

Recursion II



Overview

```
1  /*
2      - Nested data structures and recursion
3      - Nested arrays
4      - Nested objects
5  */
```



Nested data structures and recursion

```
1  /* JS can have deeply-nested data structures */
2
3  let crazyArray = [1, [2, [3, [4, [5, [6, [7, [8, [9]]]]]]]]];
4
5  /* are you going to write 9 nested for loops to iterate through the crazy
6     array?? no way! */
7
8  /* recursion can be a great tool to iterate through a nested data
9     structure, especially if you don't know how many levels of nesting
10    will be in the array or object! */
11
12
13
14
```



Example: logsAnArray

```
1  /* when writing recursive functions that will handle a nested data
2     structure, it's good to start by making sure it works with a flat
3     data structure. think of this as the base case!
4
5  function logsAnArray(array) {
6      for (let i = 0; i < array.length; i++) {
7          let element = array[i];
8          console.log(element);
9      }
10 }
11
12 logsAnArray([1, 2, 3]);
13
14
```



Example: logsAnArray

```
1 function logsAnArray(array) {
2   for (let i = 0; i < array.length; i++) {
3     let element = array[i];
4     console.log(element);
5   }
6 }
7
8 logsAnArray([1, [2, 3]]); // what if the input is nested?
9 /* consider element on line 3. that could be a number, or it could be
10    another array! */
11
12 /* if element is an array, we want to log every number inside of it. if
13    only we had a function that takes an array and logs out all of its
14    values! oh wait... */
```



Example: logsAnArray

```
1 function logsAnArray(array) {  
2   for (let i = 0; i < array.length; i++) {  
3     let element = array[i];  
4  
5     if (Array.isArray(element)) {  
6       logsAnArray(element);  
7     }  
8     else {  
9       console.log(element);  
10    }  
11  }  
12 }  
13  
14 logsAnArray([1, [2, 3]]);
```

Callstack



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     finalString += element;
6   }
7   return finalString;
8 }
9
10 let result = concatEls(['a', 'b', 'c']);
11 console.log(result);
12
13
14
```



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['a', ['b', 'c']])

''



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['a', ['b', 'c']])

' ' += 'a'



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['a', ['b', 'c']])

'a'



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['a', ['b', 'c']]) 'a' += concatEls(['b', c'])



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['b', 'c'])

''

concatEls(['a', ['b', 'c']]) 'a' += concatEls(['b', c'])



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['b', 'c'])

'' += 'b'

concatEls(['a', ['b', 'c']]) 'a' += concatEls(['b', c'])



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['b', 'c'])

'b'

concatEls(['a', ['b', 'c']]) 'a' += concatEls(['b', c'])



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['b', 'c'])

'b' += 'c'

concatEls(['a', ['b', 'c']]) 'a' += concatEls(['b', c'])



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['b', 'c'])

'bc'

concatEls(['a', ['b', 'c']]) 'a' += concatEls(['b', c'])



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['b', 'c'])

=> 'bc'

concatEls(['a', ['b', 'c']]) 'a' += concatEls(['b', c'])



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['a', ['b', 'c']])

'a' += 'bc'



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['a', ['b', 'c']])

'abc'



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString

concatEls(['a', ['b', 'c']])

=> 'abc'



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b
14 console.log(result);
```

Callstack

finalString



Example: concatEls

```
1 function concatEls(array) {
2   let finalString = '';
3   for (let i = 0; i < array.length; i++) {
4     let element = array[i];
5     if (Array.isArray(element)) {
6       finalString += concatEls(element);
7     } else {
8       finalString += element;
9     }
10  }
11  return finalString;
12 }
13 let result = concatEls(['a', ['b', 'c']]);
14 console.log(result);
```



Nested objects

```
1  /* working with nested objects is very similar to working with nested
2     arrays */
3
4  /* use a for-in loop to iterate through the object */
5
6  /* if the value is another object, recursively call the function on the
7     nested object */
8
9
10
11
12
13
14
```




Example: sumVals

```
1  /* write a function sumVals that sums the values in an object */
2
3  function sumVals(obj) {
4      let sum = 0;
5      for (let key in obj) {
6          let value = obj[key];
7          sum += value;
8      }
9      return sum;
10 }
11
12 let result = sumVals({a: 10, b: 20});
13 console.log(result);
14
```



Example: sumVals

```
1  function sumVals(obj) {
2    let sum = 0;
3    for (let key in obj) {
4      let value = obj[key];
5      if (typeof value === 'object') {
6        sum += sumVals(value)
7      } else {
8        sum += value;
9      }
10   }
11   return sum;
12 }
13
14 let result = sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}})
```



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

0



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

Callstack

sum

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}}

0 += 1



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

Callstack

sum

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}}

1



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

Callstack

sum

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}) 1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

Callstack

sum

sumVals({c: {d: {e:2, f: 3}}})

0

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}) 1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

Callstack

sum

```
13 sumVals({c: {d: {e:2, f: 3}}}) 0 += sumVals({d: {e:2, f: 3}})
14 let result = sumVals(sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}) 1 += sumVals({c: {d: {e:2, f: 3}}})
```




Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

13	sumVals({c: {d: {e:2, f: 3}}})	0 += sumVals({d: {e:2, f: 3}})
14	sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})	1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({d: {e:2, f: 3}})

0 += sumVals({e:2, f: 3})

sumVals({c: {d: {e:2, f: 3}}})

0 += sumVals({d: {e:2, f: 3}})

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({e:2, f: 3})

0

sumVals({d: {e:2, f: 3}})

0 += sumVals({e:2, f: 3})

sumVals({c: {d: {e:2, f: 3}}})

0 += sumVals({d: {e:2, f: 3}})

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({e:2, f: 3})

0 += 2

sumVals({d: {e:2, f: 3}})

0 += sumVals({e:2, f: 3})

sumVals({c: {d: {e:2, f: 3}}})

0 += sumVals({d: {e:2, f: 3}})

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({e:2, f: 3})

2

sumVals({d: {e:2, f: 3}})

0 += sumVals({e:2, f: 3})

sumVals({c: {d: {e:2, f: 3}}})

0 += sumVals({d: {e:2, f: 3}})

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({e:2, f: 3})

2 += 3

sumVals({d: {e:2, f: 3}})

0 += sumVals({e:2, f: 3})

sumVals({c: {d: {e:2, f: 3}}})

0 += sumVals({d: {e:2, f: 3}})

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({e:2, f: 3})

5

sumVals({d: {e:2, f: 3}})

0 += sumVals({e:2, f: 3})

sumVals({c: {d: {e:2, f: 3}}})

0 += sumVals({d: {e:2, f: 3}})

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({e:2, f: 3})

=> 5

sumVals({d: {e:2, f: 3}})

0 += sumVals({e:2, f: 3})

sumVals({c: {d: {e:2, f: 3}}})

0 += sumVals({d: {e:2, f: 3}})

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

sumVals({d: {e:2, f: 3}})

0 += 5

sumVals({c: {d: {e:2, f: 3}}})

0 += sumVals({d: {e:2, f: 3}})

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

```
13   sumVals({c: {d: {e:2, f: 3}}})      0 += sumVals({d: {e:2, f: 3}})
14 let result = sumVal                  sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}} 1 += sumVals({c: {d: {e:2, f: 3}}})
```



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

```
13   sumVals({c: {d: {e:2, f: 3}}})      0 += sumVals({d: {e:2, f: 3}})
14 let result = sumVal sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}) 1 += sumVals({c: {d: {e:2, f: 3}}})
```

Callstack	sum
-----------	-----

sumVals({d: {e:2, f: 3}})	=> 5
---------------------------	------

sumVals({c: {d: {e:2, f: 3}}})	0 += sumVals({d: {e:2, f: 3}})
--------------------------------	--------------------------------

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})	1 += sumVals({c: {d: {e:2, f: 3}}})
---	-------------------------------------



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

Callstack

sum

sumVals({c: {d: {e:2, f: 3}}})

0 += 5

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}) 1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

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10  }
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12 }
```

Callstack

sum

sumVals({c: {d: {e:2, f: 3}}})

5

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}) 1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

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11  return sum;
12 }
```

Callstack

sum

sumVals({c: {d: {e:2, f: 3}}})

=> 5

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}) 1 += sumVals({c: {d: {e:2, f: 3}}})



Example: sumVals

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5     if (typeof value === 'object') {  
6       sum += sumVals(value)  
7     } else {  
8       sum += value;  
9     }  
10  }  
11  return sum;  
12 }  
13  
14 let result = sumVal
```

Callstack

sum

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}}}

1 += 5



Example: sumVals

```
1 function sumVals(obj) {  
2   let sum = 0;  
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5     if (typeof value === 'object') {  
6       sum += sumVals(value)  
7     } else {  
8       sum += value;  
9     }  
10  }  
11  return sum;  
12 }
```

Callstack

sum

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

6



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
3   for (let key in obj) {
4     let value = obj[key];
5     if (typeof value === 'object') {
6       sum += sumVals(value)
7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
```

Callstack

sum

```
14 let result = sumVal
```

sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})

=> 6



Example: sumVals

```
1 function sumVals(obj) {
2   let sum = 0;
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7     } else {
8       sum += value;
9     }
10  }
11  return sum;
12 }
13
14 let result = sumVal
```

Callstack

sum

Example: sumVals

```
1  function sumVals(obj) {
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8        sum += value;
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10   }
11   return sum;
12 }
13
14 let result = sumVals({a: 1, b: {c: {d: {e:2, f: 3}}}})
```



Recap

```
1  /*
2      - Nested data structures and recursion
3      - Nested arrays
4      - Nested objects
5  */
6
7
8
9
10
11
12
13
14
```