# Advanced JavaScript Concepts — Destructuring, Rest Operator, Closures

This document explains important advanced JavaScript concepts in **simple English**, each with: - Definition - Syntax - When to use - Advantages & disadvantages - Practice examples - Step-by-step explanation

This is designed for students preparing for interviews and real-world development.

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## 1. Array Destructuring

### Definition

Array destructuring allows you to extract values from an array into separate variables.

### Syntax

```
const [a, b, c] = array;
```

### Why We Use It

- Makes code short and easy to understand
- Useful when working with functions returning arrays
- Helpful when taking only a few values from large arrays

### Advantages

- Cleaner syntax
- Avoids manual indexing

### Disadvantages

- Confusing for beginners
- Errors occur if structure doesn't match

### Example 1

#### Input

```
const arr = [10, 20, 30];
```

**Output**

```
10 20 30
```

**Explanation**

```
const [x, y, z] = arr; // assigns x=10, y=20, z=30
```

### Example 2: Skipping Values

```
const [first, , third] = [1, 2, 3];
```

Output:

```
first = 1
target = 3
```

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## 2. Object Destructuring

### Definition

It allows extracting values from objects into variables.

### Syntax

```
const { key1, key2 } = object;
```

### Why We Use It

- Cleanly extracts needed fields
- Reduces repeated `object.key` usage

### Advantages

- Improves readability
- Flexible — order does not matter

### Disadvantages

- Variable name must match key name

### Example 1

```
const user = {
  name: "John",
  age: 25
};

const { name, age } = user;
```

Output:

```
name = John
age = 25
```

### Example 2: Renaming Variables

```
const { name: userName } = user;
```

Output:

```
userName = "John"
```

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## 3. Rest Operator (...)

### Definition

The rest operator collects multiple values into a single array.

### Syntax

```
function demo(...values) {
  console.log(values);
}
```

### Why We Use It

- To accept unlimited parameters
- To gather remaining values

## Advantages

- Flexible parameter handling

## Disadvantages

- Overuse can reduce clarity

## Example 1 — Sum All Numbers

```
function sumAll(...nums) {
  let total = 0;
  for (let n of nums) total += n;
  return total;
}
```

Input:

```
sumAll(1,2,3,4)
```

Output:

```
10
```

## Example 2 — First Value Separate, Rest Together

```
const [first, ...others] = [10,20,30,40];
```

Output:

```
first = 10
others = [20,30,40]
```

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# 4. Closures

## 4.1 Definition (Very Simple English)

A **closure** happens when: 1. You have **one function inside another function**. 2. The inner function **uses variables from the outer function**. 3. The outer function **finishes**, but the inner function **still remembers** those variables.

> Short idea: **A closure is a function + the data around it.**

## 4.2 Why Do We Use Closures?

- To **remember values** between function calls.
- To create **private variables** (not directly accessible from outside).
- To avoid using **global variables**.
- Used a lot in **real projects** and **interview questions**.

**Advantages** - Keeps data safe inside functions. - Easy to create functions that keep a "memory".

**Disadvantages** - Confusing for beginners. - If overused, can make code hard to read.

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## Example 1 — Simple Counter Closure

### Problem

Create a function that gives you a counter. Every time you call it, it should give the **next number**.

### Input

```
const counter = createCounter();
counter();
counter();
counter();
```

### Output

```
1
2
3
```

### Step-by-step Explanation

1. We want a **number** that increases every time.
2. We do **not** want this number to be a global variable.
3. So we put the number inside an **outer function**.
4. The outer function returns an **inner function**.
5. The inner function uses the `count` variable.
6. Because of closure, even after the outer function finishes, the inner function **remembers** `count`.

### Code

```
function createCounter() {
  let count = 0; // private variable
  function inner() {
    count = count + 1; // increase count
    return count;      // return updated value
  }

  return inner; // return the inner function
}

const counter = createCounter();
// counter() → 1
// counter() → 2
// counter() → 3
```

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## Example 2 — Greeting With Name (Function Remembers Data)

### Problem

Create a function that remembers a person’s name and greets them later.

### Input

```
const greetJohn = createGreeter("John");
const greetSara = createGreeter("Sara");

greetJohn();
greetSara();
```

### Output

```
"Hello, John"
"Hello, Sara"
```

### Step-by-step Explanation

1. The outer function `createGreeter` receives a `name`.
2. Inside it, we create an inner function that uses that `name`.
3. We return the inner function.
4. When we call `createGreeter("John")`, it returns a function that **remembers** `"John"`.
5. When we call `greetJohn()`, it uses the remembered name and returns the greeting.

### Code

```
function createGreeter(name) {
  function inner() {
    return "Hello, " + name;
  }
  return inner;
}

const greetJohn = createGreeter("John");
const greetSara = createGreeter("Sara");

// greetJohn() → "Hello, John"
// greetSara() → "Hello, Sara"
```

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## Example 3 — Private Balance (Bank Style Closure)

### Problem

Create a function that manages a bank account balance. The balance should not be directly changeable from outside.

### Input

```
const account = createAccount(1000);
account.getBalance();
account.deposit(500);
account.getBalance();
account.withdraw(300);
account.getBalance();
```

### Output

```
1000
1500
1200
```

### Step-by-step Explanation

1. We want a **balance** that is not global and not directly editable.
2. We put `balance` inside an outer function `createAccount`.
3. This function returns an **object** containing 3 inner functions:
4. `getBalance`
5. `deposit`
6. `withdraw`
7. All these inner functions use the same `balance` variable.
8. Because of **closure**, `balance` stays alive even after `createAccount` ends.
9. Only these functions can change or read `balance`.

### Code

```
function createAccount(startBalance) {
  let balance = startBalance; // private

  function getBalance() {
    return balance;
  }

  function deposit(amount) {
    balance = balance + amount;
  }

  function withdraw(amount) {
    if (amount > balance) {
      return "Not enough balance";
    }
    balance = balance - amount;
  }

  return {
    getBalance: getBalance,
    deposit: deposit,
    withdraw: withdraw
  };
}

const account = createAccount(1000);
// account.getBalance() → 1000
// account.deposit(500)
// account.getBalance() → 1500
// account.withdraw(300)
// account.getBalance() → 1200
```

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## Example 4 — Closure With Counter Per User

### Problem

Each user should have their **own** counter, but logic should be same.

### Input

```
const user1Counter = createUserCounter("User1");
const user2Counter = createUserCounter("User2");

user1Counter();
```

```
user1Counter();
user2Counter();
```

### Output

```
"User1 clicked 1 times"
"User1 clicked 2 times"
"User2 clicked 1 times"
```

### Step-by-step Explanation

1. `createUserCounter` takes a `name`.
2. It creates a private `count` variable for that user.
3. Inner function increases the `count` and returns a message.
4. Each time you call `createUserCounter`, a **new closure** is created with its own `count`.

### Code

```
function createUserCounter(name) {
  let count = 0; // private for this user

  function inner() {
    count = count + 1;
    return name + " clicked " + count + " times";
  }

  return inner;
}

const user1Counter = createUserCounter("User1");
const user2Counter = createUserCounter("User2");

// user1Counter() → "User1 clicked 1 times"
// user1Counter() → "User1 clicked 2 times"
// user2Counter() → "User2 clicked 1 times"
```

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## Important Points to Remember About Closures

1. Closure = **function + remembered variables**.
2. Inner function can still use outer variables even after outer function ends.
3. Every time you call the outer function, a **new closure** is created.
4. Useful for private data, counters, configurations, etc.

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## 5. Practice Problems

### 1. Swap Two Variables Using Array Destructuring

Input:

```
let a = 10, b = 20;
```

Expected Output:

```
a = 20
b = 10
```

### 2. Extract City Using Object Destructuring

Input:

```
{ user: { address: { city: "Delhi" } } }
```

### 3. Create a Function That Accepts Unlimited Numbers Using Rest Operator

Input:

```
sumNumbers(5,10,15,20)
```

Output:

```
50
```

### 4. Create a Closure That Tracks Login Count

Output:

```
login(); // 1
login(); // 2
```

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## 6. Summary

This document provides clear explanations and examples for destructuring, rest operator, and closures — concepts frequently asked in interviews and needed in real development. You can request more examples, project-style applications, or interview questions anytime.