



# TypeScript Fundamentals

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.NET

*A static typechecker is a tool run on code before the code itself is run to ensure that the data types will be consistent at runtime.*

*TypeScript is a static typechecker for JavaScript programs.*

[HTTPS://WWW.TYPESCRIPTLANG.ORG/DOCS/HANDBOOK/INTRO.HTML#ABOUT-THIS-HANDBOOK](https://www.typescriptlang.org/docs/handbook/intro.html#about-this-handbook)

# TypeScript –

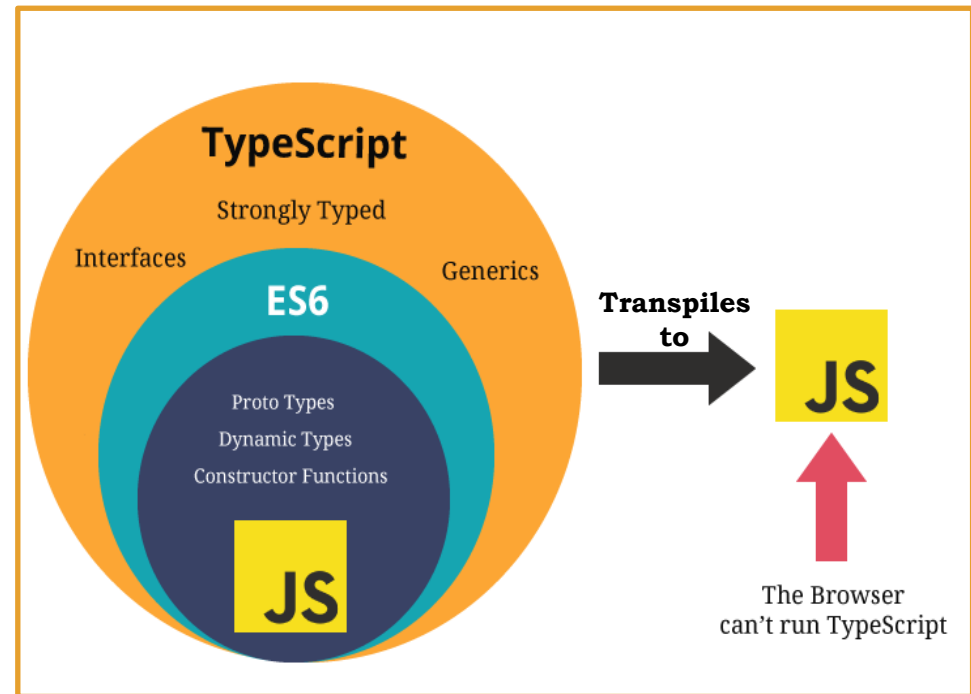
<https://www.typescriptlang.org/docs/handbook/typescript-from-scratch.html>  
<https://angular.io/guide/glossary>

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The relationship between TypeScript (TS) and JavaScript (JS) is unique among modern programming languages.

TypeScript checks JavaScript programs for errors before execution, and does so based on the *kinds of values*, it's a *static type checker*.

TypeScript is a ***typed superset*** of JavaScript. This means that it 'transpiles' to plain JavaScript. TypeScript enforces strict ***typing*** along with other rules. It has classes, modules, ***type*** checking, and interfaces. TypeScript must be ***transpiled*** into JavaScript code to be run.



# TypeScript – Compiling vs Transpiling

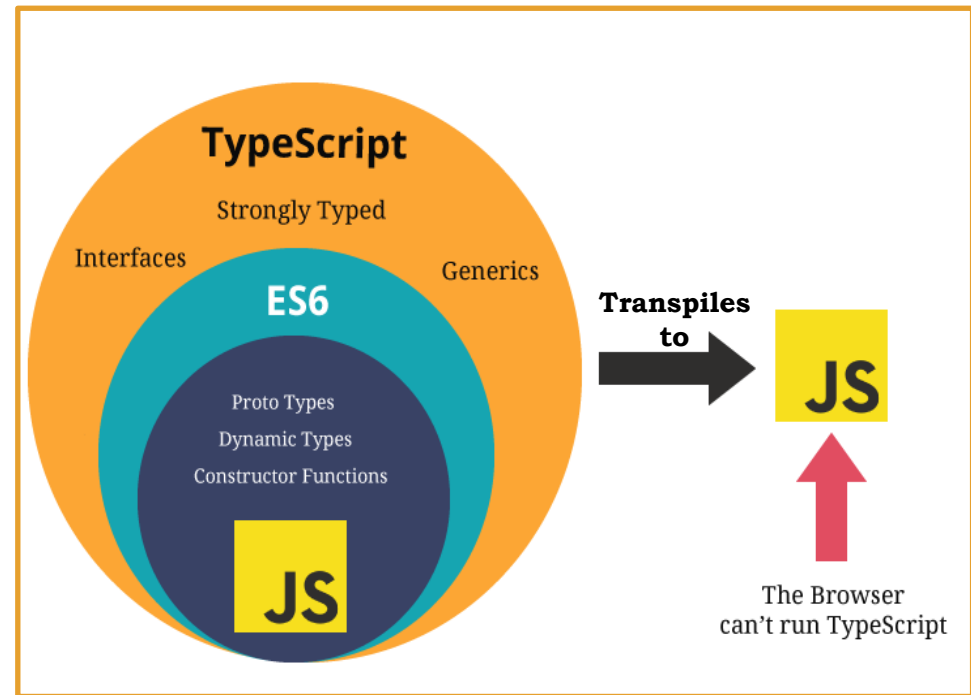
<https://www.stevefenton.co.uk/2012/11/compiling-vs-transpiling/>  
<https://code.visualstudio.com/docs/typescript/typescript-compiling>  
<https://www.typescriptlang.org/play>

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## “Transpiling” vs. “Compiling”

- **Compiling** is the term for taking source code written in one language and transforming into another.
- **Transpiling** is a specific term for taking source code written in one language and transforming into another language that has a similar level of abstraction.

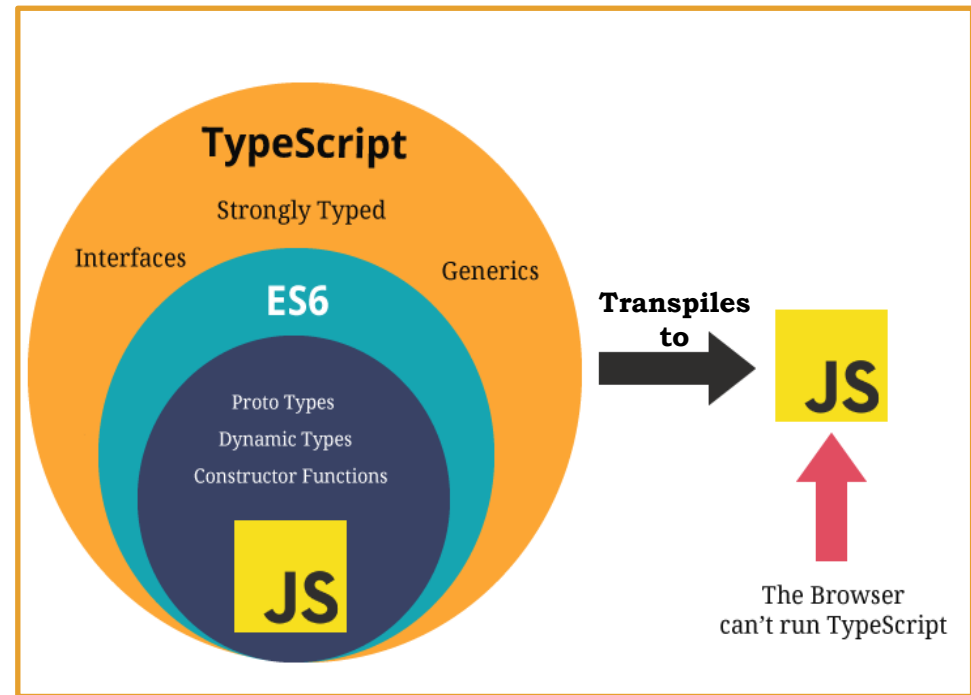
Click [here](#) to see TS and JS compared.



# TypeScript – Overview

<https://www.typescriptlang.org/docs/handbook/typescript-from-scratch.html>  
<https://angular.io/guide/glossary>

- **Static Checking** – The process of detecting errors in code without running it.
- TypeScript is a **Static Type Checking\*** language. It checks a program for errors before it's run based on the types of the values.
- TypeScript is a **Superset** of JavaScript. All JavaScript syntax is legal within a **.ts** (TypeScript) file. You don't need **'use strict'**.
- All JavaScript rules also apply to TypeScript.
- There are no browsers that can run TypeScript. It must be **'transpiled'** to JS.



\*Dynamic Type Checking is when type checking is done at runtime

# TypeScript – Types

<https://www.typescriptlang.org/docs/handbook/typescript-from-scratch.html>

TypeScript adds rules about how different value **types** can be used. **TS** can infer value **types** and will enforce explicit and inferred **types** throughout a program.

TypeScript's **type** system imposes restrictions that are designed to allow correct programs through, while catching as many common errors as possible.

If you move code from a JavaScript file to a TypeScript file, you might see type errors that are legitimate problems with the code, or it may be that TypeScript is being overly conservative.

```
console.log(4 / []);
```

**JS** allows division by an empty set while **TS** will not. The below example in **JS** will print **NaN**, but **TS** will give an error.

```
const user = {  
  firstName: "Angela",  
  lastName: "Davis",  
  role: "Professor"  
}
```

```
console.log(user.name)
```

```
Property 'name' does not exist on type '{ firstName: string;  
lastName: string; role: string; }'.
```



# TypeScript Type Annotations

<https://www.tutorialsteacher.com/typescript/type-annotation>

<https://www.typescriptlang.org/docs/handbook/basic-types.html#type-assertions>

One of the primary benefits of TypeScript over JavaScript is that variable types can be explicitly specified. This is done with **Type Annotations** (Type Assertions).

A **Type Annotation** is placed after the name of the variable (or parameter, property, etc).

TypeScript has all the primitive types of JavaScript plus adds some new ones.

```
var age: number = 32; // number variable
var name: string = "John"; // string variable
var isUpdated: boolean = true; // Boolean variable
```

```
function display(id:number, name:string)
{
    console.log("Id = " + id + ", Name = " + name);
}
```

```
var employee : {
    id: number;
    name: string;
};
```

```
employee = {
    id: 100,
    name : "John"
}
```

Type assertions have two forms. One is the "angle-bracket" syntax:

```
let someValue: any = "this is a string";
let strLength: number = (<string>someValue).length;
```

And the other is the `as`-syntax:

```
let someValue: any = "this is a string";
let strLength: number = (someValue as string).length;
```

# Type Definitions

<https://www.typescriptlang.org/docs/handbook/typescript-in-5-minutes.html#defining-types>

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- **Type Definitions** (also known as **Type Assertions**) are used to define the type for a variable or object.
- TypeScript supports classes and OOP.
- There are two syntaxes for building types: **Interfaces** and **Types**.
- TypeScript infers most **types**, but you can enforce **strict typing** by using an **interface** to declare a class. TypeScript will enforce the **typing** declared in the interface.
- Conventionally, **interface** is used more often. Use **type** when you need to enforce specific properties on objects.

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

```
const user: User = {  
  username: "Hayes",
```

Type '{ username: string; id: number; }' is not assignable to type 'User'.

Object literal may only specify known properties, and 'username' does not exist in type 'User'.

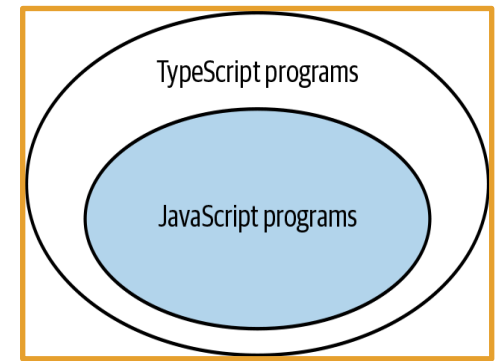
```
  id: 0,  
};
```

The above interface is declared and later an object is instantiated based on the **User** interface. TypeScript will throw an error if a property called username is inserted.



# TypeScript – Erased Types

<https://www.typescriptlang.org/docs/handbook/typescript-from-scratch.html#erased-types>



- Due to Typescript's **type** annotations there are no browsers that can run TypeScript itself.
- TypeScript has its own compiler in order to strip out (erase) TypeScript-specific code so that it can be run as JavaScript.
- There is no persisted **type** information in the resulting **JS** code.
- TypeScript preserves the runtime behavior of JavaScript.
- Typescript never changes the behavior of a program based on the **types** inferred. This means the **type** system has no influence on how a program works once it's running.
- Typescript uses JavaScript libraries so there's no additional Typescript-specific framework to learn.

```
1 // @showEmit
2 function greet(person: string, date: Date) {
3   console.log(`Hello ${person}, today is ${date.toDateString()}!`);
4 }
5
6 greet("Maddison", new Date());
```

**TypeScript**

**JavaScript**

```
"use strict";
// @showEmit
function greet(person, date) {
  console.log(`Hello ${person}, today is ${date.toDateString()}!`);
}
greet("Maddison", new Date());
```

# TypeScript – Primitive Types

<https://www.typescriptlang.org/docs/handbook/typescript-in-5-minutes.html#defining-types>

<https://www.typescriptlang.org/docs/handbook/basic-types.html>

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TypeScript uses all JavaScripts data types. TypeScript extends JavaScript types with a few of its own.

Type	Purpose
<a href="#">any</a>	Allow any type
<a href="#">unknown</a>	Ensure someone using the type declares what the type is. Unknown is the type-safe counterpart of any.
<a href="#">never</a>	Represents the type of values that never occur. EX. <b>never</b> is the return type for a function expression that always throws an exception or one that never returns.
<a href="#">void</a>	A function which returns undefined or has no return value

# Duck-Typing

<https://www.javatpoint.com/typescript-duck-typing>

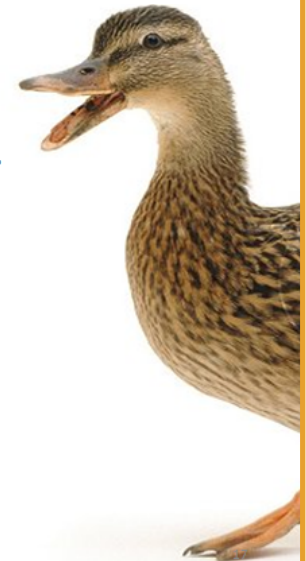
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‘Duck-Typing’ is a method/rule used to check the type compatibility for more complex types.

TypeScript uses ‘duck-typing’ to compare objects. It checks that both objects have the same matching names and types.

If two objects have different properties, functions, or types, the TypeScript compiler will generate a compile-time error.

- If it walks like a duck, flies like a duck, and quacks like a duck...
- Feature selection:
  - Walking
  - Flying
  - Quacking



# TypeScript – Structural Type System

<https://www.typescriptlang.org/docs/handbook/typescript-in-5-minutes.html#structural-type-system>

A core principle of TypeScript is that **type** checking focuses on the shape (structure) that objects have. This is called “**Structural Typing**” (or “**Duck Typing**”). The compiler only checks that at least the variable names required are present in arguments passed and that they match the **types** required.

```
interface Point {  
  x: number;  
  y: number;  
}
```

1. Declare an  
interface object.

```
function printPoint(p: Point) {  
  console.log(`${p.x}, ${p.y}`);  
}
```

2. Define a function  
that takes  
that object.

```
// prints "12, 26"
```

```
const point = { x: 12, y: 26 };  
printPoint(point);
```

3. Instantiate the object.

4. Invoke the function.

```
const point3 = { x: 12, y: 26, z: 89 };  
printPoint(point3); // prints "12, 26"
```

Prints 2 of the  
3 parameters

```
const rect = { x: 33, y: 3, width: 30, height: 80 };  
printPoint(rect); // prints "33, 3"
```

Prints 2 of the  
4 parameters

```
const color = { hex: "#187ABF" };  
  
printPoint(color);
```

ERROR Result

Argument of type '{ hex: string; }' is not assignable to parameter of type 'Point'.

Type '{ hex: string; }' is missing the following properties from type 'Point': x, y

# TypeScript – Composing Types

<https://www.typescriptlang.org/docs/handbook/typescript-in-5-minutes.html#composing-types>

Because JavaScript has loose *typing*, you sometimes may need to verify the *type* of a variable in your TypeScript code at runtime so you can take appropriate action.

Type	Predicate*
string	<code>typeof myString === "string"</code>
number	<code>typeof myNum === "number"</code>
boolean	<code>typeof myBool === "boolean"</code>
undefined	<code>typeof undef === "undefined"</code>
function	<code>typeof myFunc === "function"</code>
array	<code>Array.isArray(a)</code>

A *Union* allows you to declare what the type could be.

```
function wrapInArray(obj: string | string[]) {  
  if (typeof obj === "string") {  
    //      ^ = (parameter) obj: string  
    return [obj];  
  } else {  
    return obj;  
  }  
}
```

\*Often used in a if-else comparison.

# TypeScript Interfaces and Class Types

<https://www.typescriptlang.org/docs/handbook/interfaces.html#class-types>

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Interfaces are a great way to explicitly enforce that a class meets a particular contract for properties and functions.

In TypeScript, Interfaces only describe the public properties and fields of a class.

```
interface ClockInterface {  
    currentTime: Date;  
    setTime(d: Date): void;  
}  
  
class Clock implements ClockInterface {  
    currentTime: Date = new Date();  
    setTime(d: Date) {  
        this.currentTime = d;  
    }  
    constructor(h: number, m: number) {}  
}
```



# TypeScript Classes and Inheritance

<https://www.typescriptlang.org/docs/handbook/classes.html>

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TypeScript developers can use OOP techniques. As in JavaScript, **Abstract** classes in TypeScript may only be inherited.

```
class Greeter {
  greeting: string;
  constructor(message: string) {
    this.greeting = message;
  }
  greet() {
    return "Hello, " + this.greeting;
  }
}

let greeter = new Greeter("world");
```

```
class Animal {
  move(distanceInMeters: number = 0) {
    console.log(`Animal moved ${distanceInMeters}m.`);
  }
}

class Dog extends Animal {
  bark() {
    console.log("Woof! Woof!");
  }
}

const dog = new Dog();
dog.bark();
dog.move(10);
dog.bark();
```

```
abstract class Animal {
  abstract makeSound(): void;
  move(): void {
    console.log("roaming the earth...");
  }
}
```

# TypeScript Inheritance with *this*

<https://www.typescriptlang.org/docs/handbook/classes.html#inheritance>

As in JavaScript, each *derived* class that contains a constructor function must call **super()** to execute the constructor of the *base* class and before any property on **this** is accessed from within the constructor body.

This is a rule that TypeScript will enforce.

```
class Animal {
  name: string;
  constructor(theName: string) {
    this.name = theName;
  }
  move(distanceInMeters: number = 0) {
    console.log(`${this.name} moved ${distanceInMeters}m.`);
  }
}

class Snake extends Animal {
  constructor(name: string) {
    super(name);
  }
  move(distanceInMeters = 5) {
    console.log("Slithering...");
    super.move(distanceInMeters);
  }
}

class Horse extends Animal {
  constructor(name: string) {
    super(name);
  }
  move(distanceInMeters = 45) {
    console.log("Galloping...");
    super.move(distanceInMeters);
  }
}

let sam = new Snake("Sammy the Python");
let tom: Animal = new Horse("Tommy the Palomino");

sam.move();
tom.move(34);
```

# TypeScript – Class Property Modifiers

<https://www.typescriptlang.org/docs/handbook/classes.html#public-private-and-protected-modifiers>

- In TypeScript, each class member is **public** by default.
- TypeScript has a way to declare a **private** member.
- TypeScript supports the new JavaScript syntax for **private** fields.
- **Private** fields cannot be accessed from outside of their containing classes.
- **Protected members** can be accessed from within their class and **deriving** classes.
- A **protected class constructor** means that the class cannot be instantiated outside of its containing class but can be **extended**.
- **Readonly** properties must be initialized at their declaration or in the class constructor.

```
class Animal {  
  private name: string;  
  constructor(theName: string) {  
    this.name = theName;  
  }  
}
```

```
class Animal {  
  #name: string;  
  constructor(theName: string) { this.#name = theName; }  
}
```

```
class Person {  
  protected name: string;  
  protected constructor(theName: string) {  
    this.name = theName;  
  }  
}  
  
// Employee can extend Person  
class Employee extends Person {  
  private department: string;  
  
  constructor(name: string, department: string) {  
    super(name);  
    this.department = department;  
  }  
  
  public getElevatorPitch() {  
    return `Hello, my name is ${this.name} and I work in ${this.department}.`;  
  }  
}  
  
let howard = new Employee("Howard", "Sales");  
let john = new Person("John"); // Error: The 'Person' constructor is protected
```

# TypeScript – Static Class Properties

<https://www.typescriptlang.org/docs/handbook/classes.html#static-properties>

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**Static** members of a class are only accessible on the class itself. Not on the instances.

Each class instance accesses this shared value through prepending the name of the containing class.

```
class Grid {  
  static origin = { x: 0, y: 0 };  
  calculateDistanceFromOrigin(point: { x: number; y: number }) {  
    let xDist = point.x - Grid.origin.x;  
    let yDist = point.y - Grid.origin.y;  
    return Math.sqrt(xDist * xDist + yDist * yDist) / this.scale;  
  }  
  constructor(public scale: number) {}  
}  
  
let grid1 = new Grid(1.0); // 1x scale  
let grid2 = new Grid(5.0); // 5x scale  
  
console.log(grid1.calculateDistanceFromOrigin({ x: 10, y: 10 }));  
console.log(grid2.calculateDistanceFromOrigin({ x: 10, y: 10 }));
```

# TypeScript Interfaces

<https://www.typescriptlang.org/docs/handbook/interfaces.html>

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- Here, **LabeledValue** is an interface with a string property, **label**.
- It is not required to explicitly state that the object passed into a function implements an interface (as in C#).
- In **TS**, only the objects' **shape** matters. If the argument passed into the function meets the requirements listed (the **shape**), it is allowed.
- **Type** checking does not require that properties come in any specific order.
- The only requirement is that property names required by the interface must be present\* AND have the required **type**.

```
interface LabeledValue {  
    label: string;  
}  
  
function printLabel(labeledObj: LabeledValue) {  
    console.log(labeledObj.label);  
}  
  
let myObj = { size: 10, label: "Size 10 Object" };  
printLabel(myObj);
```

\*Mark a property **optional** with '?' at the end of the property name.

# TypeScript – Extending Interfaces

<https://www.typescriptlang.org/docs/handbook/interfaces.html#extending-interfaces>

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Classes and Interfaces can extend other Interfaces.

This allows you to copy the members of one interface into another interface or class.

```
interface Shape {  
    color: string;  
}  
  
interface PenStroke {  
    penWidth: number;  
}  
  
interface Square extends Shape, PenStroke {  
    sideLength: number;  
}  
  
let square = {} as Square;  
square.color = "blue";  
square.sideLength = 10;  
square.penWidth = 5.0;
```



# TypeScript Functions

<https://www.typescriptlang.org/docs/handbook/functions.html>

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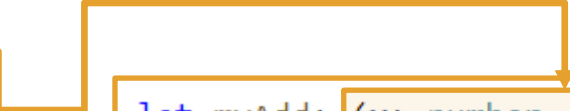
In *TypeScript*, there are classes, namespaces, and modules, and *TypeScript* adds some new capabilities to JS, but *functions* still play the key role in describing how to complete actions.

*TypeScript* functions can be *named* or *anonymous* functions. They can also refer to variables outside of the function body.

You must explicitly **type** the parameters of functions.

A function's **type** has the same two parts: the **type** of the arguments and the return **type**. When writing out the whole function **type**, both parts are required.

```
function add(x: number, y: number): number {  
    return x + y;  
}  
  
let myAdd = function(x: number, y: number): number { return x + y; };
```



```
let myAdd: (x: number, y: number) => number = function(  
    x: number,  
    y: number  
): number {  
    return x + y;  
};
```

# TS Function Parameter Types

<https://www.typescriptlang.org/docs/handbook/functions.html#optional-and-default-parameters>

- In **TS**, every function parameter is assumed to be **required** by the function.
- Make a parameter **optional** by placing a '?' behind the parameter name.
- **Optional** parameters must be last.
- Give parameters **default** values with 'paramName = "value"'.  
• When a **default** parameter comes last, it is treated as **optional**.
- **Rest** Parameters ('...paramName') in **TS** are like **args** parameters in **JS**.
- **Rest** parameters are treated as **optional** parameters. The compiler builds an array of the additional arguments passed with the name given after the ellipsis (...).

```
function buildName(firstName: string, lastName?: string) {  
    if (lastName) return firstName + " " + lastName;  
    else return firstName;  
}
```

Optional parameters

```
function buildName(firstName: string, lastName = "Smith")  
    return firstName + " " + lastName;  
}
```

Default parameters

```
function buildName(firstName: string, ...restOfName: string[]) {  
    return firstName + " " + restOfName.join(" ");  
}
```

Rest parameters

# TypeScript Modules

<https://www.typescriptlang.org/docs/handbook/modules.html>

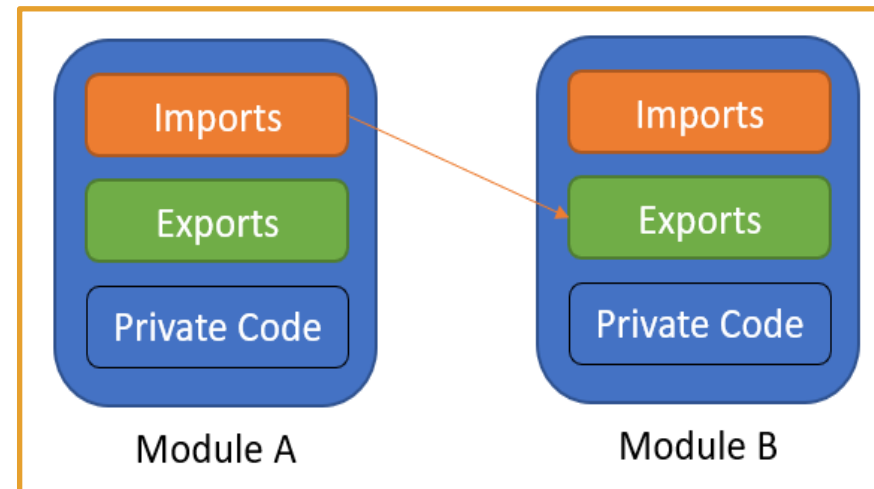
TypeScript shares the JavaScript concept of **Modules**. **Modules** in TypeScript have their own scope. A module must be explicitly **exported** to make its members visible.

To consume a property **exported** from a different **module**, it must be **imported** using an **import** method.

The relationships between **modules** are specified in terms of **imports** and **exports** at the file level.

In TypeScript, any file containing a top-level **import** or **export** is considered a **module**.

As in JS, a TS file without any top-level **import** or **export** declarations is treated as a script whose contents are available in the global scope and in **modules** as well.



# TypeScript - Exporting a Declaration

<https://www.typescriptlang.org/docs/handbook/modules.html#export>

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Any declaration (variable, function, class, type alias, interface) can be **exported** by adding the **export** keyword before the type keyword.

1. Use **export** to make a class, function, or variable available to other *modules*.
2. Use an **import** statement in a *module (component)* to gain access to a class, function, or variable what has been exported.

```
export interface StringValidator {  
    isAcceptable(s: string): boolean;  
}
```

```
import { StringValidator } from "./StringValidator";  
  
export const numberRegexp = /^[0-9]+$/;  
  
export class ZipCodeValidator implements StringValidator {  
    isAcceptable(s: string) {  
        return s.length === 5 && numberRegexp.test(s);  
    }  
}
```

# TypeScript - Export

<https://www.typescriptlang.org/docs/handbook/modules.html#export-statements>

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**export** and **import** statements allow you to rename a *module*.

Conventionally, **import** statements are listed at the top of the document while **export** statements are listed at the bottom.

```
class ZipCodeValidator implements StringValidator {  
    isAcceptable(s: string) {  
        return s.length === 5 && numberRegexp.test(s);  
    }  
}  
  
export { ZipCodeValidator };  
export { ZipCodeValidator as mainValidator };
```

```
import { ZipCodeValidator } from "../ZipCodeValidator";  
  
let myValidator = new ZipCodeValidator();
```

```
import { ZipCodeValidator as ZCV } from "../ZipCodeValidator";  
let myValidator = new ZCV();
```

# Create a TS version of GuessingGame (1/2)

<https://www.valentinog.com/blog/typescript/>

<https://www.typescriptlang.org/docs/handbook/asp-net-core.html>

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1. Create a new folder for this project in your repo.
2. Make sure you have Node.js with `node -v` in Command Line. If not, go to [nodejs.org](https://nodejs.org) to get it.
3. In Command Line, run `npm init -y` to create a `package.json` file.
4. In Command Line, run `npm i typescript --save-dev` (dash-dash) (why [--save-dev](#)?) to install a TypeScript dev dependency via `npm` (`--save-dev` installs for just this program, in dev mode).
5. In the new `package.json` file, add to the node script commands a command to compile with `tsc`. Add `"scripts":{ "tsc": "tsc"}`. `"scripts"` should already be among the key:value pairs.
6. Run `npm run tsc -- --init` (dash-dash, space, dash-dash) in Command Line to create a `tsconfig.json` file for which the TS compiler (`tsc`) will look. You should get `message TS6071: Successfully created a tsconfig.json file.` in the Command Line.



# Create a TS version of GuessingGame (2/2)

<https://www.valentinog.com/blog/typescript/>

<https://www.typescriptlang.org/docs/handbook/asp-net-core.html>

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7. Replace all the original content of the `tsconfig.json` file with:
  - `{ "compilerOptions": { "target": "es5", "module": "es2015", "strict": true } }`
  - [Why “es2015”?](#)
8. ES5 is the newest JS release. “strict” enforces TypeScript’s highest level of strictness. Visit <https://aka.ms/tsconfig.json> for info on the `tsconfig.json` file.
9. Create a `.ts` file in the same folder and add `.ts` code to it. Or complete the [Migrating from JavaScript](#) tutorial.
10. Compile and run with `npm run tsc` in Command Line. This will transpile the TypeScript code to JavaScript code and create a like-named `.js` file in the same folder.
11. Make sure to use `<script type=“module” src=“jsFileName.js”>` to include the new `.js` file inside your `.html`.