Introduction to TypeScript

Our Team

Eric Bermúdez Hernández

eric.bermudez.16@ull.edu.es

Adrián Alejandro Padrón López

adrian.padron.30@ull.edu.es

Diego Rodríguez Martín

diego.rodriguez.28@ull.edu.es

Index

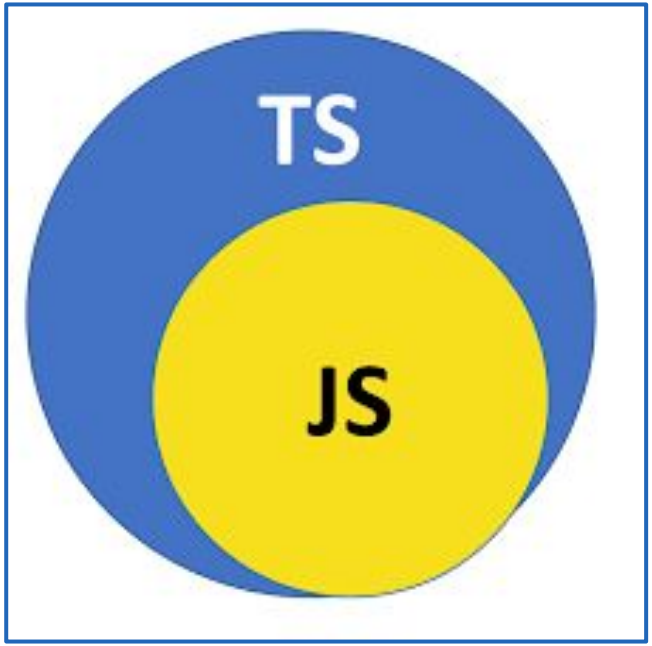
01 Introduction

What is Typescript?

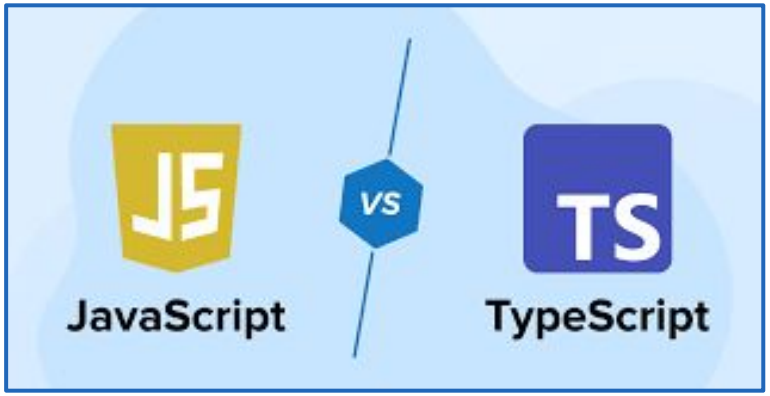
TypeScript is a programming language that comes as a superset of JavaScript

This means that any valid JavaScript code is also valid TypeScript code

Adds additional features and tools that improve the development experience



Main differences



The main differences between Typescript and Javascript are:

1. Typing
2. Object-oriented programming
3. Improved development tools
4. Greater scalability and maintainability

Benefits of using TypeScript

1. Early error detection
2. Better readability and documentation
3. Greater producti
4. Greater secu
5. JavaScript support

02

Installation

¿What do we need?

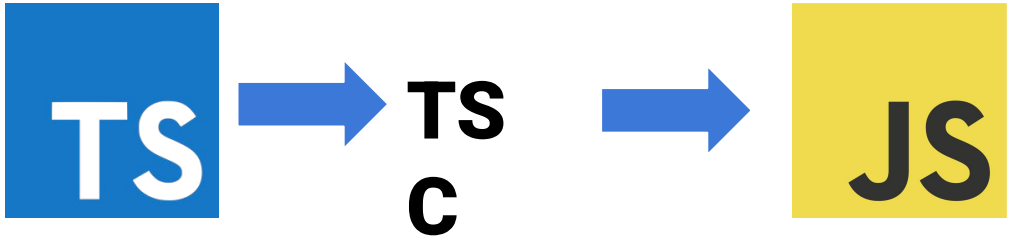
1. Install Node.js and npm/pnpm

Node version must be greater than **14.17**

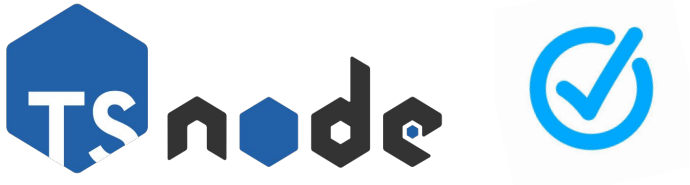
2. Install a TypeScript compiler

We have two options to compile TS!

1. With `tsc`

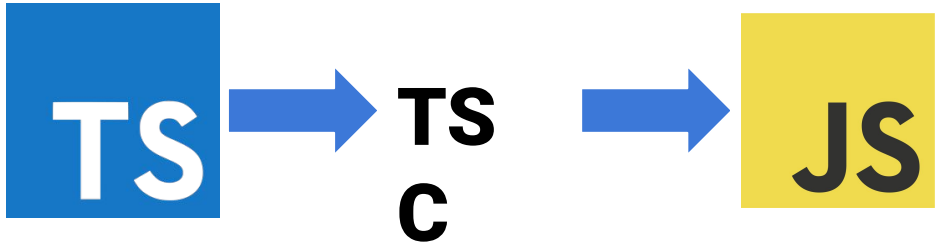


2. With `ts-node`



First one, `tsc`

- Official TS compiler



- Translates TS code into JS code, generating a new .js file

- Check static types for errors before executing the code

How to install `tsc`

➔ Execute the following command:

```
npm install -g typescript
```

➔ Check the version with:

```
tsc -v
```

Second one, `ts-node`

- ➔ Compiles and runs TypeScript code directly
- ➔ More comfortable than tsc

How to install `ts-node`

➔ Execute the following command:

```
npm install -g ts-node
```

➔ Check the version with:

```
ts-node -v
```

Starting a TS project

We can generate the package.json using the following command:

```
npm init -y
```

→ But now we need a configuration file for TS!

tsconfig file

- Configuration file for TypeScript
- Defines how to compile the code
- We can customize this file with many options
- An usual TSconfig.json
- tsconfig.json documentation

03

Basic Concepts

Types

- string
- number
- boolean
- array
- object
- tuple: 2 or more elements of different type
- enum: list of constants

```
// Example for tuples
function main() {
  let tuple: [string, number] = ['hello', 10];
}
```

Types

- any: lets every type. Avoid using: breaks the strongly typed feature
- unknown: similar like any but it can’t be assigned to any type unlike any.
- never: it never should be a type. In a function that returns a never value, we are specifying that function should never return anything.
- void: no value

Variable Declaration

- let
- const
- NEVER use var to declare a variable

Should I always specify the type?

- Some programmers does not specify the type in cases where it can be assumed easily
- Our advice: Always declare with type specification
- Even more in:
  - Functions
  - Objects

```
function dummyFunction(): void {
  const user: { name: string; age: number } = {
    name: 'Diego', age: 20
  };
}
```

Why NOT using *var*?

- var has function scope instead of block scope
- This means it ignores the block (like if {}, for {}) in which it is wrapped

```
function showFunctionScopeProblem(): void {
  var age: number = 20;
  if (age >= 18) {
    var isAdult: boolean = true;
  }
  console.log(isAdult); // true
}
```

Why NOT using *var*?

- var allows redeclarations
- This makes the code very confusing, also causing inconsistencies and unexpected errors

```
function showVarProblem(): void {
  var userName: string = 'Diego';
  var userName: string = 'Adrian';
  console.log(userName);
}
```

Why NOT using *var*?

- var implies hoisting what means the declarations go to the start of the scope without initialization
- This may produce confusing errors, because the value will be undefined instead of throwing an error

```
function showHoisitingProblem(): void {
  console.log(age); // undefined
  var age: number = 20;
}
```

Conditionals: if-else

```
// if-else statement
let age: number = 20;
if (age >= 18) {
  console.log('You are an adult');
} else {
  console.log('You are a minor');
}
```

Conditionals: Switch Statement

```
// Switch statement
let color: string = 'red';
switch (color) {
  case 'red':
    console.log('Color is red');
    break;
  case 'blue':
    console.log('Color is blue');
    break;
  default:
    console.log('Color is not red or blue');
    break;
}
```

Conditionals: Ternary Operator

```
// Ternary Operator
function showAgeMessage(age: number): void {
  let height: number = 180; // height in centimeters
  let message: string =  height >= 185 ? 'You are tall!' : 'You are not tall!';
  console.log(message); // "You're not tall!"
}
```

Loops: for, for of

```
// Classic for loop
function myClassicForLoop() {
  console.log('Classic for loop');
  for (let i = 0; i < 5; i++) {
    console.log(i);
  }
}
```

```
// for-in loop
function myForInLoop() {
  console.log('For-in loop');
  let colors: string[] = ['red', 'blue', 'green'];
  for (let index in colors) {
    console.log(colors[index]);
  }
}
```

Loops: for in

```
// for-in loop
function myForInLoop() {
  console.log('For-in loop');
  let person = { name: 'Diego', age: 20 };
  for (let key in person) {
    console.log(`${key}: ${person[key]}`);
  }
}
```

Loops: forEach

```
// ForEach loop
function myForEachLoop() {
    console.log('ForEach loop');
    let numbers = [1, 2, 3, 4, 5];
    numbers.forEach((number) => {
        console.log(number);
    });
}
```

Loops: while

```
// while loop
function myWhileLoop() {
  console.log('While loop');
  let i: number = 0;
  while (i < 5) {
    console.log(i);
    i++;
  }
}
```

Functions: Declared Functions

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

function main(): void {
  console.log(greet('Diego'));
}
```

Functions: Anonymous Functions

```
// Anonymous functions
let sum = function (left: number, right: number): number {
  return left + right;
}

function main(): void {
  console.log(sum(2, 3));
}
```

Functions: Arrow Functions

```
// Arrow function
const factorial = (number: number): number => {
  if (number === 0) {
    return 1;
  }
  return number * factorial(number - 1);
}
```

Functions: Optional Parameters

- Important: Optional parameters must be always after the required ones

```
// Optional Parameters
function greetOptional(name: string, id?: number): string {
  if (id) {
    return `Hello, ${name}! Your id is ${id}`;
  }
  return `Hello, ${name}!`;
}
```

04

Remarkable Features

Type Assertions

- Allows you to change the type of an specified value, to be treated like that
- You can use as or < > as well

```
const element = document.querySelector('input[type="text"]');
console.log(element.value);
```

- element is an Element type value
- Does not have *value* property

```
const input = element as HTMLInputElement;
```

```
console.log((<HTMLInputElement>element).value);
```

Type Assertion Errors

- Compile-Time Errors

```
// Compilation Time Error
function compileTimeError(): void {
  let price: string = '100';
  let numberPrice: number = price as number;
}
```

- Runtime errors: if element is not an input element

```
let element = document.querySelector('#name');
let input = element as HTMLInputElement;
console.log(input.value.length);
```

Non Null Assertion

- ! operator
- Avoiding unnecessary null and undefined checks in our code
- Only use this when we definitely know the variable or expression can't be null or undefined

From this

```
function duplicate(text: string | null): string {
  if (text === null || text === undefined) {
    text = '';
  }
  return text.concat(text);
}
```

To this

```
function nonNullAssertion(text: string | null): string {
  return text!.concat(text!);
}
```

Optional Chaining

- Access an object property or calls a function
- If is undefined or null -> short circuits and evaluates to undefined instead of throwing an error
- Shorter and simpler expressions when accessing chained properties when the possibility exists that a reference may be missing

Optional Chaining

```
function main() {
  let object = { first: { second: { third: 'value' } } };
  const nestedProperty = object === null ||
  object === undefined ? undefined : object.first.second.third;

  const nestedPropertyOptionalChaining = object?.first?.second?.third;
}
```

Optional Chaining with Methods

- If custmoMethod is not found, return undefined
- If someInterface may be also null or undefined, use ?. at this point as well

```
const result = someInterface?.customMethod?.();
```

Optional Chaining: Invalid Cases

- Assign to the result of an optional chaining expression
- The constructor of new expressions cannot be an optional chain

```
function invalidCases() {
  const object = { size: 2 };
  object?.size = 3; // Compilation Error

  new Number(10)?.toFixed(); // Compilation Error
}
```

Nullish coalescing operator

- If left is null or undefined -> return right. Otherwise -> return left
- It is used to give default values
- “Special case” of OR (||) operator. While OR operator returns right operand if left operand is any falsy value, ?? operator returns it only if it's a null or undefined value

Nullish coalescing operator

- Usage: if you treat 0 or “” as valid values, you may use coalescing operator instead because these are “falsy” values

- It is important that it is not possible to combine it with && and || operators without parentheses

Nullish coalescing operator

```
function differenceWithOr(): void {
  const myText: string = '';

  const noFalsyText = myText || 'Default Text';
  console.log(noFalsyText); // Default Text

  const preservingFalsyText = myText ?? 'Default Text';
  console.log(preservingFalsyText); // ''
}
```

Relationship with Optional Chaining Operator

```
function realtionshipWithOptionalChaining(): void {
  const foo = {
    someProperty: 'hi'
  };

  console.log(foo.someProperty?.toUpperCase() ?? 'Default'); // HI
  console.log(foo.someOtherProperty?.toUpperCase() ?? 'Default');
  // There is no property
}
```

05

OOP

¿What is a class?

- Is a template to create objects
- Defines the properties(data) and methods(actions) for objects
- Used to organize and structure the code

Differences between C++ and TS classes

→ In TS:

- Creates constructor with the keyword `constructor`
- `readonly` properties
- You cannot overload constructors
- Getters and Setters are created with the keyword `get` and `set` respectively

Differences between C++ and TS classes

- Public visibility by default for everything
- `extends` keyword for inheritance
- Abstract classes with keyword `abstract` both for the definition of the class and for the methods
- Properties at the beginning of the class (Google style)
- Classes do not end with semicolon `;`

Differences between C++ and TS classes

- All members of a TypeScript class must specify their access level using public, private, or protected
  Example: Visibility in TS classes

- Methods cannot be defined in a class and implemented outside of it, they must be fully implemented within the class

Parameter Properties

- In TypeScript, adding an access modifier to a constructor parameter automatically creates a class property with the same name and assigns it the given value

  → Example with parameter properties:
  With parameter properties

  → Example without parameter properties:

  Without parameter properties

Keyword `this`

- Is a reference to the current object on which the code is being executed
- Inside a TypeScript class, it is used to access properties and methods of the actual object

Example of a use of this

readonly properties

- This type of properties cannot be changed!

Example of this:

readonly properties example

- There are differences between readonly and const properties

Differences between readonly and const

readonly	const
• When we assign a value we cannot modify it	• We need to assign a value when we declare it
• Is used for properties within the members of a class	• It is used for variables

Constructor overloading

- You can only implement one constructor
- But we can simulate this with optional parameters in the constructor

→ Example:

Simulating constructor overloading

Getters and Setters

- Getters and Setters are created with the keyword `get` and `set` respectively

- Although these reserved words exist, we are going to ignore them and use normal methods that return and modify values

- Example of getters and setters with the keywords in a class: Getters and Setters in a class

Static members

- Useful when you need functionalities that are related with the class and not with a specific object
  Some common examples are:
  - Constants: Values that are shared by all instances of a class
  - Counters: Variables that keep track of the number of instances created

→ Example of a class with a static member:

Static members

Class inheritance

- We need the keyword `extends` for class inheritance

→ Example of simple inheritance:

Simple Inheritance

- TS not supports multiple inheritance, but it can be simulated with interfaces

→ Example of a simulation of multiple inheritance:

Simulation multiple inheritance

Keyword `super()`

- The `super()` keyword in TypeScript calls the parent class constructor, ensuring proper initialization before adding subclass functionality

- It is required to call `super()` in the constructor of a subclass before using the keyword ‘this’

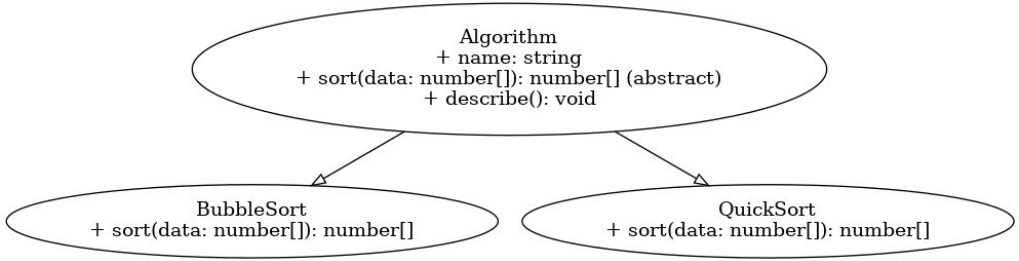
- If the parent class has a constructor with parameters, `super()` should receive those values

- `super`.method() can be used to call methods of the parent class
  Use example of `super()`: `super()` use example

Abstract classes

- Templates for other classes
- They cannot be instantiated directly
- They are used when several classes share a common structure, but each one needs to implement its own version of certain methods

Abstract classes



- We use the keyword `abstract` before the keyword `class`
- They are defined with abstract and have no implementation in the base class. They must be implemented in the derived classes
- An abstract class can have concrete methods and properties that will be inherited by its subclasses

→ Example of an abstract class: Abstract classes

Templates in TS classes

- Allow classes to work with multiple data types
- Makes code more reusable and flexible
- An example of templates with classes:
  Templates with classes

06

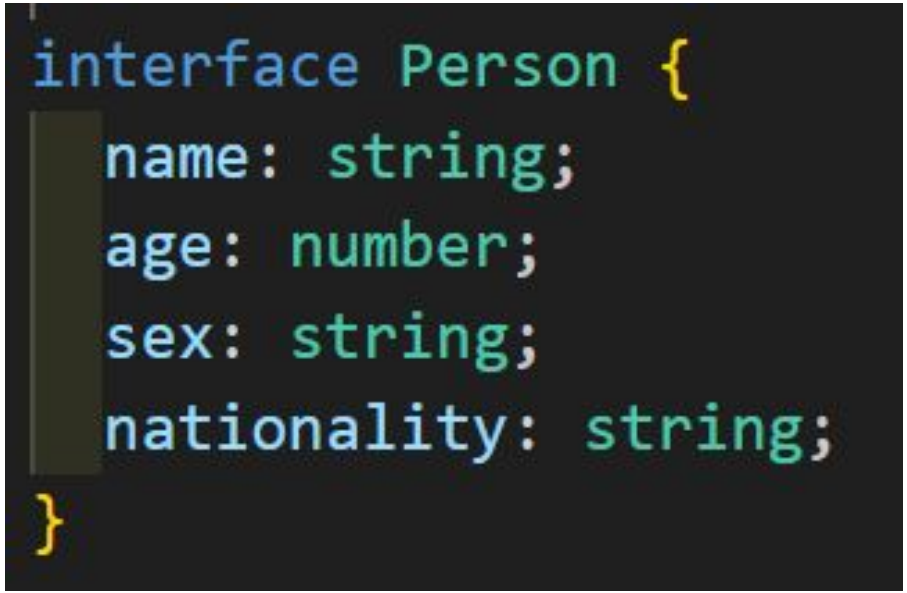
Interfaces

Interfaces

Interfaces in TypeScript are a fundamental tool for defining the shape that objects in your code should have

They act as contracts that specify what properties and methods the objects that implement them must have

It should be noted that everything that is within an interface is public



Interface extension

```typescript
interface BasicAddress {
  name?: string;
  street: string;
  city: string;
  country: string;
  postalCode: string;
}
```

```typescript
let address: AddressWithUnit = {
  name: 'John Doe',
  street: '123 Main Street',
  city: 'Springfield',
  country: 'USA',
  postalCode: '12345',
  unit: '456',
};
```

```typescript
interface AddressWithUnit extends BasicAddress {
  unit: string;
}
```

Intersection types

```
interface Colorful {
  color: string;
}

interface Circle {
  radius: number;
}

type ColorfulCircle = Colorful & Circle;
```

Interface extension VS Intersection type

We observe two ways of combining types that are similar, but are actually subtly different. The main difference between the two is how conflicts are handled

Interface extension:

- TypeScript attempts to merge properties if they are compatible
- If two interfaces have a property with the same name but different types, an error occurs
- Recommended for defining complex structures

Intersection types:

- No error occurs if properties have the same name but different types
- TypeScript merges the types
- Unexpected results if the types are incompatible

Abstract classes

- Mix between already implemented methods and abstract methods.
- A class can only inherit / extend a single abstract class.
- They have all available types of visibility.
- They can have a constructor.

Interfaces

- They are completely abstract.
- A class can implement multiple interfaces.
- They act as contracts.
- Everything is public.

07

Modules

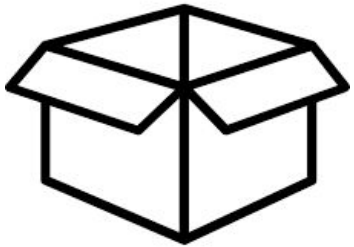
What is a module?

Modules in TypeScript are a fundamental tool for organizing and structuring code in projects of any size

They allow the code to be divided into logical and reusable units, which makes it easier to understand, maintain and scalable

Reasons why you should use modules:

- Better code organization
- Avoid name collisions
- Code reuse
- Better performance



Types of modules

CommonJS

- First widely used module system in JavaScript
- Use “require” to import
- Use “module.exports” to export
- Module loading is synchronous

ES Modules

- Standard for modern modules
- Use “import” to import
- Use “exports” to export
- Module loading is asynchronous

08 Bibliography

Tipos de datos en TypeScript. Nicolás F. Ormeño Rojas - Medium. Disponible en: https://normeno.medium.com/tipos-de-datos-en-typescript-d67482f2da6c

TypeScript Best Practices 2021. Warki Ringoda - Medium. Disponible en: https://medium.com/@warkiringoda/typescript-best-practices-2021-a58aee199661

Type Casting. TypeScript Tutorial. Disponible en: https://www.typescripttutorial.net/typescript-tutorial/type-casting/

Non-Null Assertion Operator. Learn TypeScript. Disponible en: https://learntypescript.dev/07/l2-non-null-assertion-operator

Nullish Coalescing Operator (??). MDN Web Docs. Disponible en: https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/Nullish_coalescing

TypeScript 3.7 Release Notes. TypeScript Official Website. Disponible en: https://www.typescriptlang.org/docs/handbook/release-notes/typescript-3-7.html

Optional Chaining (?.). MDN Web Docs. Disponible en: https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/Optional_chaining

Hoisting. MDN Web Docs. Disponible en: https://developer.mozilla.org/es/docs/Glossary/Hoisting

Explain about noImplicitAny in TypeScript. GeeksforGeeks. Disponible en: https://www.geeksforgeeks.org/explain-about-noimplicitany-in-typescript/

tsconfig.json. TypeScript Official Website. Disponible en: https://www.typescriptlang.org/docs/handbook/tsconfig-json.html

¿Qué es TypeScript vs JavaScript?. Profile.es. Disponible en: https://profile.es/blog/que-es-typescript-vs-javascript/

TypeScript vs JavaScript: Similitudes y diferencias. Imagina Formación. Disponible en: https://imaginaformacion.com/tutoriales/typescript-vs-javascript-similitudes-y-diferencias

Entendiendo ES Module y CommonJS: diferencias clave y compatibilidad. NelkoDev. Disponible en: https://nelkodev.com/blog/entendiendo-es-module-y-commonjs-diferencias-clave-y-compatibilidad/

Modules. TypeScript Official Website. Disponible en: https://www.typescriptlang.org/docs/handbook/2/modules.html

tsconfig. TypeScript Official Website. Disponible en: https://www.typescriptlang.org/tsconfig/

CommonJS vs ESM. Lenguaje JS. Disponible en: https://lenguajejs.com/nodejs/fundamentos/commonjs-vs-esm/

THANKS!

Do you have any questions?

Eric Bermúdez Hernández eric.bermudez.16@ull.edu.es
Adrián Alejandro Padrón López adrian.padron.30@ull.edu.es
Diego Rodríguez Martín diego.rodriguez.28@ull.edu.es