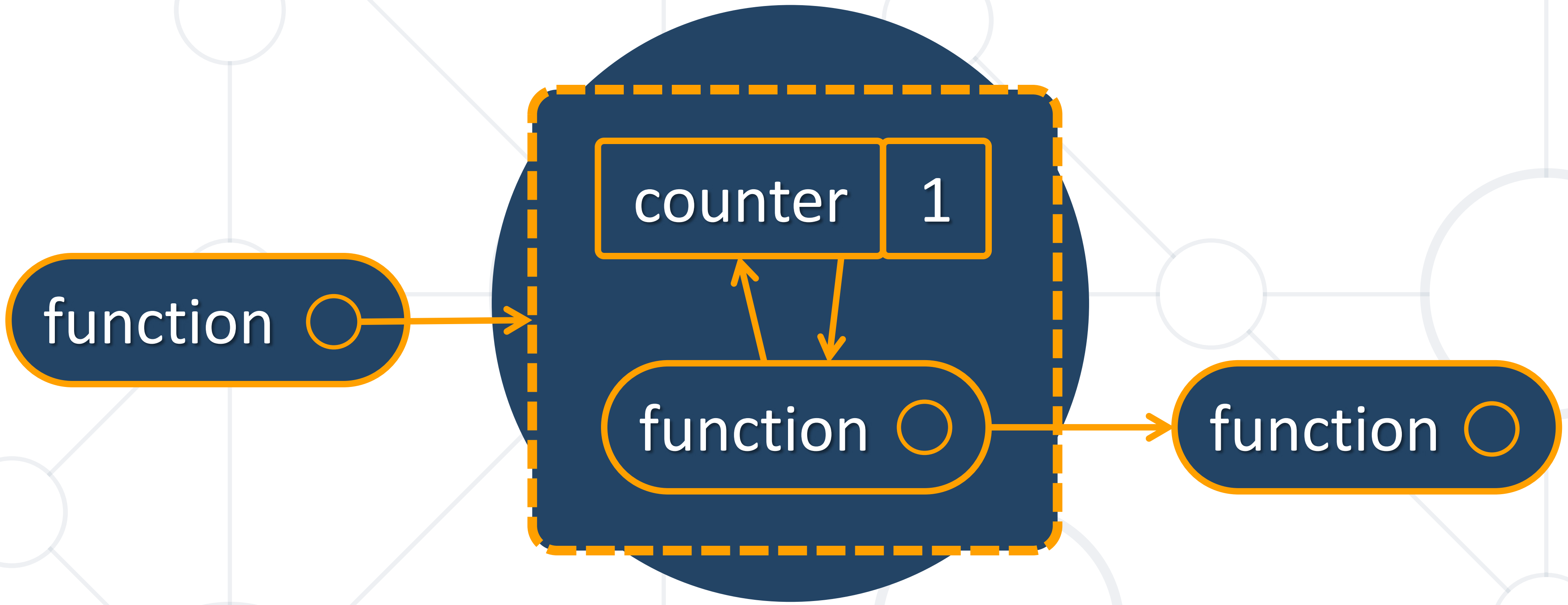
```
function createRect(width, height) {
  let rect = {
    width: width,
    height: height,
    area: () => rect.width * rect.height,
    compareTo: function(other) {
      let result = other.area() - rect.area();
      return result || (other.width - rect.width);
    }
  };
  return rect;
}
```

Solution: Order Rectangles by Size (2)

```
function orderRects(rectsData) {
  let rects = [];
  for (let [width, height] of rectsData) {
    let rect = createRect(width, height);
    rects.push(rect);
  }
  rects.sort((a,b) => a.compareTo(b));
  return rects;
}
```

```
orderRects([[3, 4], [5, 3], [3, 4], [3, 5], [12, 1]])
```

Check your solution here: https://judge.softuni.bg/Contests/334



Closures

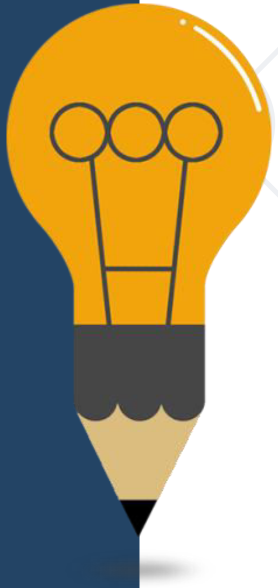
Enclosing Object State in a Function

What is Closure?

- Closure == state maintained (closed) inside a function
  - Hidden from the outside world
- Example: counter with closures

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

```
let count =
  counterClosure();
count(); // 1
count(); // 2
count(); // 3
count(); // 4
count(); // 5
```



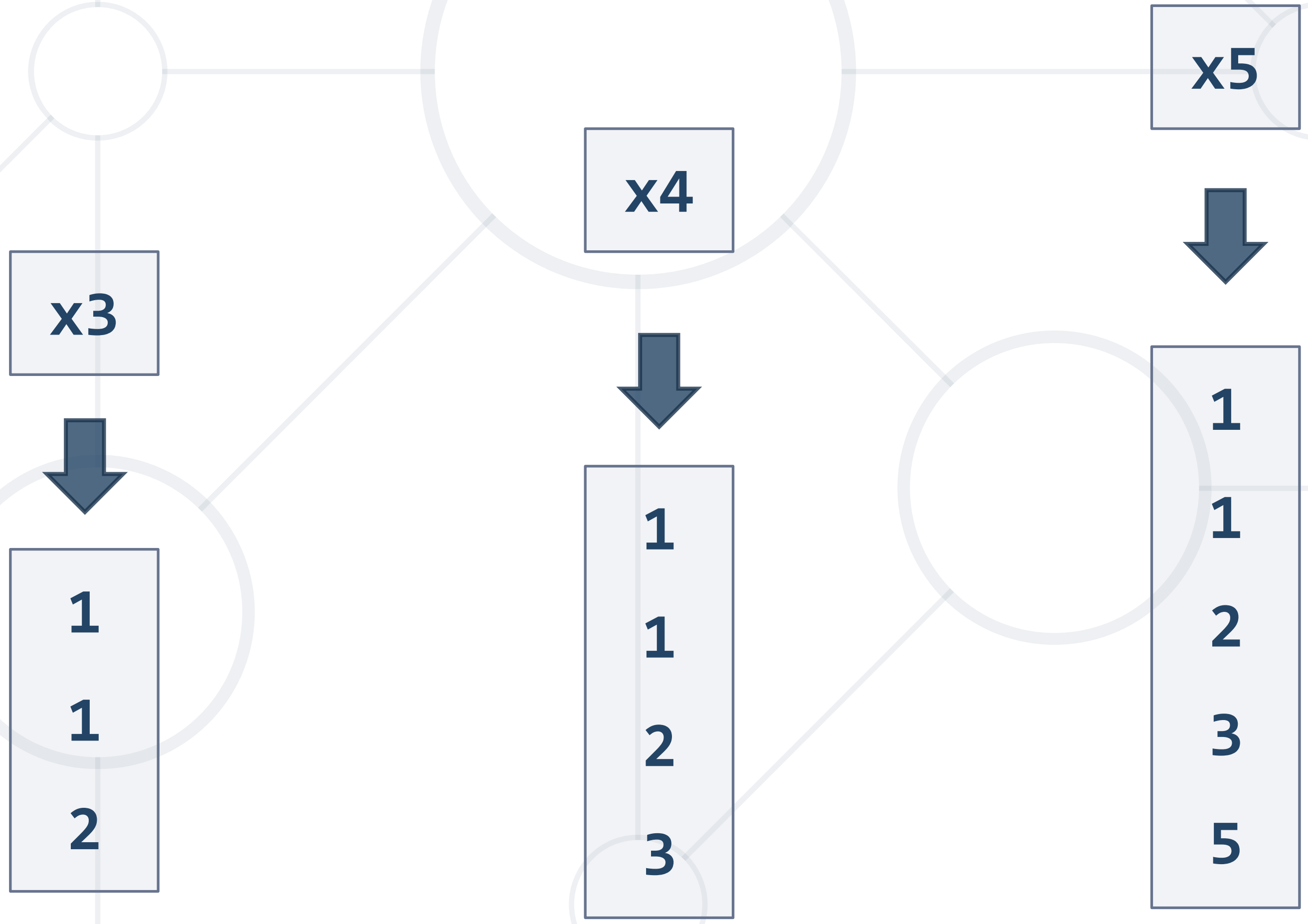
Closures – Shorter Syntax with IIFE

```
let counter = (function() {
  let num = 0;
  return function() {
    console.log(++num);
  };
})();
counter(); // 1
counter(); // 2
counter(); // 3
```

```
let counter = (() => {
  let num = 0;
  return () =>
    console.log(++num);
})();
counter(); // 1
counter(); // 2
counter(); // 3
counter(); // 4
```

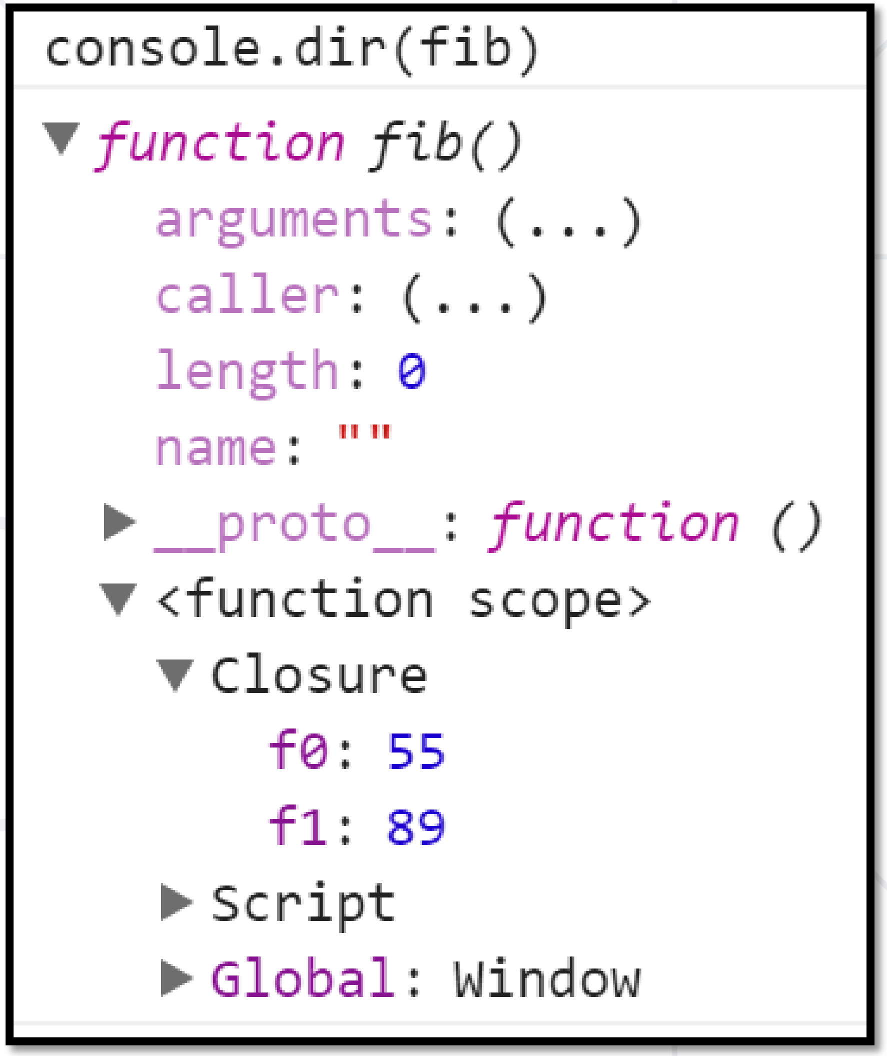
Problem: Fibonacci with Closures

- Using closures write a JS function that returns the next **Fibonacci** number, each time it's called



Solution: Fibonacci with Closures

```
function getFibonator() {
  let f0 = 0, f1 = 1;
  return function() {
    let f2 = f0 + f1;
    f0 = f1;
    f1 = f2;
    return f1;
  };
}
let fib = getFibonator();
fib(); // 1
fib(); // 1
fib(); // 2
```



```
console.dir(fib)
▼ function fib()
    arguments: (...)
    caller: (...)
    length: 0
    name: ""
  ▶ __proto__: function ()
  ▼ <function scope>
    ▼ Closure
        f0: 55
        f1: 89
    ▶ Script
    ▶ Global: Window
```

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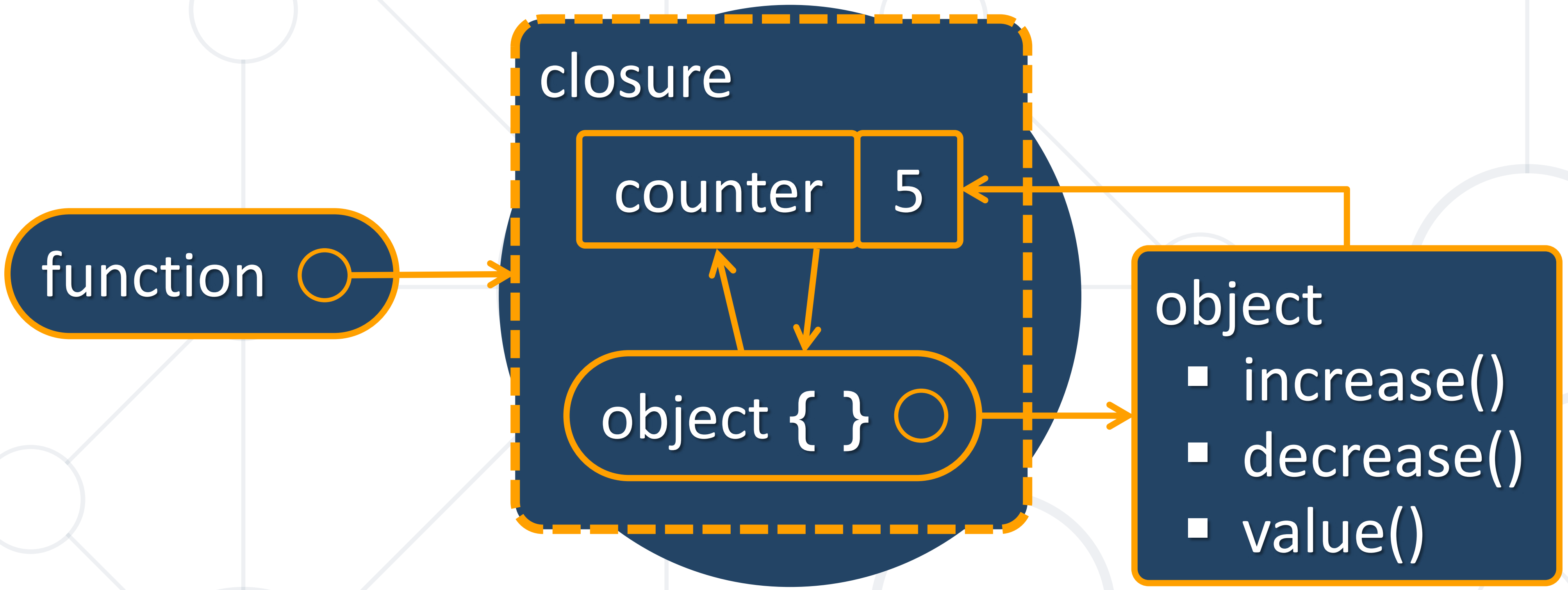


Module and Revealing Module Patterns

"Module" Pattern (with Object Literal)

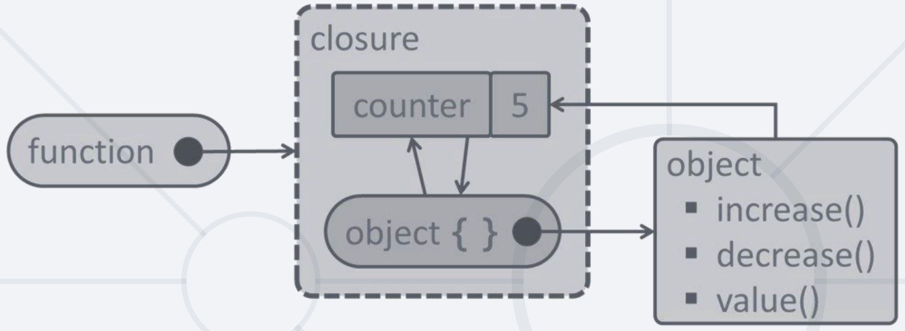
```
let moduleObj = {
  count: 0, // public
  increase: function(num) { return this.count += num },
  decrease: function(num) { return this.count -= num },
  value: function() { return this.count }
};

moduleObj.count = 2; // the counter is accessible
console.log(moduleObj.value()); // 2
console.log(moduleObj.increase(5)); // 7
console.log(moduleObj.decrease(1)); // 6
```

object
- count
- increase()
- decrease()
- value()

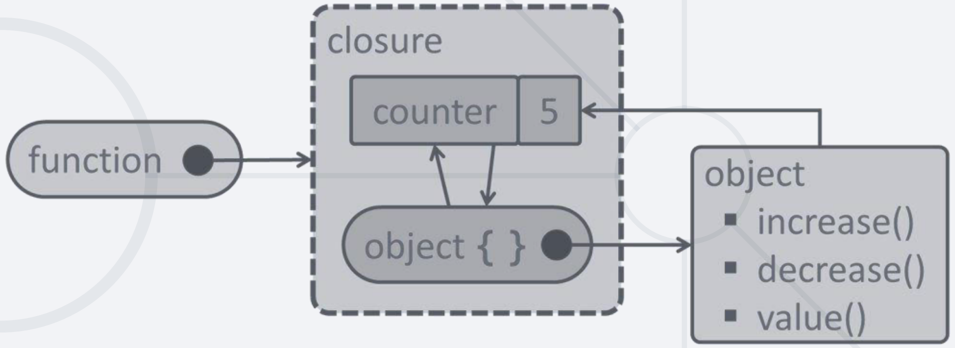
"Module" Pattern (with Closure)

```
let module = (function() {
  let count = 0; // private
  return {
    increase: (num) => count += num,
    decrease: (num) => count -= num,
    value: () => count,
  };
})();
console.log(module.value()); // 0
console.log(module.increase(5)); // 5
console.log(module.decrease(2)); // 3
console.log(module.count); // undefined (not accessible)
```



"Revealing Module" Pattern (with Closure)

```javascript
let revModule = (function() {
  let count = 0; // private
  function change(amount) { return count += amount; }
  function increase(num) { return change(num); }
  function decrease(num) { return change(-num); }
  function value() { return count; }
  return { increase, decrease, value };
})();
console.log(revModule.value()); // 0
console.log(revModule.increase(5)); // 5
console.log(revModule.decrease(2)); // 3
console.log(module.count); // undefined (not accessible)
```



Problem: List Processor

- Using a **closure** (IIFE holding a state inside it) implement a command execution engine to **process list commands** like shown below

```
add hello
add again
remove hello
add again
print
```

```
again, again
```

```
hello
```

```
hello, again
```

```
again
```

```
again, again
```

```
again, again
```

Solution: List Processor

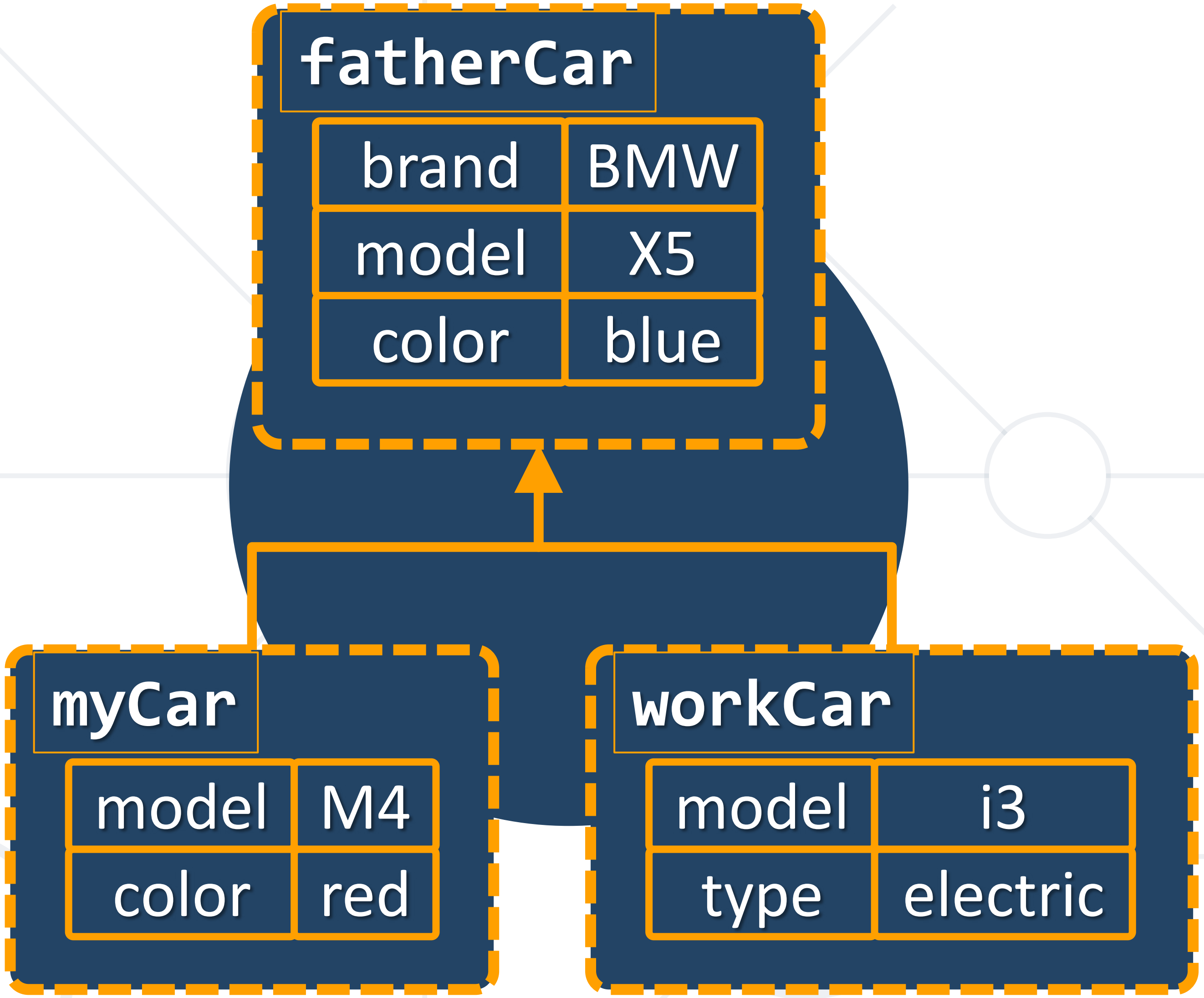
```
let commandProcessor = (function() {
  let list = [];
  return {
    add: (newItem) => list.push(newItem),
    remove: (item) => list = list.filter(x => x != item),
    print: () => console.log(list)
  }
})();
```

Solution: List Processor (2)

```
function processCommands(commands) {
  let commandProcessor = (function(){ … })();
  for (let cmd of commands) {
    let [cmdName, arg] = cmd.split(' ');
    commandProcessor[cmdName](arg);
  }
}
```

```
processCommands(['add hello', 'add again', 'remove hello',
'add again', 'print']);
```

Check your solution here: https://judge.softuni.bg/Contests/334



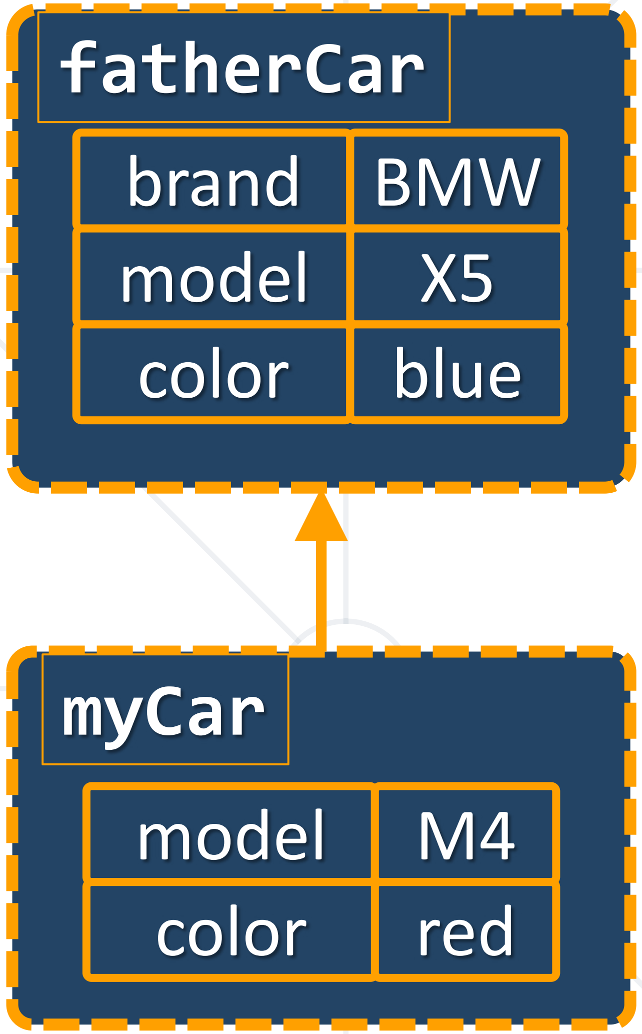
Object Inheritance

Object Inheritance

```
let fatherCar = { brand: 'BMW',
  model: 'X5', color: 'blue',
  toString: function() { return `[brand:
    ${this.brand}, model: ${this.model},
    color: ${this.color}]`; }
};
console.log('' + fatherCar);
```

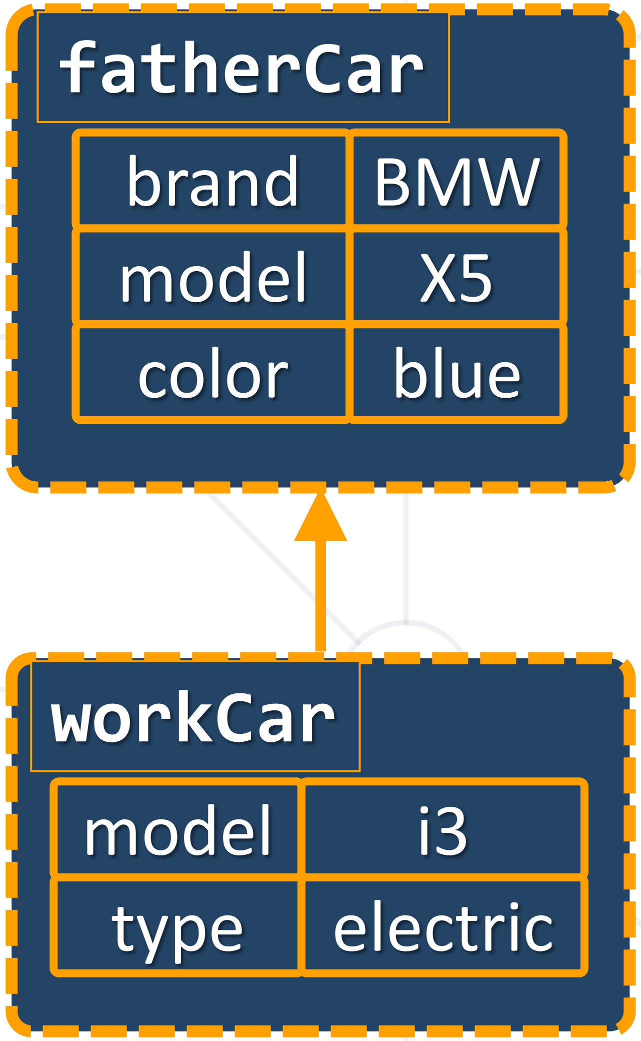
```
let myCar = Object.create(fatherCar);
myCar.model = 'M4';
myCar.color = 'red';
console.log('' + myCar);
```

Object.create() inherits an object

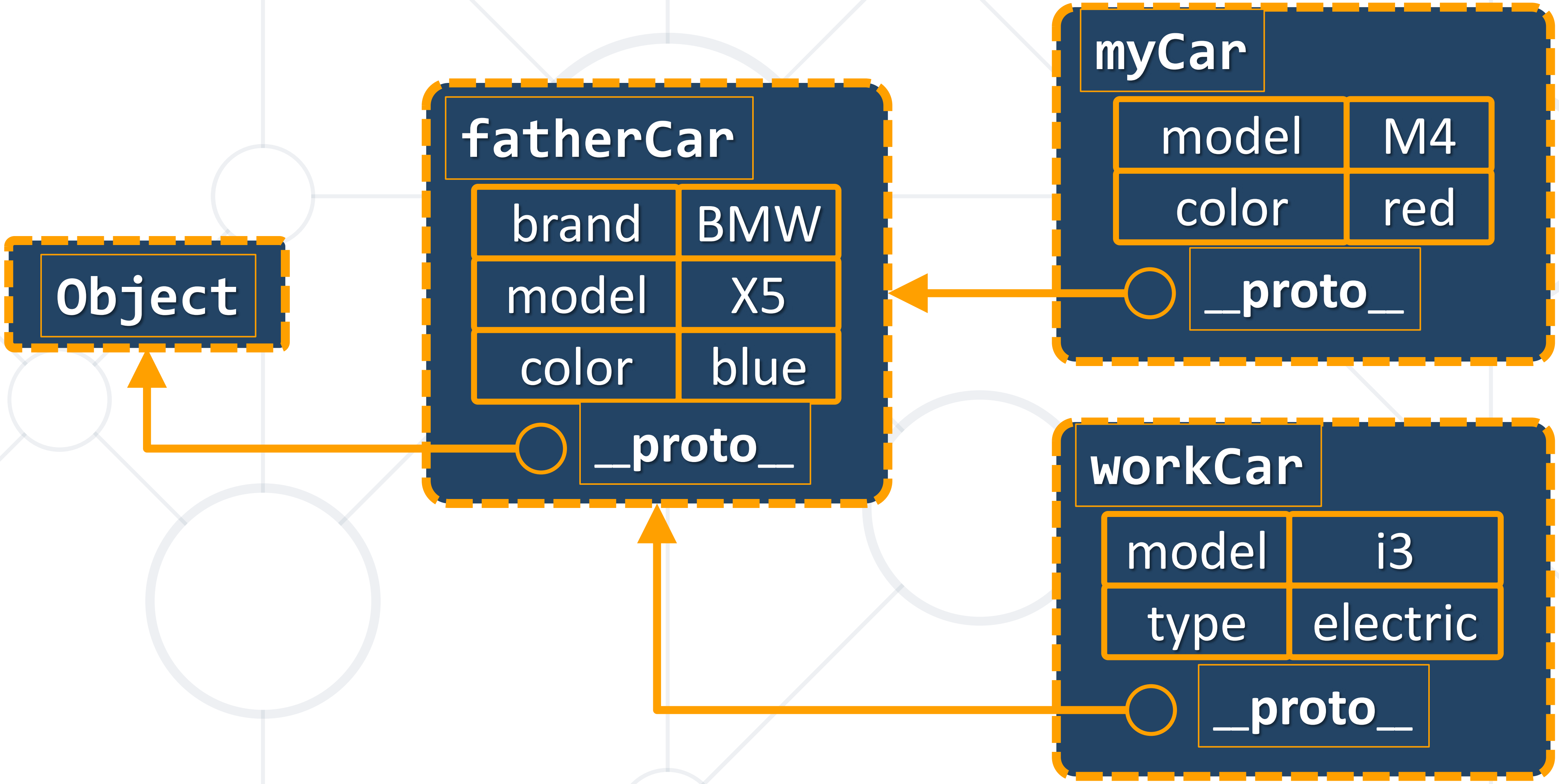


Object Inheritance (2)

```
let workCar =
  Object.create(fatherCar);
workCar.model = 'i3';
workCar.type = 'electric';
workCar.toString = function() {
  return `[brand: ${this.brand}, model:
    ${this.model}, color: ${this.color},
    type: ${this.type}]`;
}
console.log('' + workCar);
```



Prototype Chain



Prototype Chain

- Objects have **prototype** (a parent object)
  - Prototypes form a **prototype chain**

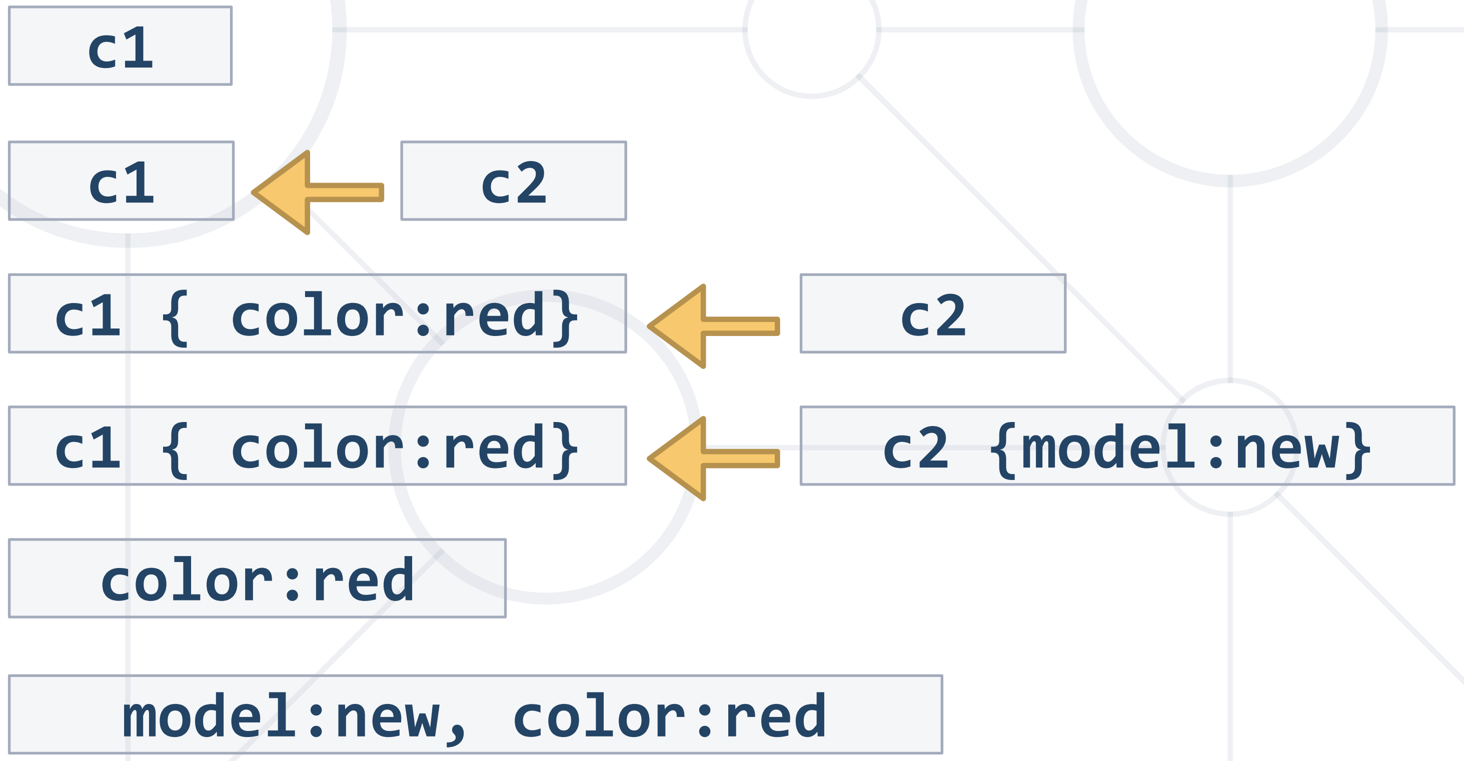
```
Object.getPrototypeOf(fatherCar);
// Object {}
Object.getPrototypeOf(myCar);
// Object {brand: "BMW", model: "X5", color: "blue"}
```

  - If a property is not found in the object itself, it is searched in the parent objects (in the prototype chain)

Problem: Object Inheritance

- Write a JS function to execute commands which create, inherit and modify objects:

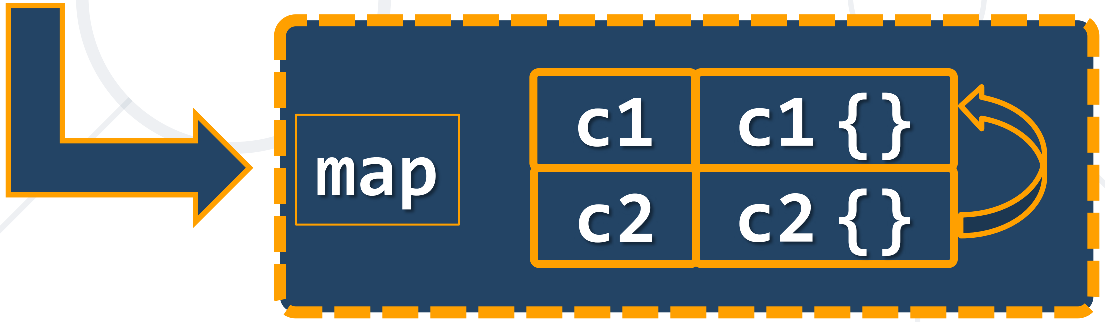
```
create c1
create c2 inherit
c1
set c1 color red
set c2 model new
print c1
print c2
```



Solution: Object Inheritance – Parser

```
function processCommands(commands) {
  let map = new Map();
  let cmdExecutor = { … };
  for (let command of commands) {
    let commandParameters = command.split(' ');
    let action = commandParameters.shift();
    cmdExecutor[action](commandParameters);
  }
}
```

```
processCommands(['create c1','create c2 inherit c1'])
```



Solution: Object Inheritance – Executor

```
let cmdExecutor = {
  create: function ([objName, inherits, parent]) {
    parent = parent ? map.get(parent) : null;
    let newObj = Object.create(parent);
    map.set(objName, newObj);
    return newObj;
  },
  set: function ([objName, key, value]) {
    let obj = map.get(objName);
    obj[key] = value;
  },
  print: function ([objName]) {
    let obj = map.get(objName), objects = [];
    for (let key in obj) { objects.push(`${key}:${obj[key]}`); }
    console.log(objects.join(', '));
  }
};
```

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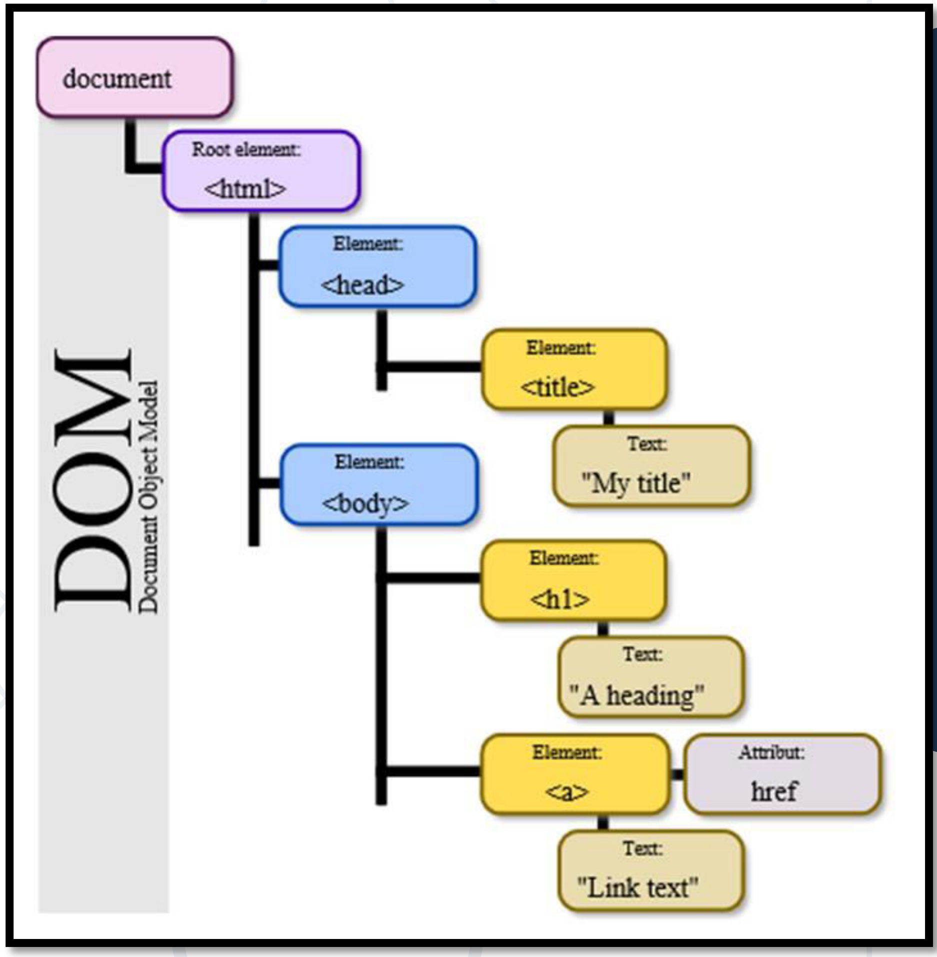
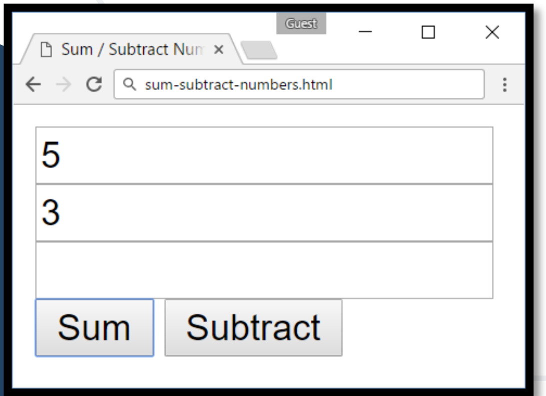
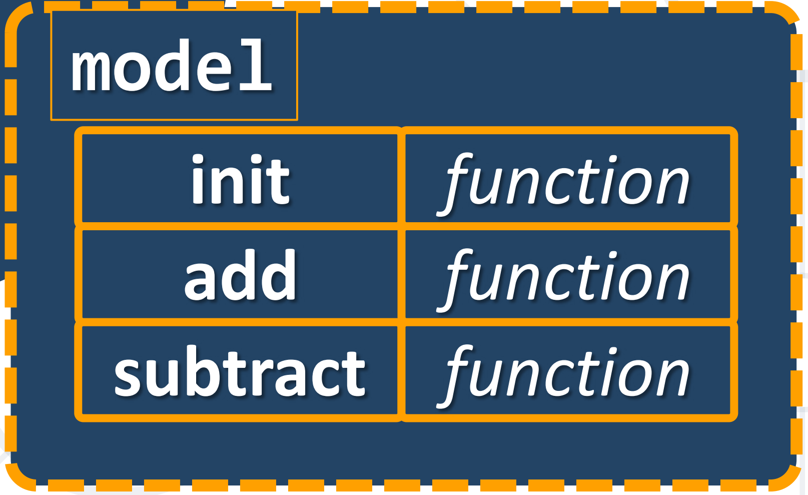




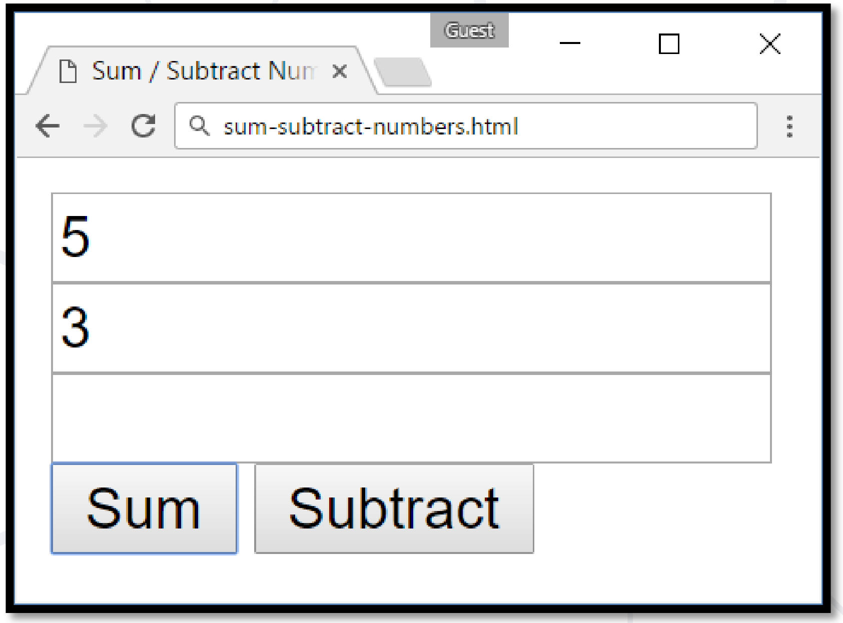


Objects Interacting with DOM

Problem: Sum / Subtract Numbers

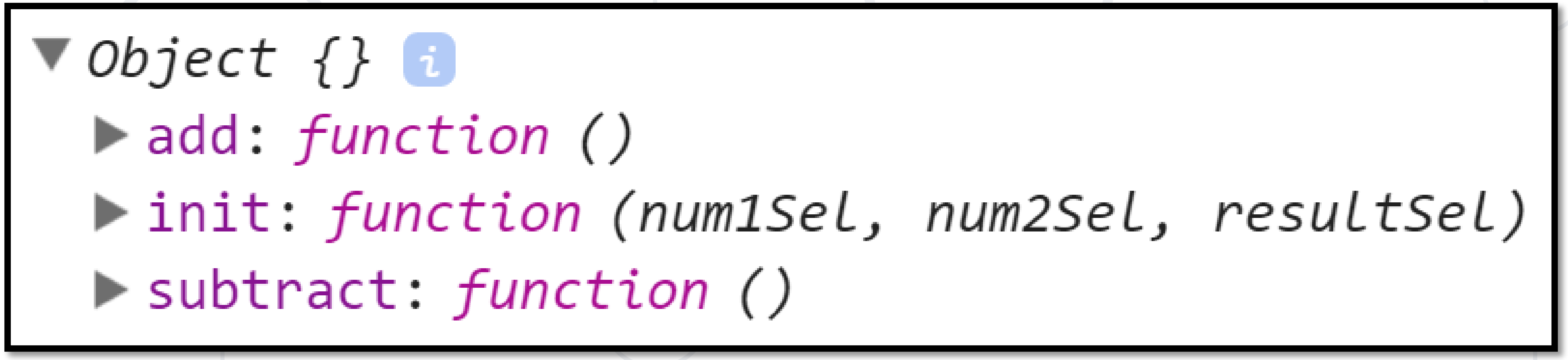
- You are given the following HTML form

```
<input type="text" id="num1" />
<input type="text" id="num2" />
<input type="text" id="result"
readonly />
<br>
<button id="sumButton">
Sum</button>
<button id="subtractButton">
Subtract</button>
```



Problem: Sum / Subtract Numbers (2)

- Write a JS function **getModel()** to return a JS object holding
  - function **init**(**num1Sel**, **num2Sel**, **resultSel**) → initializes selectors for finding the fields **num1**, **num2** and **result** in the **DOM**
  - function **add**() → calculates **result** = **num1** + **num2**
  - function **subtract**() → calculates **result** = **num1** - **num2**



```
▼ Object {}
  ▶ add: function ()
  ▶ init: function (num1Sel, num2Sel, resultSel)
  ▶ subtract: function ()
```

Problem: Sum / Subtract Numbers (3)

- This is how the **getModel()** function can be used to implement **add / subtract** operatons in the DOM tree:

```
$(function() {
  let model = getModel();
  model.init('#num1', '#num2', '#result');
  $('#sumButton').click(model.add);
  $('#subtractButton').click(model.subtract);
});
```

Solution: Sum / Subtract Numbers

```
// Solution using the "Module" pattern

function getModel() {
  let model = {
    init: function(num1Sel, num2Sel, resultSel) {
      model.num1 = $(num1Sel);
      model.num2 = $(num2Sel);
      model.result = $(resultSel);
    },

    add: () => model.action((a, b) => a + b),

    subtract: () => model.action((a, b) => a - b),
```

Solution: Sum / Subtract Numbers (2)

```
    action: function(operation) {
      let val1 = Number(model.num1.val());
      let val2 = Number(model.num2.val());
      model.result.val(operation(val1, val2));
    }
  };

  return model;
}
```

Check your solution here: https://judge.softuni.bg/Contests/334

Another Solution: Sum / Subtract Numbers

```
// Solution using the "Revealing Module" pattern

function getModel() {
  let num1, num2, result;

  function init(num1Sel, num2Sel, resultSel) {
    num1 = $(num1Sel);
    num2 = $(num2Sel);
    result = $(resultSel);
  }

  function add() { action((a, b) => a + b); }

  function subtract() { action((a, b) => a - b); }
```

Another Solution: Sum / Subtract Numbers (2)

```
  function action(operation) {
    let val1 = Number(num1.val());
    let val2 = Number(num2.val());
    result.val(operation(val1, val2));
  }

  let model = { init, add, subtract };
  return model;
}
```

Check your solution here: https://judge.softuni.bg/Contests/334

Live Exercises

Summary

- Object composition combines data and functions into JS objects

```
let r = {w:5, h:3, grow:function() { … }}
```

- The "Module" pattern hides data into a function and reveals a JS object
- The "Revealing Module" pattern hides data and functions are reveals them as JS object
- Objects can inherit parent object by **Object.create(parent)**

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