Unit Testing with JEST

What is Software Testing

The process of Evaluating and conforming thar our application does what it is supposed to do

Why do we need to Test?

- To prevent Bugs
- Improve Perfomance
- Reduce Development cost
- Reliability and customer satisfaction

Types of Tests

- Unit Test: Testing Individual units of source code.i.e function, method, object, module ....
- Intergration Test: Combines different units..
- End-to-End Test: Involves replicating end user behaviour

What is JEST

Jest is a JavaScript framework. It works with project using TypeScript, Node, Angular, React.....

It was created by Facebook to help test JavaScript code

Link to the official documentation

- Most popular and most supported
- It is all in one solution
- It is a test runner and also an assertion library that gives us powerful set of Matchers,

Intro to Unit Test

step 1. Setup Your Project with TypeScript

use the Readme.md on GitHub to setup typescript project: link to the repo

step 2: Install Jest with additional dependencies

pnpm i -D jest ts-jest @types/jest ts-node

Description:

ts-jest - It integrates seamlessly with Jest, making it easier to run tests on TypeScript code without needing additional transpilation steps.

@types/jest - provides type definitions for Jest, a unit testing framework for JavaScript. It provides type-checking and auto-completion for Jest functions, objects, and classes.

step 3: Create a jest config file

on the root dir, create a file with the name: ***jest.config.ts***

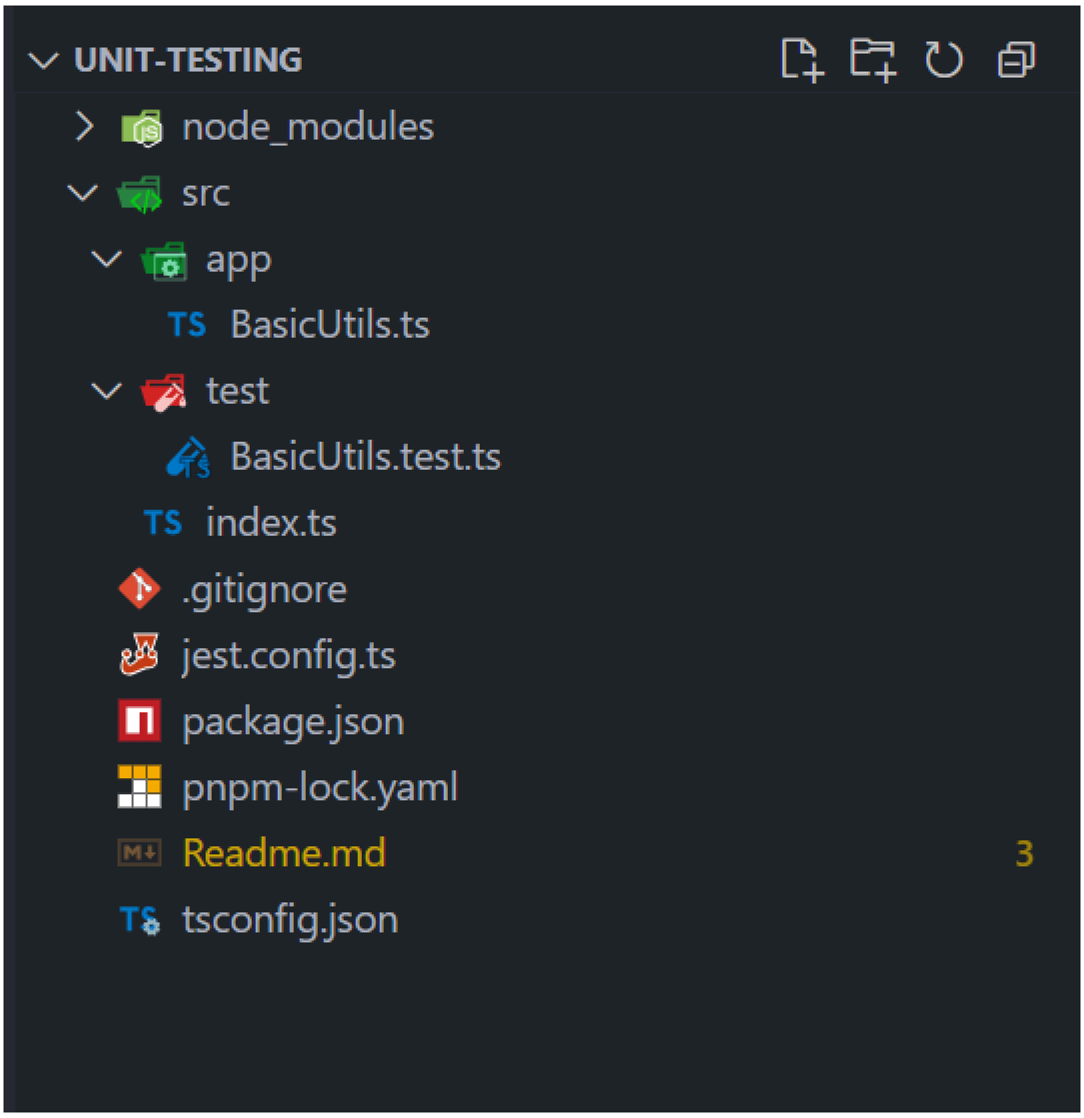
Add the following code in the created file:

```
import type {Config} from 'jest';

const config: Config = {
  preset: "ts-jest",
  testEnvironment: "node",
  verbose: true,
};

export default config;
```

This will create jest.config.js, It allows developers to customize Jest's behavior by specifying various settings, such as test environment, coverage collection, module resolution, and more.

*step 4: Create src folder and add **app** and **test***

Attached is a screenshot of how your folder structure should look like.



step 5: Running our first test ur first test

- Create a file: ***BasicUtils.ts*** inside app folder and add the following code.

```
export function product(a: number, b: number): number {
    return a * b;
}
```

- Create a file: ***BasicUtils.test.ts*** inside test folder and add the following code.

```
import { product } from "../app/BasicUtils"

describe("BasicUtils test suite ", () => {
    it("should return the product of 3 and 2 ", () => {
        const actual = product(3, 2)
        expect(actual).toBe(6)
    })
})
```

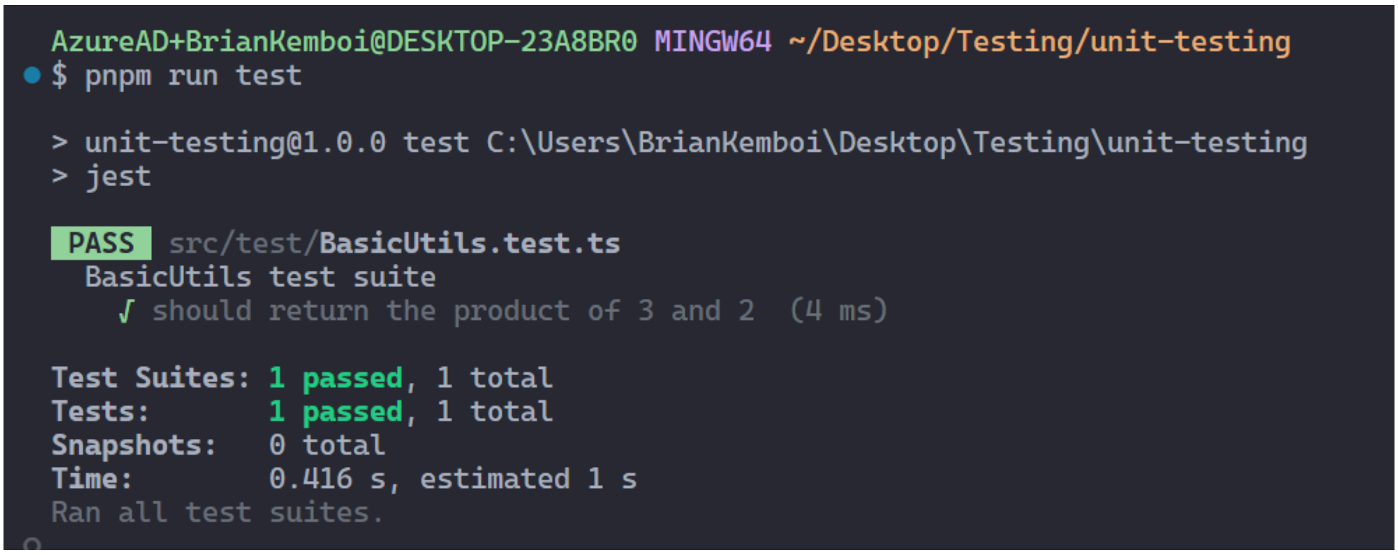
Add test script on package.json file

```json
{
  "name": "unit-testing",
  "version": "1.0.0",
  "description": "",
  "main": "index.js",
  "scripts": {
    "dev": "tsx watch src/index.ts",
    "build": "tsc",
    "start": "npm run build && node dist/index.js",
    "test": "jest"
  },
  "keywords": [],
  "author": "",
  "license": "ISC",
  "packageManager": "pnpm@10.11.0",
  "devDependencies": {
    "ts-node": "^10.9.2",
    "tsx": "^4.19.4",
    "typescript": "^5.8.3"
  },
  "dependencies": {
    "@types/jest": "^29.5.14",
    "jest": "^29.7.0",
    "ts-jest": "^29.3.4"
  }
}
```

Open your terminal and run the following command:

```
pnpm run test
```

You should have the following on your terminal:



```
AzureAD+BrianKemboi@DESKTOP-23A8BR0 MINGW64 ~/Desktop/Testing/unit-testing
$ pnpm run test

> unit-testing@1.0.0 test C:\Users\BrianKemboi\Desktop\Testing\unit-testing
> jest

 PASS  src/test/BasicUtils.test.ts
  BasicUtils test suite
    √ should return the product of 3 and 2  (4 ms)

Test Suites: 1 passed, 1 total
Tests:       1 passed, 1 total
Snapshots:   0 total
Time:        0.416 s, estimated 1 s
Ran all test suites.
```

Congratulations you written your first test with Jest

Matchers

Definition:

```
it("should return the product of 3 and 2 ", () => {
        const actual = product(3, 2)
        expect(actual).toBe(6)
        expect(actual).not.toBe(5) // This is a negative test case
        expect(actual).toEqual(6) // This is a positive test case
        expect(actual).toBeLessThan(10) // toBeLessThan is a matcher that checks if
the value is less than the expected value
        expect(actual).toBeLessThanOrEqual(6) // toBeLessThanOrEqual is a matcher
that checks if the value is less than or equal to the expected value
        expect(actual).toBeGreaterThan(5) // This is a positive test case
        expect(actual).toBeGreaterThanOrEqual(6) // This is a positive test case
        expect(actual).toBeCloseTo(6.0) // This is a positive test case
    })
```

Properly Written Unit Test

A well written unit test should undergo the AAA phases

A - Arrange: Initialises a small piece of an application it wants to test (SUT)

A- Act: Applies some stimulus

A- Assert: Observes the resulting behaviour

Demo

Create an Interface ***authData.ts*** under app directory

```
export interface IAuthData {
    usernameToLower: string;
    usernameCharacters: string[];
    userDetails: Object | undefined;
    isAuthenticated: boolean;
}
```

Under ***BasicUtils.ts*** add the following function

```
// This function simulates an authentication process
export function authenticateUser(username: string, password: string): IAuthData {
    // simulate an authentication process
    const authStatus = username === "deveLOPER" && password === "dev";
    return {
        usernameToLower: username.toLowerCase(),
        usernameCharacters: username.split(''),
        userDetails: {},
        isAuthenticated: authStatus,
    }
}
```

Write a test for to simulate user login process

```
import { authenticateUser, product } from "../app/BasicUtils"

describe("BasicUtils test suite ", () => {
    it("should return the product of 3 and 2 ", () => {
        const actual = product(3, 2)
        expect(actual).toBe(6)
    })

    // step 2:  if any of the above test cases fail, it will show the error message
in the console and the test will fail
    it('User authentication test', () => {
        // Arrange
        const sut = authenticateUser // System Under Test
        // Act
        const actual = sut("deveLOPER", "dev") // System Under Test
        // Assert
        expect(actual.usernameToLower).toBe("developer")
        //    Arrays (tobe) will fail because an array is a reference type whereas
string is a value type, toBe will only work for primitive types
        // expect(actual.usernameCharacters).toBe(['d', 'e', 'v', 'e', 'l', 'o',
'p', 'e', 'r']) // This is a negative test case
        expect(actual.usernameCharacters).toEqual(['d', 'e', 'v', 'e', 'L', 'O',
'P', 'E', 'R']) // This is a positive test case
        expect(actual.usernameCharacters).toContain('Q') // toContain is a matcher
that checks if the array contains the expected value
    })
})
```

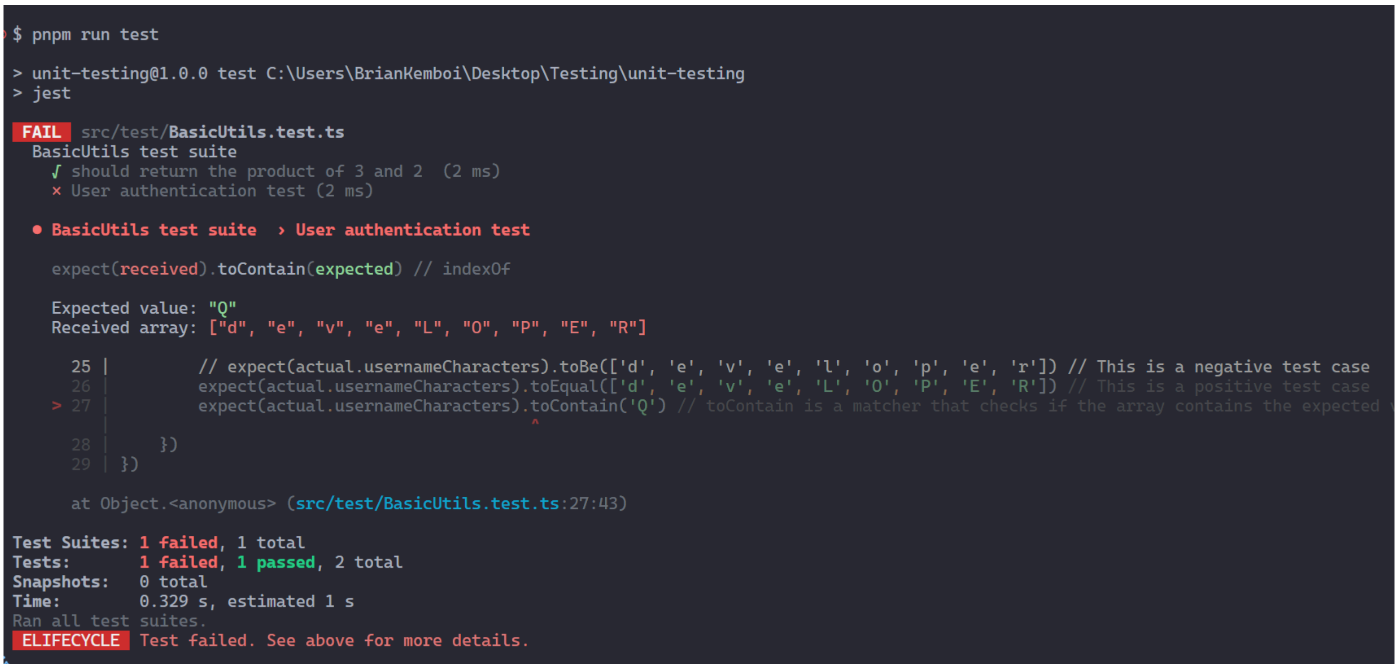
With the above demo, you have known how to write a proper test using AAA phases.

NOTE ‼️ ‼️

We are not yet there yet, while using the above way to writeour tests, we are not separating tests. Whenever a matcher fails, the entire test will fail and this is not the best practice. Therefore, we need to understand the FIRST-U Principle

`expect(actual.usernameCharacters).toContain('Q')`

This line makes the test fail and the entire test registers a fail



```
$ pnpm run test

> unit-testing@1.0.0 test C:\Users\BrianKemboi\Desktop\Testing\unit-testing
> jest

 FAIL  src/test/BasicUtils.test.ts
  BasicUtils test suite
    √ should return the product of 3 and 2  (2 ms)
    × User authentication test (2 ms)

  ● BasicUtils test suite › User authentication test

    expect(received).toContain(expected) // indexOf

    Expected value: "Q"
    Received array: ["d", "e", "v", "e", "L", "O", "P", "E", "R"]

      25 |         // expect(actual.usernameCharacters).toBe(['d', 'e', 'v', 'e', 'l', 'o', 'p', 'e', 'r']) // This is a negative test case
      26 |         expect(actual.usernameCharacters).toEqual(['d', 'e', 'v', 'e', 'L', 'O', 'P', 'E', 'R']) // This is a positive test case
    > 27 |         expect(actual.usernameCharacters).toContain('Q') // toContain is a matcher that checks if the array contains the expected
         |                                           ^
      28 |     })
      29 | })

      at Object.<anonymous> (src/test/BasicUtils.test.ts:27:43)

Test Suites: 1 failed, 1 total
Tests:       1 failed, 1 passed, 2 total
Snapshots:   0 total
Time:        0.329 s, estimated 1 s
Ran all test suites.
 ELIFECYCLE  Test failed. See above for more details.
```

- Some Hacks is using ***it.only*** to skip running other tests

FIRST-U Principle

To write a good unit test, we should apply the FIRST-U

1. F - Fast: Unit test should be fast
2. I - Independent: Should not depend on other test cases
3. R - Repeatable: should produce the same result each time you run it
4. S - Self-validating: determine if the actual output is according to the expected. No manual interpretation
5. T - Timely: It can be written anytime but TDD is a good practice
6. U - Understandable: clear and easy to understand

Make the following changes on BasicUtils.test.ts

```
import { authenticateUser, product } from "../app/BasicUtils"

// 😁😁 A better way but not yet
```

```
describe("BasicUtils test suite ", () => {
    it("should return the product of 3 and 2 ", () => {
        const actual = product(3, 2)
        expect(actual).toBe(6)
    })

    // TODO - Add a describe here - added only for testing
    describe.only('User authentication test', () => {

        it("Return the lowercase username of a valid user", () => {
            // Arrange
            const sut = authenticateUser // System Under Test
            // Act
            const actual = sut("deveLOPER", "dev") // System Under Test
            // Assert
            expect(actual.usernameToLower).toBe("developer")
        });

        it("Return the username characters of a valid user", () => {
            // Arrange
            const sut = authenticateUser // System Under Test
            // Act
            const actual = sut("deveLOPER", "dev") // System Under Test
            // Assert
            expect(actual.usernameCharacters).toEqual(['d', 'e', 'v', 'e', 'L',
'O', 'P', 'E', 'R'])
        });

        // what is a user enters -   'L', 'O', 'P', 'E', 'R', 'd', 'e', 'v', 'e',,
        it("Return username characters contsains a valid user", () => {
            // Arrange
            const sut = authenticateUser // System Under Test
            // Act
            const actual = sut("deveLOPER", "dev") // System Under Test
            // Assert
            expect(actual.usernameCharacters).toEqual(
                expect.arrayContaining(['L', 'O', 'P', 'E', 'R', 'd', 'e', 'v',
'e']));
        });

        // more matchers
        it("Return userDetails as empty object for a valid user", () => {
            // Arrange
            const sut = authenticateUser // System Under Test
            // Act
            const actual = sut("deveLOPER", "dev") // System Under Test
            // Assert
            expect(actual.userDetails).toEqual({}) // This is a positive test case
            expect(actual.isAuthenticated).toBeDefined()
            expect(actual.isAuthenticated).not.toBeUndefined()
            expect(actual.isAuthenticated).toBeTruthy() // This is a positive test
case
            expect(actual.isAuthenticated).not.toBeFalsy() // This is a positive
test case
        });
        // Truthy and Falsy
        it("Return isAuthenticated as true for a valid user", () => {
            // Arrange
            const sut = authenticateUser // System Under Test
            // Act
            const actual = sut("deveLOPER", "dev") // System Under Test
            // Assert
            expect(actual.isAuthenticated).toBeTruthy() // This is a positive test
case
            expect(actual.isAuthenticated).not.toBeFalsy() // This is a positive
test case
        });
    })
})
```

JEST hooks

Setup and Tear Down are the most common hooks.

Setup runs before a test runs example:

```
// setup
beforeEach(() => {
            console.log("Setup is here");
        })
```

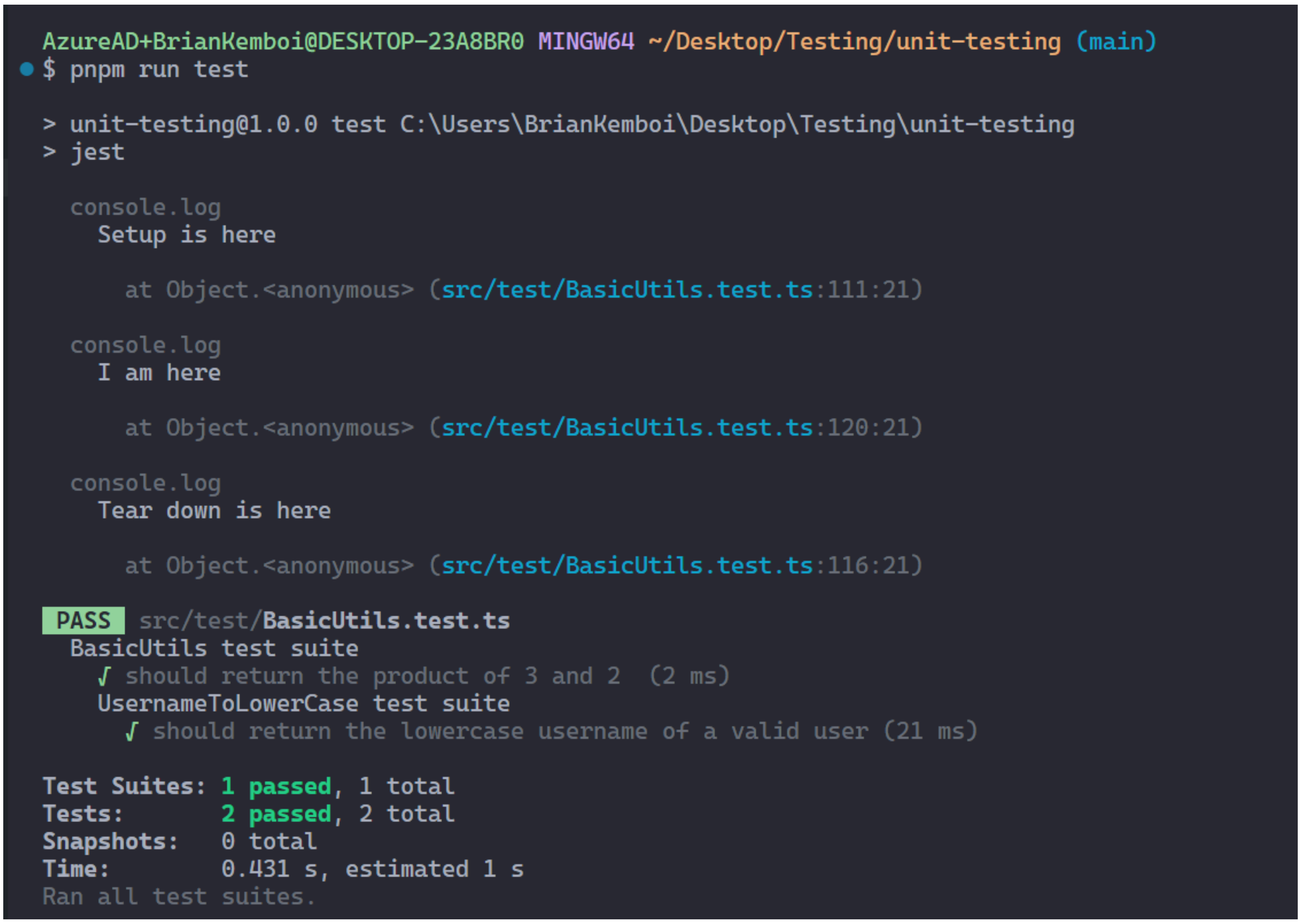
Teardown runs after a test is complete

```
// teardown
        afterEach(() => {
            console.log("Tear down is here");
        })
```

Illustration, write another describe in ***BasicUtils.test.ts***

```
  describe("UsernameToLowerCase test suite ", () => {
        // setup
        let sut: UserNameToLowerCase
        beforeEach(() => {
            console.log("Setup is here");
            sut = new UserNameToLowerCase()
        })
        // teardown
        afterEach(() => {
            console.log("Tear down is here");
        })

        it("should return the lowercase username of a valid user", () => {
            const actual = sut.toLower("Bob");
            console.log("I am here");
            expect(actual).toBe("bob")
        })
    })
```

The output of the above hooks simulates how we can write test without having to repeat outselves. We shall use ***aftereach* **hook when we shall be interacting with the database



```
AzureAD+BrianKemboi@DESKTOP-23A8BR0 MINGW64 ~/Desktop/Testing/unit-testing (main)
$ pnpm run test

> unit-testing@1.0.0 test C:\Users\BrianKemboi\Desktop\Testing\unit-testing
> jest

  console.log
    Setup is here

      at Object.<anonymous> (src/test/BasicUtils.test.ts:111:21)

  console.log
    I am here

      at Object.<anonymous> (src/test/BasicUtils.test.ts:120:21)

  console.log
    Tear down is here

      at Object.<anonymous> (src/test/BasicUtils.test.ts:116:21)

 PASS  src/test/BasicUtils.test.ts
  BasicUtils test suite
    √ should return the product of 3 and 2  (2 ms)
    UsernameToLowerCase test suite
      √ should return the lowercase username of a valid user (21 ms)

Test Suites: 1 passed, 1 total
Tests:       2 passed, 2 total
Snapshots:   0 total
Time:        0.431 s, estimated 1 s
Ran all test suites.
```

Using the Hooks, lets test for an Error

Create a class **UserNameToLowerCase** in ***BasicUtils.ts***

```
export class UserNameToLowerCase {
    public toLower(username: string): string {
        if (username === "") {
            throw new Error("Username cannot be empty");
        }
```

```
            return username.toLowerCase();
        }
    }
```

Write a test to test the suite of converting a username to lowercase in ***BasicUtils.test.ts***

```
    describe("UsernameToLowerCase test suite ", () => {
        // setup
        let sut: UserNameToLowerCase
        beforeEach(() => {
            console.log("Setup is here");
            sut = new UserNameToLowerCase()
        })

        it("should return the lowercase username of a valid user", () => {
            const actual = sut.toLower("Bob");
            console.log("I am here");
            expect(actual).toBe("bob")
        })

        it('should throw an error when username is empty', () => {
            expect(() => {
                sut.toLower("")
            }).toThrow("Username cannot be empty")

            // or
            expect(() => sut.toLower("")).toThrow()
        })
    })
```

- describe.only - will run only this test case
- describe.skip - will skip this test case
- it.only - will run only this test case
- it.skip - will skip this test case
- it.todo - will create a test case but not run it
- fit (only)- will run only this test case, works with describe and it meaning it will run only this test case
- xit - will skip this test case. works with describe and it meaning it will skip this test case

Parameterized Testing

Assuming that you want to test more than one input, it will be tiresome to repeat the test manually. For this, Parameterized testing will help.

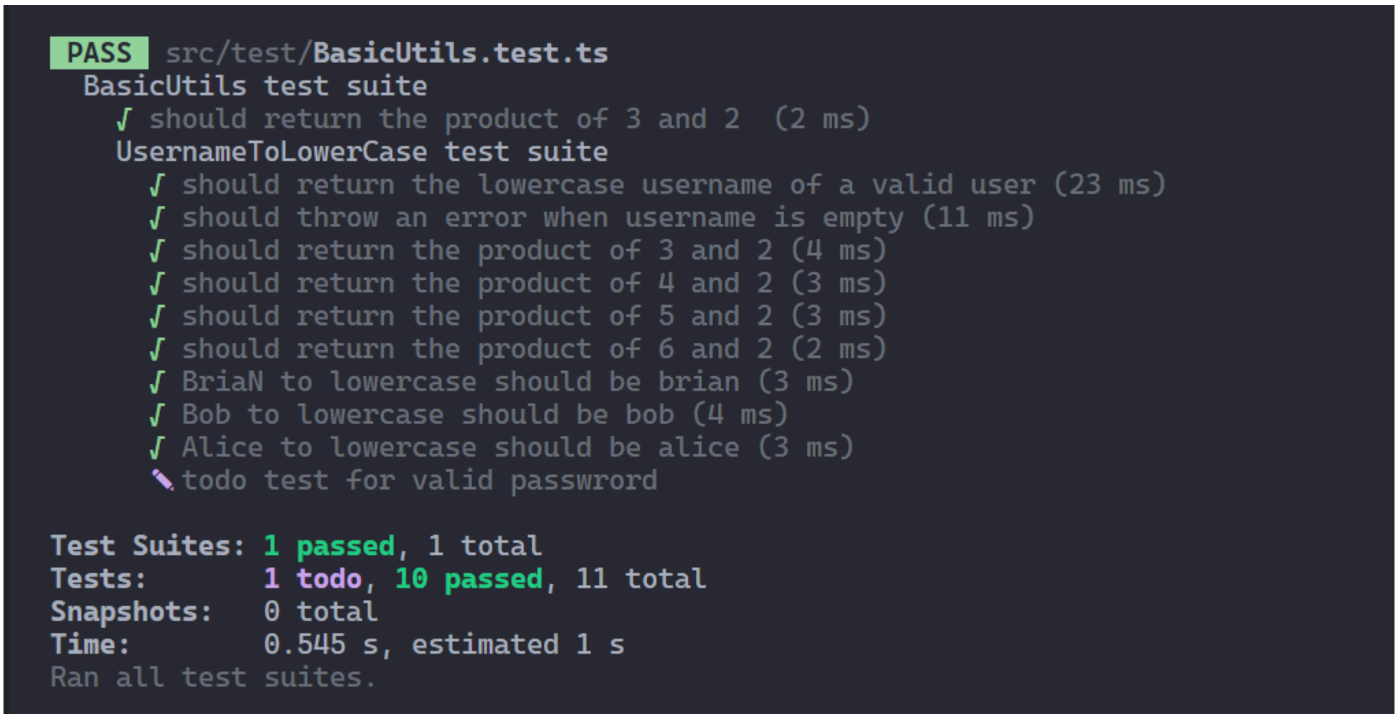
```
 it.each([
            [3, 2, 6],
            [4, 2, 8],
            [5, 2, 10],
            [6, 2, 12],
        ])("should return the product of %i and %i", (a: number, b: number,
expected: number) => {
            const actual = product(a, b)
            expect(actual).toBe(expected)
        })
```

Parameterized Strings

Write the Parameterized String Test

```
it.each([
            { input: 'BriaN', expected: 'brian' },
            { input: 'Bob', expected: 'bob' },
            { input: 'Alice', expected: 'alice' },
        ])('$input to lowercase should be $expected', ({ input, expected }) => {
            const actual = sut.toLower(input)
            expect(actual).toBe(expected)
        })
```

Whenever you run your code, you should expect such an output:



```
 PASS  src/test/BasicUtils.test.ts
  BasicUtils test suite
    √ should return the product of 3 and 2  (2 ms)
    UsernameToLowerCase test suite
      √ should return the lowercase username of a valid user (23 ms)
      √ should throw an error when username is empty (11 ms)
      √ should return the product of 3 and 2 (4 ms)
      √ should return the product of 4 and 2 (3 ms)
      √ should return the product of 5 and 2 (3 ms)
      √ should return the product of 6 and 2 (2 ms)
      √ BriaN to lowercase should be brian (3 ms)
      √ Bob to lowercase should be bob (4 ms)
      √ Alice to lowercase should be alice (3 ms)
      ✎ todo test for valid passwrord

Test Suites: 1 passed, 1 total
Tests:       1 todo, 10 passed, 11 total
Snapshots:   0 total
Time:        0.545 s, estimated 1 s
Ran all test suites.
```

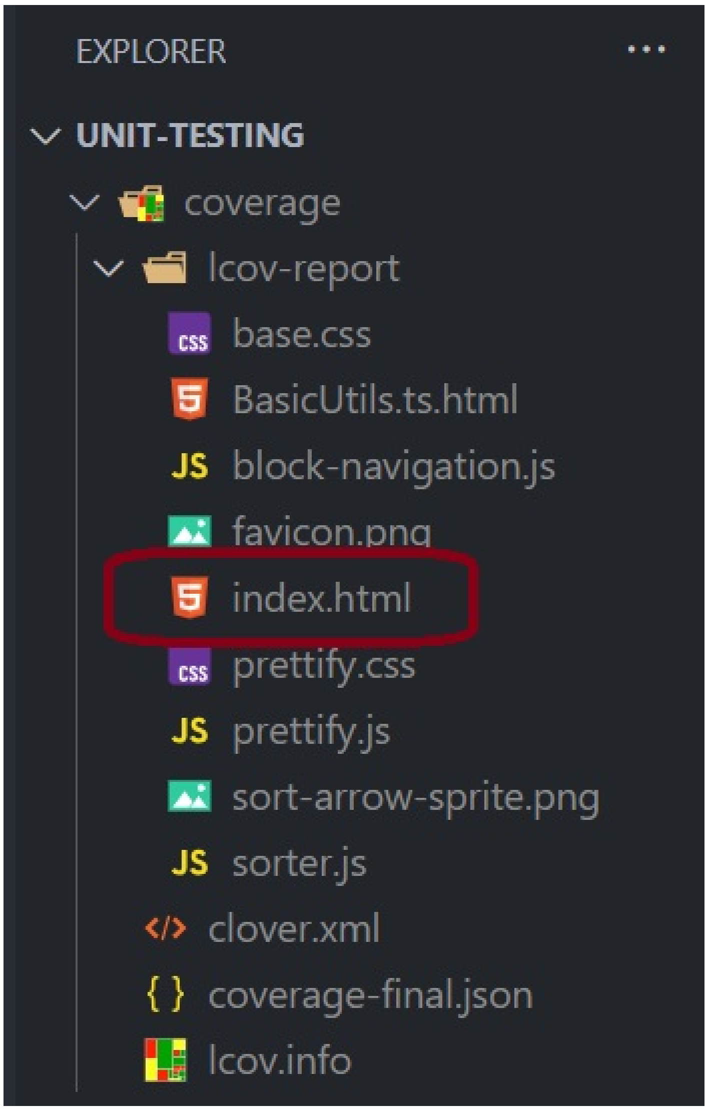
Coverage

Used to report the percentage of lines your code was tested

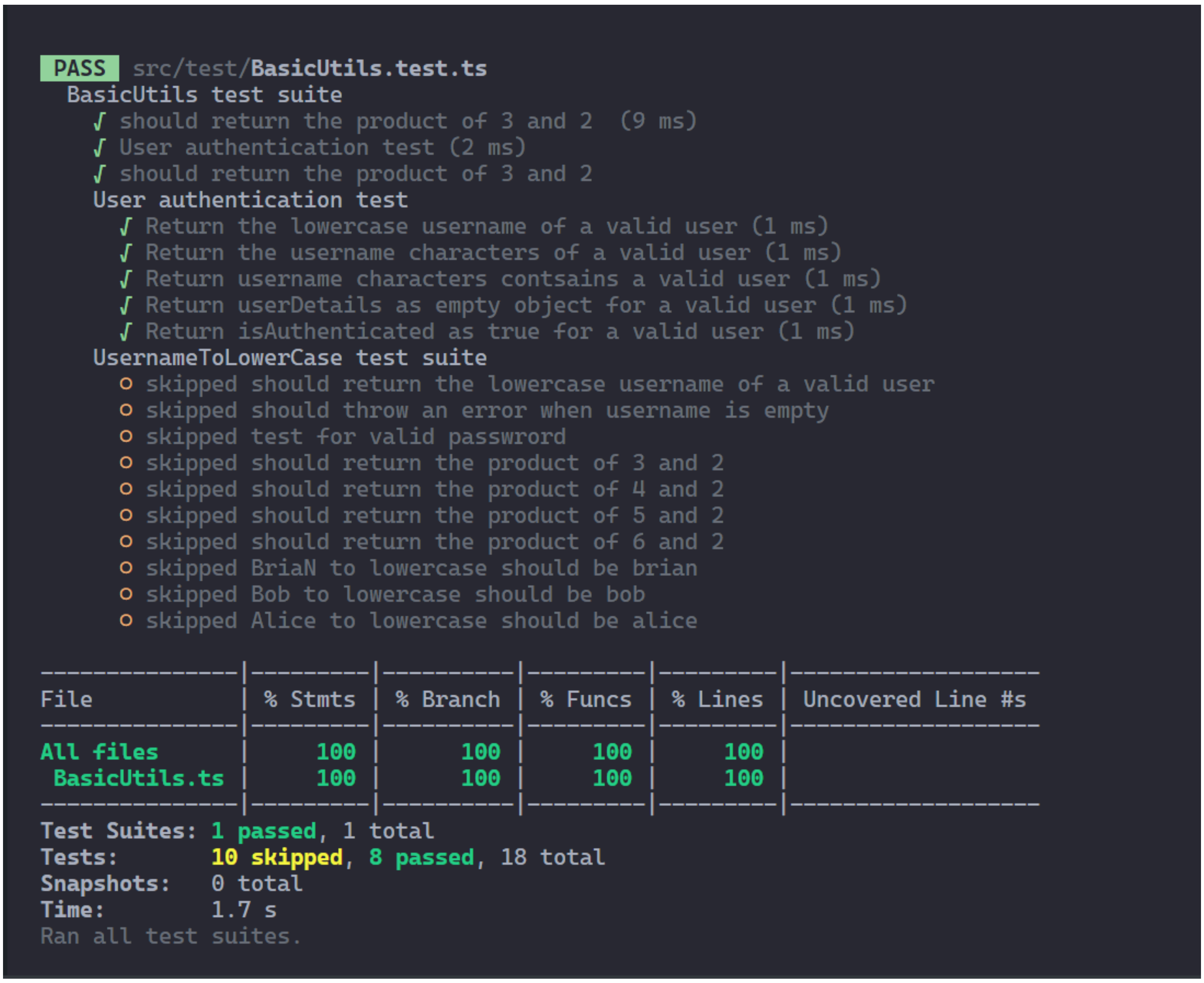
Use the following comment to skip test on most common functions

```
/* istanbul ignore next */
```

The generated coverage has index.html file with the test report.



Coverage report on the terminal



```
 PASS  src/test/BasicUtils.test.ts
  BasicUtils test suite
    √ should return the product of 3 and 2  (9 ms)
    √ User authentication test (2 ms)
    √ should return the product of 3 and 2
    User authentication test
      √ Return the lowercase username of a valid user (1 ms)
      √ Return the username characters of a valid user (1 ms)
      √ Return username characters contsains a valid user (1 ms)
      √ Return userDetails as empty object for a valid user (1 ms)
      √ Return isAuthenticated as true for a valid user (1 ms)
    UsernameToLowerCase test suite
      o skipped should return the lowercase username of a valid user
      o skipped should throw an error when username is empty
      o skipped test for valid passwrord
      o skipped should return the product of 3 and 2
      o skipped should return the product of 4 and 2
      o skipped should return the product of 5 and 2
      o skipped should return the product of 6 and 2
      o skipped BriaN to lowercase should be brian
      o skipped Bob to lowercase should be bob
      o skipped Alice to lowercase should be alice

---------------|---------|----------|---------|---------|-------------------
File           | % Stmts | % Branch | % Funcs | % Lines | Uncovered Line #s
---------------|---------|----------|---------|---------|-------------------
All files      |     100 |      100 |     100 |     100 |
 BasicUtils.ts |     100 |      100 |     100 |     100 |
---------------|---------|----------|---------|---------|-------------------
Test Suites: 1 passed, 1 total
Tests:       10 skipped, 8 passed, 18 total
Snapshots:   0 total
Time:        1.7 s
Ran all test suites.
```

Detailed coverage report on the webpage

All files BasicUtils.ts

100% Statements 6/6 **100%** Branches 2/2 **100%** Functions 2/2 **100%** Lines 6/6

Press *n* or *j* to go to the next uncovered block, *b*, *p* or *k* for the previous block.

```
    import { IAuthData } from "./authData";

    // This function takes two numbers and returns their sum
1x  export function product(a: number, b: number): number {
2x      return a * b;
    }

    // This function simulates an authentication process
1x  export function authenticateUser(username: string, password: string): IAuthData {
        // simulate an authentication process
6x      const authStatus = username === "deveLOPER" && password === "dev";
6x      return {
            usernameToLower: username.toLowerCase(),
            usernameCharacters: username.split(''),
            userDetails: {},
            isAuthenticated: authStatus,
        }
    }
    /* istanbul ignore next */
1x  export class UserNameToLowerCase {
        public toLower(username: string): string {
            if (username === "") {
                throw new Error("Username cannot be empty");
            }
            return username.toLowerCase();
        }
    }

```