← Getting Started

Async JavaScript & Node.js →

QE Fundamentals & TypeScript for Test Automation

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Overview of Quality Engineering

throughout the entire development lifecycle. Unlike traditional Quality Assurance (QA), which focuses on finding defects, Quality Engineering emphasizes **preventing defects** through better engineering practices.

Key Principles of Quality Engineering

1. Shift-Left Testing

- Testing activities begin early in the development cycle
- Prevents expensive late-stage bug fixes
- Involves collaboration between developers and QE engineers

2. Continuous Testing

- Testing integrated into CI/CD pipelines
- Automated tests run on every code commit
- Provides immediate feedback to developers

3. Quality Culture

- Quality is everyone's responsibility
- Developers write unit tests
- QE engineers focus on integration and E2E tests

4. Test Automation First

- Automate repetitive test cases
- Manual testing for exploratory and usability testing
- Automation enables faster releases

The Role of QE Engineers

Responsibilities:

- Design and implement test automation frameworks
- Write automated test scripts (UI, API, Mobile)

- Collaborate with developers to improve code quality
- Perform exploratory testing for critical features
- Maintain and update test suites

Skills Required:

- Programming (JavaScript, TypeScript, Python, Java)
- Test automation tools (Playwright, Cypress, Selenium)
- API testing (REST, GraphQL)
- Version control (Git, GitHub)
- CI/CD (Jenkins, GitHub Actions, GitLab CI)
- Cloud platforms (AWS, Azure, BrowserStack)
- Database and SQL knowledge

Manual vs Automation Testing

Manual Testing

Definition: Human testers execute test cases step-by-step without automation tools.

When to Use Manual Testing:

- Exploratory testing
- Usability testing
- Ad-hoc testing
- Visual verification (UI/UX)
- One-time test scenarios
- Complex scenarios requiring human judgment

Advantages:

- Flexible and adaptable

- No initial setup cost

Disadvantages:

- Time-consuming
- Prone to human error
- Not repeatable
- Expensive for regression testing
- Cannot simulate load/stress

Automation Testing

Definition: Using tools and scripts to execute tests automatically.

When to Use Automation Testing:

- Regression testing
- Smoke testing
- Data-driven testing
- Load and performance testing
- Repetitive test scenarios
- Cross-browser/device testing
- API testing

Advantages:

- Fast execution
- Reliable and repeatable
- Cost-effective for regression
- Enables CI/CD
- Can run 24/7
- Detailed reporting

Disadvantages:

- Maintenance overhead
- Cannot find all bugs
- Limited to scripted scenarios

Manual vs Automation Comparison

Aspect	Manual Testing	Automation Testing
Speed	Slow	Fast
Reliability	Human error prone	Highly reliable
Cost (Short-term)	Low	High (setup)
Cost (Long-term)	High (repetitive)	Low
Flexibility	High	Limited to scripts
Regression Testing	Inefficient	Highly efficient
Exploratory Testing	Excellent	Not suitable
CI/CD Integration	Difficult	Easy
ROI	Low for repetitive	High for repetitive

Test Automation Pyramid

Overview

The Test Automation Pyramid is a testing strategy that defines the optimal distribution of different types of automated tests.

```
        /--------\
       /   API    \        ← Moderate (30%)
      /------------\
     /     Unit     \      ← Many (60%)
    /________________\
```

Unit Tests (Base - 60%)

Purpose: Test individual functions, methods, or classes in isolation.

Characteristics:

- Very fast execution (milliseconds)
- Test smallest units of code
- No external dependencies (mocked)
- Written by developers
- Run on every code commit

Tools:

- Jest (JavaScript/TypeScript)
- Mocha/Chai
- JUnit (Java)
- pytest (Python)

Example:

```
 // Function to test
function add(a: number, b: number): number {
  return a + b;
}

// Unit test
describe('add function', () => {
  it('should return sum of two numbers', () => {
    expect(add(2, 3)).toBe(5);
    expect(add(-1, 1)).toBe(0);
```

Benefits:

- Catch bugs early
- Fast feedback
- Easy to debug
- High code coverage
- Enable refactoring

Integration/API Tests (Middle - 30%)

Purpose: Test interactions between components, modules, or services.

Characteristics:

- Test business logic
- Validate API contracts
- Test database interactions
- Moderate execution speed
- More complex than unit tests

Tools:

- Playwright (API Testing)
- Postman/Newman
- REST Assured
- Supertest

Example:

```
 // API Integration Test
test('GET /users should return user list', async ({ request }) => {
  const response = await request.get('/api/users');
  expect(response.status()).toBe(200);
  const users = await response.json();
  expect(users.length).toBeGreaterThan(0);
```

Benefits:

- Test business logic
- Faster than E2E tests
- Catch integration issues
- Independent of UI

End-to-End Tests (Top - 10%)

Purpose: Test complete user workflows from start to finish.

Characteristics:

- Simulate real user scenarios
- Test entire application stack
- Slow execution (minutes)
- Fragile (UI changes break tests)
- High maintenance cost

Tools:

- Playwright
- Cypress
- Selenium WebDriver
- TestCafe

Example:

```
 // E2E Test
test('User can complete checkout process', async ({ page }) => {
  await page.goto('/products');
  await page.getByRole('button', { name: 'Add to Cart' }).first().click();
  await page.getByRole('link', { name: 'Checkout' }).click();
  await page.getByLabel('Email').fill('user@example.com');
  await page.getByLabel('Card Number').fill('4111111111111111');
```

Benefits:

- Test real user scenarios
- Validate entire system
- Catch system-level issues
- Build confidence in releases

Why the Pyramid Shape?

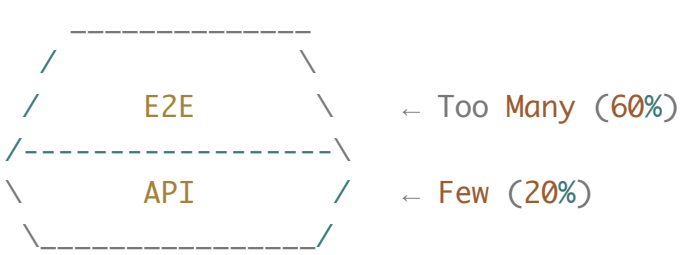
Reasons for More Unit Tests:

1. **Speed**: Unit tests execute in milliseconds
2. **Stability**: Less flaky than UI tests
3. **Cost**: Cheaper to maintain
4. **Debugging**: Easy to pinpoint failures
5. **Coverage**: Can test edge cases easily

Reasons for Fewer E2E Tests:

1. **Slow**: Take minutes to execute
2. **Fragile**: UI changes break tests
3. **Expensive**: High maintenance cost
4. **Debugging**: Hard to identify root cause
5. **Environment**: Require full stack setup

Anti-Pattern: Ice Cream Cone



Problems:

- Slow test suite execution
- Flaky tests
- High maintenance cost
- Late feedback
- Difficult debugging

Development Environment Setup

Prerequisites

Before starting test automation, set up your development environment with essential tools.

Node.js and npm

Node.js is a JavaScript runtime that executes JavaScript outside the browser. **npm** (Node Package Manager) manages JavaScript packages.

Installation:

Windows:

1. Download Node.js from https://nodejs.org/
2. Run the installer (LTS version recommended)
3. Verify installation:

```
node --version
npm --version
```

macOS:

```
# Verify
node --version
npm --version
```

Linux (Ubuntu/Debian):

```
 # Using apt
curl -fsSL https://deb.nodesource.com/setup_lts.x | sudo -E bash -
sudo apt-get install -y nodejs

# Verify
node --version
npm --version
```

Visual Studio Code (VS Code)

Why VS Code?

- Free and open-source
- Excellent TypeScript support
- Rich extension ecosystem
- Integrated terminal
- Built-in debugger
- Git integration

Installation:

1. Download from https://code.visualstudio.com/
2. Install for your operating system

Essential Extensions:

- ESLint (Code linting)
- Prettier (Code formatting)
- Playwright Test for VSCode

- Thunder Client (API testing)
- Path Intellisense
- Auto Rename Tag
- Bracket Pair Colorizer

VS Code Configuration:

Create `.vscode/settings.json` :

```
{
  "editor.formatOnSave": true,
  "editor.defaultFormatter": "esbenp.prettier-vscode",
  "editor.codeActionsOnSave": {
    "source.fixAll.eslint": true
  },
  "typescript.preferences.importModuleSpecifier": "relative",
  "files.autoSave": "onFocusChange"
}
```

Git

Why Git?

- Version control for code
- Collaboration with team
- Track changes and history
- Integration with CI/CD

Installation:

Windows:

- Download from https://git-scm.com/
- Run installer with default options

macOS:

Linux:

```
sudo apt-get install git
```

Configuration:

```
git config --global user.name "Your Name"
git config --global user.email "your.email@example.com"
git config --global init.defaultBranch main
```

Create Project Structure

Initialize a Test Automation Project:

```
# Create project directory
mkdir test-automation-project
cd test-automation-project

# Initialize npm project
npm init -y

# Initialize git repository
git init

# Create .gitignore
cat > .gitignore << EOF
node_modules/
test-results/
playwright-report/
.env
*.log
EOF

# Create folder structure
mkdir -p tests/web tests/api tests/mobile
mkdir -p utils
mkdir -p pages
mkdir -p fixtures
```

```
test-automation-project/
├── node_modules/
├── tests/
|   ├── web/
|   ├── api/
|   └── mobile/
├── pages/
├── utils/
├── fixtures/
├── .gitignore
├── package.json
├── tsconfig.json
└── playwright.config.ts
```

JavaScript Fundamentals Recap

Variables

Three Ways to Declare Variables:

```
// var (old way - avoid in modern code)
var name = "John";

// let (block-scoped, can be reassigned)
let age = 25;
age = 26; // OK

// const (block-scoped, cannot be reassigned)
const PI = 3.14159;
// PI = 3.14; // Error: Cannot reassign const
```

Best Practices:

- Use `const` by default
- Use `let` only if you need to reassign
- Avoid `var` completely

```
// String
const name = "Alice";
const greeting = 'Hello';
const template = `Hello, ${name}!`;

// Number
const age = 30;
const price = 19.99;
const negative = -42;

// Boolean
const isActive = true;
const hasError = false;

// Undefined
let value; // undefined
console.log(value); // undefined

// Null
const empty = null;

// Symbol (unique identifier)
const id = Symbol('id');
```

Reference Types:

```
// Object
const user = {
  name: "Bob",
  age: 28,
  email: "bob@example.com"
};

// Array
const numbers = [1, 2, 3, 4, 5];
const mixed = [1, "two", true, null];

// Function
function greet(name) {
  return `Hello, ${name}!`;
```

Operators

Arithmetic Operators:

```
 const a = 10;
const b = 3;

console.log(a + b);  // 13 (Addition)
console.log(a - b);  // 7 (Subtraction)
console.log(a * b);  // 30 (Multiplication)
console.log(a / b);  // 3.333... (Division)
console.log(a % b);  // 1 (Modulus/Remainder)
console.log(a ** b); // 1000 (Exponentiation)
```

Comparison Operators:

```
 const x = 5;
const y = "5";

console.log(x == y);   // true (loose equality - converts types)
console.log(x === y);  // false (strict equality - no type conversion)
console.log(x != y);   // false
console.log(x !== y);  // true
console.log(x > 3);    // true
console.log(x >= 5);   // true
console.log(x < 10);   // true
```

Logical Operators:

```
 const isLoggedIn = true;
const hasPermission = false;

console.log(isLoggedIn && hasPermission);  // false (AND)
console.log(isLoggedIn || hasPermission);  // true (OR)
console.log(!isLoggedIn);                  // false (NOT)
```

Control Flow

```
const age = 20;

if (age >= 18) {
  console.log("Adult");
} else if (age >= 13) {
  console.log("Teenager");
} else {
  console.log("Child");
}

// Ternary operator
const status = age >= 18 ? "Adult" : "Minor";
```

Switch Statement:

```
const day = "Monday";

switch (day) {
  case "Monday":
  case "Tuesday":
  case "Wednesday":
  case "Thursday":
  case "Friday":
    console.log("Weekday");
    break;
  case "Saturday":
  case "Sunday":
    console.log("Weekend");
    break;
  default:
    console.log("Invalid day");
}
```

Loops:

```
// For loop
for (let i = 0; i < 5; i++) {
  console.log(i);
}

// While loop
let count = 0;
```

```
}

// Do-while loop
let num = 0;
do {
  console.log(num);
  num++;
} while (num < 5);

// For...of loop (arrays)
const fruits = ["apple", "banana", "orange"];
for (const fruit of fruits) {
  console.log(fruit);
}

// For...in loop (objects)
const person = { name: "John", age: 30 };
for (const key in person) {
  console.log(`${key}: ${person[key]}`);
}
```

TypeScript Fundamentals

What is TypeScript?

TypeScript is a **superset of JavaScript** that adds static typing. It compiles to plain JavaScript and helps catch errors during development.

Benefits:

- Type safety (catch errors at compile time)
- Better IDE support (autocomplete, refactoring)
- Self-documenting code
- Enhanced code maintainability
- Modern JavaScript features

```
 # Install TypeScript globally
npm install -g typescript

# Check version
tsc --version

# Install TypeScript in project
npm install --save-dev typescript @types/node

# Initialize TypeScript configuration
npx tsc --init
```

tsconfig.json Configuration

```
 {
  "compilerOptions": {
    "target": "ES2022",
    "module": "commonjs",
    "lib": ["ES2022"],
    "outDir": "./dist",
    "rootDir": "./src",
    "strict": true,
    "esModuleInterop": true,
    "skipLibCheck": true,
    "forceConsistentCasingInFileNames": true,
    "resolveJsonModule": true,
    "moduleResolution": "node",
    "types": ["node"]
  },
  "include": ["src/**/*"],
  "exclude": ["node_modules", "dist"]
}
```

Basic Type Annotations

Primitive Types:

```
 // String
let name: string = "Alice";
let greeting: string = 'Hello';
```

```
let price: number = 19.99;

// Boolean
let isActive: boolean = true;
let hasError: boolean = false;

// Any (avoid if possible)
let anything: any = "can be anything";
anything = 42;
anything = true;

// Unknown (safer than any)
let userInput: unknown;
userInput = "test";
if (typeof userInput === "string") {
  console.log(userInput.toUpperCase()); // Type narrowing
}

// Void (no return value)
function log(message: string): void {
  console.log(message);
}

// Never (never returns)
function throwError(message: string): never {
  throw new Error(message);
}

// Null and Undefined
let nullable: null = null;
let undefinedValue: undefined = undefined;
```

Type Inference

TypeScript can automatically infer types:

```
 // Type inferred as string
let message = "Hello"; // message: string

// Type inferred as number
let count = 10; // count: number

// Type inferred from return value
```

```
const result = add(5, 3); // result: number
```

Union Types

Variables can have multiple types:

```
 // Union type
let id: number | string;
id = 123;      // OK
id = "ABC123"; // OK
// id = true;  // Error

// Function with union type
function printId(id: number | string): void {
  if (typeof id === "string") {
    console.log(id.toUpperCase());
  } else {
    console.log(id.toFixed(2));
  }
}

// Array of union types
let mixed: (number | string)[] = [1, "two", 3, "four"];
```

Type Aliases

Create custom type names:

```
 // Simple alias
type ID = number | string;
type Status = "pending" | "approved" | "rejected";

let userId: ID = 123;
let orderStatus: Status = "pending";

// Object type alias
type User = {
  id: number;
  name: string;
```

```typescript
const user: User = {
  id: 1,
  name: "John Doe",
  email: "john@example.com"
};

// Function type alias
type CalculateFunction = (a: number, b: number) => number;

const add: CalculateFunction = (a, b) => a + b;
const multiply: CalculateFunction = (a, b) => a * b;
```

Literal Types

Exact values as types:

```typescript
 // String literal type
let direction: "north" | "south" | "east" | "west";
direction = "north"; // OK
// direction = "up"; // Error

// Numeric literal type
let diceRoll: 1 | 2 | 3 | 4 | 5 | 6;
diceRoll = 4; // OK
// diceRoll = 7; // Error

// Combined literal types
type HttpMethod = "GET" | "POST" | "PUT" | "DELETE";
type StatusCode = 200 | 201 | 400 | 401 | 404 | 500;

function makeRequest(method: HttpMethod, url: string): StatusCode {
  // Implementation
  return 200;
}
```

Functions in TypeScript

```typescript
// Basic function
function greet(name: string): string {
  return `Hello, ${name}!`;
}

// Function with optional parameter
function greetUser(name: string, greeting?: string): string {
  return `${greeting || "Hello"}, ${name}!`;
}

// Function with default parameter
function calculatePrice(price: number, tax: number = 0.1): number {
  return price + (price * tax);
}

// Function with rest parameters
function sum(...numbers: number[]): number {
  return numbers.reduce((total, num) => total + num, 0);
}

console.log(sum(1, 2, 3, 4, 5)); // 15
```

Arrow Functions

```typescript
// Basic arrow function
const add = (a: number, b: number): number => {
  return a + b;
};

// Concise arrow function
const multiply = (a: number, b: number): number => a * b;

// Arrow function with one parameter (parentheses optional)
const square = (x: number): number => x * x;

// Arrow function with no parameters
const getRandomNumber = (): number => Math.random();

// Arrow function with complex logic
const calculateDiscount = (price: number, discountPercent: number): number
  if (discountPercent < 0 || discountPercent > 100) {
    throw new Error("Invalid discount percentage");
```

Function Types

```
 // Function type
type MathOperation = (a: number, b: number) => number;

const add: MathOperation = (a, b) => a + b;
const subtract: MathOperation = (a, b) => a - b;

// Function as parameter
function calculate(
  a: number,
  b: number,
  operation: MathOperation
): number {
  return operation(a, b);
}

console.log(calculate(10, 5, add));      // 15
console.log(calculate(10, 5, subtract)); // 5

// Function returning function
function createMultiplier(multiplier: number): (value: number) => number {
  return (value: number) => value * multiplier;
}

const double = createMultiplier(2);
const triple = createMultiplier(3);

console.log(double(5)); // 10
console.log(triple(5)); // 15
```

Async Functions

```
 // Async function returning Promise
async function fetchUser(id: number): Promise<User> {
  const response = await fetch(`/api/users/${id}`);
  const user = await response.json();
  return user;
}
```

```
  const user = await fetchUser(userId);
  return user;
};

// Error handling in async functions
async function fetchUserSafe(id: number): Promise<User | null> {
  try {
    const response = await fetch(`/api/users/${id}`);
    if (!response.ok) {
      throw new Error(`HTTP error! status: ${response.status}`);
    }
    const user = await response.json();
    return user;
  } catch (error) {
    console.error("Failed to fetch user:", error);
    return null;
  }
}
```

Interfaces, Types, and Classes

Interfaces

Interfaces define the structure of objects:

```
 // Basic interface
interface User {
  id: number;
  name: string;
  email: string;
  age?: number;        // Optional property
  readonly role: string; // Read-only property
}

const user: User = {
  id: 1,
  name: "Alice",
  email: "alice@example.com",
  role: "admin"
```

```
// Interface with methods
interface Product {
  id: number;
  name: string;
  price: number;
  calculateDiscount(percent: number): number;
}

const product: Product = {
  id: 1,
  name: "Laptop",
  price: 1000,
  calculateDiscount(percent: number): number {
    return this.price - (this.price * percent / 100);
  }
};

// Interface extending another interface
interface Employee extends User {
  employeeId: string;
  department: string;
  salary: number;
}

const employee: Employee = {
  id: 1,
  name: "Bob",
  email: "bob@example.com",
  role: "employee",
  employeeId: "EMP001",
  department: "Engineering",
  salary: 75000
};
```

Type Aliases vs Interfaces

```
 // Type alias
type Point = {
  x: number;
  y: number;
};
```

```
  x: number;
  y: number;
}

// Both work similarly for objects
const p1: Point = { x: 10, y: 20 };
const p2: IPoint = { x: 10, y: 20 };

// Type aliases can represent union types
type ID = number | string;

// Interfaces can be extended
interface Shape {
  color: string;
}

interface Circle extends Shape {
  radius: number;
}

// Type aliases can use intersection
type Colorful = { color: string };
type CircleType = Colorful & { radius: number };
```

When to use Interface vs Type:

- Use **Interface** for object shapes that might be extended
- Use **Type** for unions, intersections, or primitive aliases
- Both work well for most cases

Classes

```
 // Basic class
class Person {
  // Properties
  name: string;
  age: number;

  // Constructor
  constructor(name: string, age: number) {
    this.name = name;
```

```
  // Method
  greet(): string {
    return `Hello, my name is ${this.name}`;
  }
}

const person = new Person("Alice", 30);
console.log(person.greet()); // "Hello, my name is Alice"

// Class with access modifiers
class BankAccount {
  public accountNumber: string;    // Accessible everywhere
  private balance: number;          // Accessible only within class
  protected accountType: string;    // Accessible in class and subclasses

  constructor(accountNumber: string, initialBalance: number) {
    this.accountNumber = accountNumber;
    this.balance = initialBalance;
    this.accountType = "Savings";
  }

  // Public method
  public deposit(amount: number): void {
    if (amount > 0) {
      this.balance += amount;
    }
  }

  // Public method
  public getBalance(): number {
    return this.balance;
  }

  // Private method
  private calculateInterest(): number {
    return this.balance * 0.05;
  }
}

// Shorthand constructor
class User {
  constructor(
    public id: number,
    public name: string,
    private email: string
```

```
    return this.email;
  }
}

const user2 = new User(1, "Bob", "bob@example.com");

// Class inheritance
class Animal {
  constructor(public name: string) {}

  makeSound(): void {
    console.log("Some generic sound");
  }
}

class Dog extends Animal {
  constructor(name: string, public breed: string) {
    super(name); // Call parent constructor
  }

  makeSound(): void {
    console.log("Woof! Woof!");
  }

  fetch(): void {
    console.log(`${this.name} is fetching the ball`);
  }
}

const dog = new Dog("Buddy", "Golden Retriever");
dog.makeSound(); // "Woof! Woof!"
dog.fetch();     // "Buddy is fetching the ball"

// Abstract class
abstract class Shape {
  constructor(public color: string) {}

  abstract calculateArea(): number;

  describe(): string {
    return `This is a ${this.color} shape with area ${this.calculateArea()}
  }
}

class Rectangle extends Shape {
```

```
  calculateArea(): number {
    return this.width * this.height;
  }
}

const rectangle = new Rectangle("blue", 10, 5);
console.log(rectangle.describe()); // "This is a blue shape with area 50"

// Implementing interfaces
interface Drivable {
  speed: number;
  accelerate(amount: number): void;
  brake(): void;
}

class Car implements Drivable {
  speed: number = 0;

  accelerate(amount: number): void {
    this.speed += amount;
  }

  brake(): void {
    this.speed = 0;
  }
}
```

Arrays, Objects, and Destructuring

Arrays

```
 // Array declaration
const numbers: number[] = [1, 2, 3, 4, 5];
const names: Array<string> = ["Alice", "Bob", "Charlie"];

// Array methods
const fruits = ["apple", "banana", "orange"];
```

```
// Pop (remove from end)
const lastFruit = fruits.pop();

// Shift (remove from start)
const firstFruit = fruits.shift();

// Unshift (add to start)
fruits.unshift("mango");

// Slice (extract portion)
const sliced = fruits.slice(1, 3);

// Splice (remove/add items)
fruits.splice(1, 1, "kiwi"); // Remove 1 item at index 1, add "kiwi"

// Array iteration methods
const nums = [1, 2, 3, 4, 5];

// forEach
nums.forEach((num) => console.log(num));

// map (transform array)
const doubled = nums.map((num) => num * 2);
console.log(doubled); // [2, 4, 6, 8, 10]

// filter (filter array)
const evenNumbers = nums.filter((num) => num % 2 === 0);
console.log(evenNumbers); // [2, 4]

// reduce (reduce to single value)
const sum = nums.reduce((acc, num) => acc + num, 0);
console.log(sum); // 15

// find (find first matching element)
const found = nums.find((num) => num > 3);
console.log(found); // 4

// some (check if any element matches)
const hasEven = nums.some((num) => num % 2 === 0);
console.log(hasEven); // true

// every (check if all elements match)
const allPositive = nums.every((num) => num > 0);
console.log(allPositive); // true
```

```
  id: number;
  name: string;
  price: number;
}

const products: Product[] = [
  { id: 1, name: "Laptop", price: 1000 },
  { id: 2, name: "Mouse", price: 25 },
  { id: 3, name: "Keyboard", price: 75 }
];

// Filter expensive products
const expensiveProducts = products.filter((p) => p.price > 50);

// Get product names
const productNames = products.map((p) => p.name);

// Calculate total price
const totalPrice = products.reduce((total, p) => total + p.price, 0);
```

Objects

```
 // Object literal
const user = {
  id: 1,
  name: "Alice",
  email: "alice@example.com",
  age: 30
};

// Access properties
console.log(user.name);     // Dot notation
console.log(user["email"]); // Bracket notation

// Modify properties
user.age = 31;
user["email"] = "alice.new@example.com";

// Add new properties
(user as any).phone = "123-456-7890";

// Delete properties
```

```
const person = {
  name: "Bob",
  age: 25,
  greet() {
    return `Hello, I'm ${this.name}`;
  },
  celebrateBirthday() {
    this.age++;
  }
};

console.log(person.greet()); // "Hello, I'm Bob"
person.celebrateBirthday();
console.log(person.age); // 26

// Object.keys, Object.values, Object.entries
const config = {
  host: "localhost",
  port: 3000,
  debug: true
};

console.log(Object.keys(config));   // ["host", "port", "debug"]
console.log(Object.values(config)); // ["localhost", 3000, true]
console.log(Object.entries(config)); // [["host", "localhost"], ["port", 3

// Object spread operator
const defaults = { theme: "light", fontSize: 14 };
const userPrefs = { fontSize: 16, language: "en" };
const finalConfig = { ...defaults, ...userPrefs };
console.log(finalConfig);
// { theme: "light", fontSize: 16, language: "en" }
```

Destructuring

Array Destructuring:

```
 // Basic array destructuring
const colors = ["red", "green", "blue"];
const [first, second, third] = colors;
console.log(first);  // "red"
console.log(second); // "green"
```

```
console.log(tertiary); // "blue"

// Rest operator
const numbers = [1, 2, 3, 4, 5];
const [one, two, ...rest] = numbers;
console.log(one);  // 1
console.log(two);  // 2
console.log(rest); // [3, 4, 5]

// Default values
const [a, b, c = 0] = [1, 2];
console.log(c); // 0

// Swapping variables
let x = 1;
let y = 2;
[x, y] = [y, x];
console.log(x, y); // 2, 1
```

Object Destructuring:

```
 // Basic object destructuring
const user = {
  id: 1,
  name: "Alice",
  email: "alice@example.com",
  age: 30
};

const { name, email } = user;
console.log(name);  // "Alice"
console.log(email); // "alice@example.com"

// Rename variables
const { name: userName, age: userAge } = user;
console.log(userName); // "Alice"
console.log(userAge);  // 30

// Default values
const { name, phone = "N/A" } = user;
console.log(phone); // "N/A"

// Nested destructuring
```

```
  address: {
    street: "123 Main St",
    city: "New York",
    country: "USA"
  }
};

const {
  name: empName,
  address: { city, country }
} = employee;

console.log(empName); // "Bob"
console.log(city);    // "New York"
console.log(country); // "USA"

// Rest in objects
const settings = {
  theme: "dark",
  fontSize: 16,
  language: "en",
  notifications: true
};

const { theme, ...otherSettings } = settings;
console.log(theme);         // "dark"
console.log(otherSettings);
// { fontSize: 16, language: "en", notifications: true }

// Function parameter destructuring
interface Config {
  host: string;
  port: number;
  debug?: boolean;
}

function connectDatabase({ host, port, debug = false }: Config) {
  console.log(`Connecting to ${host}:${port}`);
  if (debug) {
    console.log("Debug mode enabled");
  }
}

connectDatabase({ host: "localhost", port: 5432, debug: true });
```

VS Code Debugging Basics

Setting Up Debug Configuration

1. Create launch.json

Create `.vscode/launch.json` :

```
{
  "version": "0.2.0",
  "configurations": [
    {
      "type": "node",
      "request": "launch",
      "name": "Debug TypeScript",
      "program": "${workspaceFolder}/src/index.ts",
      "preLaunchTask": "tsc: build - tsconfig.json",
      "outFiles": ["${workspaceFolder}/dist/**/*.js"],
      "sourceMaps": true
    },
    {
      "type": "node",
      "request": "launch",
      "name": "Debug Current File",
      "program": "${file}",
      "skipFiles": ["<node_internals>/**"],
      "console": "integratedTerminal"
    }
  ]
}
```

Breakpoints

Setting Breakpoints:

1. Click in the gutter (left margin) next to line number
2. Or press F9 on the line
3. Red dot appears indicating breakpoint

- **Conditional Breakpoint**: Right-click → Add Conditional Breakpoint

```
Example: count > 5
```

- **Logpoint**: Right-click → Add Logpoint (logs without stopping)

```
Example: Count is {count}
```

Debug Controls

Toolbar Buttons:

- **Continue (F5)**: Resume execution
- **Step Over (F10)**: Execute current line, don't go into functions
- **Step Into (F11)**: Go into function calls
- **Step Out (Shift+F11)**: Exit current function
- **Restart (Ctrl+Shift+F5)**: Restart debugging
- **Stop (Shift+F5)**: Stop debugging

Watch Variables

Debug Sidebar Panels:

1. Variables Panel:

- Shows local variables
- Shows function arguments
- Expand objects to inspect properties

2. Watch Panel:

- Add expressions to watch
- Example: `user.email` , `count > 5`

- Click to navigate to different stack frames

4. Breakpoints Panel:

- List of all breakpoints
- Enable/disable breakpoints

Debug Console

Access with `Ctrl+Shift+Y` or Debug → Debug Console

Evaluate Expressions:

```
 // In debug console while paused
> count
10
> count * 2
20
> user.name
"Alice"
> JSON.stringify(user, null, 2)
{
  "id": 1,
  "name": "Alice",
  "email": "alice@example.com"
}
```

Debugging Example

Example Code:

```
 // src/calculator.ts
export function calculateTotal(items: number[]): number {
  let total = 0;

  for (let i = 0; i < items.length; i++) {
    const item = items[i];
    total += item;
```

```
  return total;
}

// src/index.ts
import { calculateTotal } from './calculator';

const prices = [10, 20, 30, 40];
const total = calculateTotal(prices);
console.log(`Final total: ${total}`);
```

Debugging Steps:

1. Set breakpoint on line with `total += item`
2. Press F5 to start debugging
3. When breakpoint hits, inspect:
   - `item` variable (current value)
   - `total` variable (running sum)
   - `i` variable (loop index)
   - `items` array (all values)
4. Press F10 to step through loop
5. Watch how `total` changes with each iteration

Common Debugging Scenarios

1. Inspect Function Arguments:

```
function processUser(user: User) {
  // Set breakpoint here
  console.log(user.name);
  // Inspect user object in Variables panel
}
```

2. Debug Async Functions:

```
  // Set breakpoint after await
  const data = await response.json();
  return data;
}
```

3. Conditional Breakpoint:

```
for (let i = 0; i < 100; i++) {
  // Right-click → Add Conditional Breakpoint
  // Condition: i === 50
  console.log(i);
}
```

4. Debug Test Code:

```
// Add this to launch.json for debugging tests
{
  "type": "node",
  "request": "launch",
  "name": "Debug Tests",
  "program": "${workspaceFolder}/node_modules/.bin/jest",
  "args": ["--runInBand"],
  "console": "integratedTerminal"
}
```

Practice Exercises

Exercise 1: TypeScript Basics

Task: Create a User Management System

```
// Define interfaces
interface User {
```

```
  role: "admin" | "user" | "guest";
  createdAt: Date;
}

// Create user array
const users: User[] = [];

// Add functions
function addUser(name: string, email: string, role: User["role"]): User {
  // Implementation
}

function getUserById(id: number): User | undefined {
  // Implementation
}

function updateUser(id: number, updates: Partial<User>): boolean {
  // Implementation
}

function deleteUser(id: number): boolean {
  // Implementation
}

function getUsersByRole(role: User["role"]): User[] {
  // Implementation
}

// Test your implementation
const user1 = addUser("Alice", "alice@example.com", "admin");
const user2 = addUser("Bob", "bob@example.com", "user");
console.log(getUsersByRole("admin"));
```

Exercise 2: Array and Object Manipulation

Task: Create a Product Inventory System

```
interface Product {
  id: number;
  name: string;
  category: string;
  price: number;
  inStock: boolean;
```

```
const inventory: Product[] = [
  { id: 1, name: "Laptop", category: "Electronics", price: 1000, inStock:
  { id: 2, name: "Mouse", category: "Electronics", price: 25, inStock: tru
  { id: 3, name: "Desk", category: "Furniture", price: 300, inStock: false
  { id: 4, name: "Chair", category: "Furniture", price: 150, inStock: true
];

// Tasks:
// 1. Get all products in stock
const inStockProducts = // Your code

// 2. Get products by category
function getProductsByCategory(category: string): Product[] {
  // Your code
}

// 3. Calculate total inventory value
const totalValue = // Your code

// 4. Get most expensive product
const mostExpensive = // Your code

// 5. Update product quantity
function updateQuantity(id: number, quantity: number): boolean {
  // Your code
}

// 6. Get low stock products (quantity < 5)
const lowStockProducts = // Your code
```

Exercise 3: Function Types and Callbacks

Task: Create a Calculator with Higher-Order Functions

```
type Operation = (a: number, b: number) => number;

const add: Operation = (a, b) => a + b;
const subtract: Operation = (a, b) => a - b;
const multiply: Operation = (a, b) => a * b;
const divide: Operation = (a, b) => {
  if (b === 0) throw new Error("Division by zero");
  return a / b;
};
```

```
}

// Create a function that returns a function
function createCalculator(operation: Operation) {
  return (a: number, b: number) => {
    console.log(`Calculating: ${a} and ${b}`);
    return operation(a, b);
  };
}

// Test
const adder = createCalculator(add);
console.log(adder(5, 3)); // 8

// Advanced: Chain operations
function chainOperations(
  initial: number,
  operations: Array<{ op: Operation; value: number }>
): number {
  // Your code
}

// Test chaining
const result = chainOperations(10, [
  { op: add, value: 5 },
  { op: multiply, value: 2 },
  { op: subtract, value: 10 }
]);
console.log(result); // Should be 20
```

Exercise 4: Classes and OOP

Task: Create a Library Management System

```
 // Book class
class Book {
  constructor(
    public id: number,
    public title: string,
    public author: string,
    public isbn: string,
    private available: boolean = true
  ) {}
```

```
      this.available = false;
      return true;
    }
    return false;
  }

  return(): void {
    this.available = true;
  }

  isAvailable(): boolean {
    return this.available;
  }
}

// Library class
class Library {
  private books: Book[] = [];

  addBook(book: Book): void {
    // Your code
  }

  findBookByTitle(title: string): Book | undefined {
    // Your code
  }

  findBooksByAuthor(author: string): Book[] {
    // Your code
  }

  checkoutBook(id: number): boolean {
    // Your code
  }

  returnBook(id: number): boolean {
    // Your code
  }

  getAvailableBooks(): Book[] {
    // Your code
  }
}

// Test
```

```
console.log(library.checkoutBook(1)); // true
console.log(library.getAvailableBooks().length); // 1
console.log(library.returnBook(1)); // true
```

Exercise 5: Async Programming Practice

Task: Create an Async Data Fetcher with Error Handling

```
 interface ApiResponse<T> {
  data: T;
  status: number;
  message: string;
}

interface User {
  id: number;
  name: string;
  email: string;
}

// Simulate API call
function mockApiCall<T>(data: T, delay: number = 1000): Promise<ApiRespons
  return new Promise((resolve) => {
    setTimeout(() => {
      resolve({
        data,
        status: 200,
        message: "Success"
      });
    }, delay);
  });
}

// Simulate API error
function mockApiError(delay: number = 1000): Promise<never> {
  return new Promise((_, reject) => {
    setTimeout(() => {
      reject(new Error("API Error"));
    }, delay);
  });
}
```

```
  // Your code with error handling
}

// 2. Create async function to fetch multiple users
async function fetchMultipleUsers(ids: number[]): Promise<User[]> {
  // Your code - use Promise.all
}

// 3. Create async function with retry logic
async function fetchWithRetry<T>(
  fetchFn: () => Promise<T>,
  maxRetries: number = 3
): Promise<T> {
  // Your code
}

// 4. Create async function with timeout
async function fetchWithTimeout<T>(
  fetchFn: () => Promise<T>,
  timeout: number = 5000
): Promise<T> {
  // Your code - use Promise.race
}

// Test your implementations
async function runTests() {
  try {
    const user = await fetchUser(1);
    console.log("User:", user);

    const users = await fetchMultipleUsers([1, 2, 3]);
    console.log("Users:", users);

    const result = await fetchWithRetry(() => fetchUser(1));
    console.log("Result:", result);
  } catch (error) {
    console.error("Error:", error);
  }
}

runTests();
```

Exercise 6: Debugging Challenge

```
// This code has several bugs - find and fix them using VS Code debugger

interface Product {
  id: number;
  name: string;
  price: number;
}

function calculateTotal(products: Product[]): number {
  let total = 0;

  for (let i = 0; i <= products.length; i++) {
    total += products[i].price;
  }

  return total;
}

function applyDiscount(total: number, discountPercent: number): number {
  return total - (total * discountPercent);
}

function formatPrice(price: number): string {
  return "$" + price.toFixed(2);
}

const products: Product[] = [
  { id: 1, name: "Laptop", price: 1000 },
  { id: 2, name: "Mouse", price: 25 },
  { id: 3, name: "Keyboard", price: 75 }
];

const total = calculateTotal(products);
const discounted = applyDiscount(total, 10);
const formatted = formatPrice(discounted);

console.log("Total:", formatted);

// Expected output: Total: $990.00
// Use debugger to find and fix bugs
```

Debugging Steps:

1. Set breakpoints in calculateTotal

4. Fix the bug in loop condition
5. Set breakpoint in applyDiscount
6. Check discount calculation
7. Fix discount formula

Summary

In Day 1, you learned:

âœ… **Quality Engineering Fundamentals**

- QE vs QA differences
- Shift-left testing approach
- Role and responsibilities of QE engineers

âœ… **Manual vs Automation Testing**

- When to use each approach
- Advantages and disadvantages
- Cost-benefit analysis

âœ… **Test Automation Pyramid**

- Unit tests (60%)
- Integration tests (30%)
- E2E tests (10%)
- Anti-patterns to avoid

âœ… **Development Environment**

- Node.js and npm setup
- VS Code configuration
- Git basics

- Variables and data types
- Operators
- Control flow
- Arrays and objects

âœ… **TypeScript Fundamentals**

- Type annotations
- Type inference
- Union and literal types
- Type aliases

âœ… **TypeScript Functions**

- Function declarations
- Arrow functions
- Function types
- Async functions

âœ… **OOP in TypeScript**

- Interfaces
- Classes
- Inheritance
- Access modifiers

âœ… **Data Manipulation**

- Array methods (map, filter, reduce)
- Object operations
- Destructuring

âœ… **Debugging**

- Debug console
- Call stack

Next Steps

- Practice TypeScript coding exercises
- Set up your development environment
- Familiarize yourself with VS Code debugging
- Complete all practice exercises
- Review any concepts you found challenging

Resources

- TypeScript Official Documentation
- MDN Web Docs - JavaScript
- VS Code Debugging Guide
- Node.js Documentation

End of Day 1 Documentation

← Getting Started

Async JavaScript & Node.js →