TypeScript Fundamentals

.NET CORE

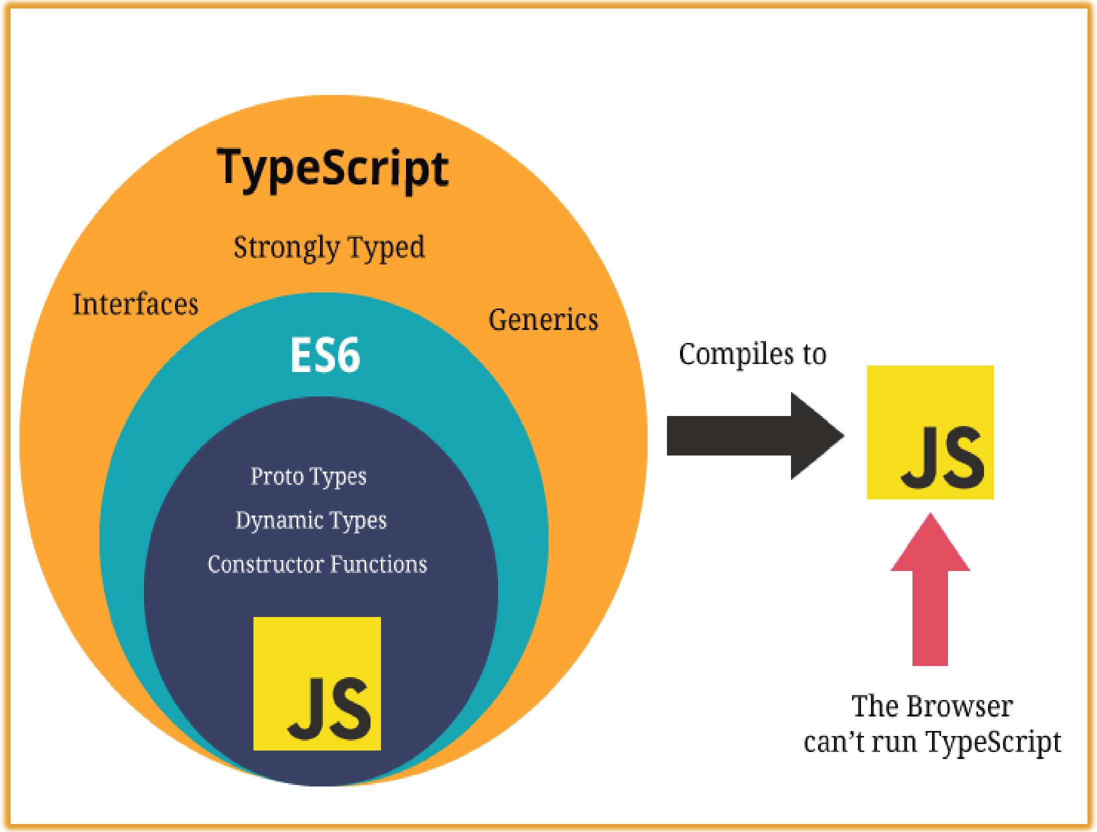
*The goal of TypeScript is to be a static typechecker for JavaScript programs - in other words, a tool that runs before your code runs (static) to ensure that the **types** of the program are correct (typechecked).*

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

TypeScript – Overview

https://www.typescriptlang.org/docs/handbook/typescript-from-scratch.html#typescript-a-static-type-checker
https://angular.io/guide/glossary

- Detecting errors in code without running it is referred to as ***Static Checking***.
- Determining what's an error (and what's not) based on the kinds of values being operated on is known as ***Type Checking***.
- ***TypeScript*** is a ***Static Type Checking*** language. It checks a program for errors before it's run and does so based on the types of the values.
- ***TypeScript*** is a ***Superset*** of ***JavaScript***. All ***JavaScript*** syntax is legal withing a .ts (***TypeScript***) file. (You don't need 'use strict')
- Remember that all ***JS*** questions also apply to ***TS***.



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

TypeScript is a ***typed superset*** of *JavaScript* that compiles to plain *JavaScript*. *TypeScript* enforces more strict ***typing*** and other rules that make *JS* more developer friendly. It offers classes, modules, ***type*** checking, and interfaces. *TypeScript* must be ***transpiled*** into *JavaScript* code.

What's the difference between "Transpiling" and "Compiling"?

- *Compiling* is the general 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, then compiling it into a lower level language like IL.

Both compilers and transpilers can optimize the code as part of the process.

Click here to see TS and JS compared

TypeScript – Types

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

TypeScript adds rules about how different kinds of values can be used. ***TS*** infers the ***types*** of values and enforces these ***types*** throughout the program.

For example, ***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.

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

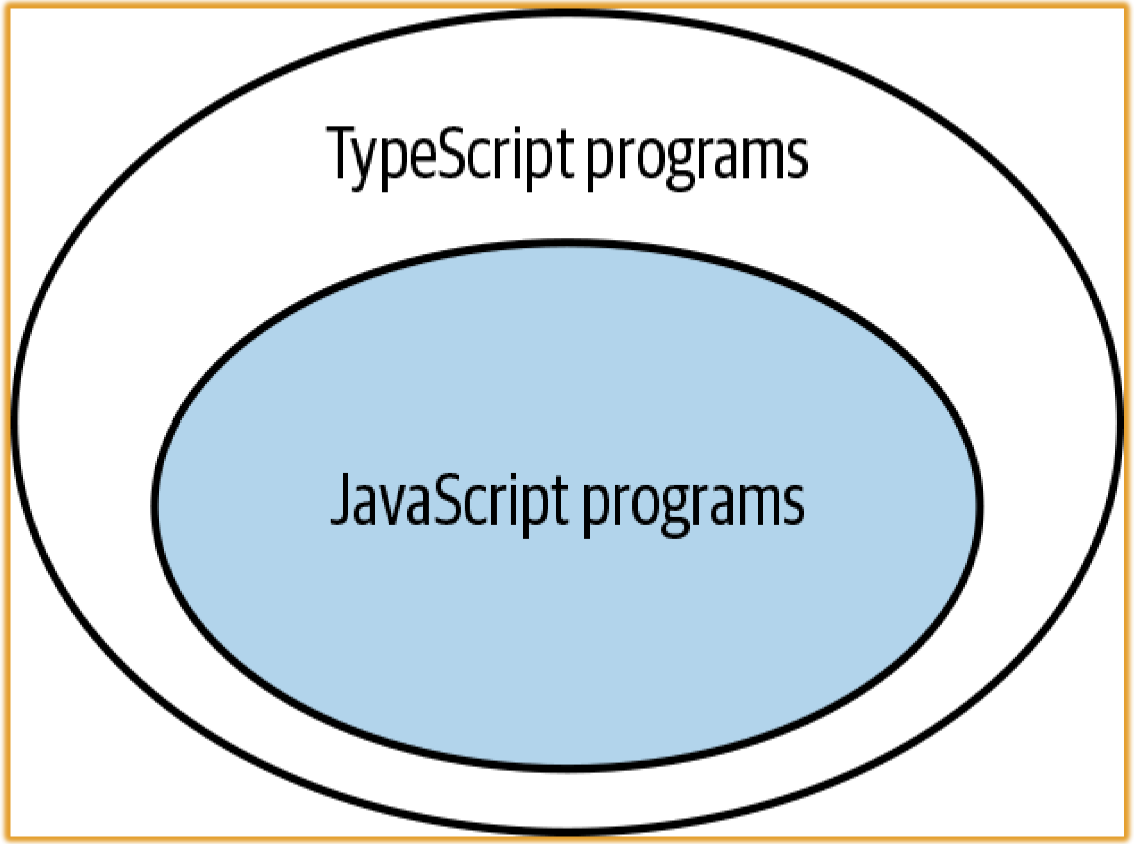
TypeScript's type system rules are designed to allow correct programs through while still catching as many common errors as possible.

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.

TypeScript – Erased Types

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

- *TypeScript* (TS) preserves the runtime behavior of *JavaScript* (JS).
- *TS* never changes the runtime behavior of *JS* code.
- ***TS's type*** system is erased on compilation. There is no persisted ***type*** information in the resulting *JS* code.
- *TS* never changes the behavior of your program based on the ***types*** it inferred, so the ***type*** system has no bearing on how a program works once it's running.
- *TS* uses ***JS's*** libraries so there's no additional *TS-specific* framework to learn.



TypeScript Type Annotations

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

One of the main benefits of *TypeScript* over *JavaScript* is that you are allowed to explicitly specify the *type* of a variable. This is done with *Type Annotations*.

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

TypeScript includes 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 Definitions

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

- *TS* infers most ***types***, but you can enforce ***strict typing*** by using an ***interface*** to declare a class and ***TS*** will enforce that ***typing***.
- **TS** supports classes and OOP, so an ***interface*** declaration can also be used with classes.
- There are two syntaxes for building types: *Interfaces* and ***Types***.
- Usually, you will use ***interface***. Use ***type*** when you need specific features.

```
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,
};
```

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

While using all *JS's* data types, *TS* extends *JS's* types with a few of its own.

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

TypeScript – Type Assertions

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

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You can use “***Type Assertion***” to assert the type of your data.

Type Assertion performs no special checking or restructuring of data.

It has no runtime impact and is used purely by the compiler.

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;
```

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 sometimes "***Duck Typing***"). The compiler only checks that at least the variable names required are present in args passed and that they match the ***types*** required.

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

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

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

1. Declare an interface object.

2. Define a function that takes that object.

3. Instantiate the object.
Invoke the function.

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

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

const color = { hex: "#187ABF" };

printPoint(color);
```

Prints 2/3

Prints 2/4

ERROR!

```
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

TypeScript understands how code can change what ***type*** a variable could be.

You can use checks to verify the ***type*** at runtime and take appropriate action.

Type	Predicate
string	typeof s === “string”
number	typeof n === “number”
boolean	typeof b === “boolean”
undefined	typeof undefined === “undefined”
function	typeof f === “function”
array	Array.isArray(a)

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;
  }
}
```

TypeScript Interfaces and Class Types

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

Interfaces explicitly enforce that a class meets a particular contract for properties and functions.

In *TS*, Interfaces only describe the public side of the 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

TypeScript developers can use OOP techniques, and ***transpile*** them into JavaScript. As in ***JS***, ***TS Abstract*** classes 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

Each ***derived*** class that contains a constructor function must call ***super()*** to execute the constructor of the ***base*** class.

Before a property on ***this*** is accessed from within a constructor body, ***super()*** must be called.

This is an important 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*** supports the new ***JavaScript*** syntax for ***private*** fields and has its own way to declare a member as being marked ***private***.
- ***Private*** fields cannot be accessed from outside of their containing classes.
- Members declared ***protected*** can be accessed from within their class and ***deriving*** classes.
- A constructor may also be marked ***protected***. This 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 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

Static members of a class are visible on the class itself rather than on the instances. Each instance accesses this shared value through prepending the name of the 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

- Here, LabeledValue represents having a single property called label that is of *type* string.
- It is not required to explicitly state that the object passed into a function implements an interface (as in other languages).
- In *TS*, only the objects' ***shape*** matters. If the object passed into the function meets the requirements listed (the ***shape***), it is allowed.
- *Type* checker 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

Classes and Interfaces can extend 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

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

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

<u>You can/should explicitly ***type*** the parameters of the function (IMPORTANT!!!).</u>

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;
};
```

TypeScript Function Param 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 '= "value"'.
- When the ***default*** parameter comes last, it is treated as ***optional***.
- ***Rest*** Parameters in *TS* are like ***args*** parameters in *JS*.
- ***Rest*** parameters are treated as a boundless number of ***optional*** parameters. The compiler builds an array of the arguments passed in with the name given after the ellipsis (**...**). The ellipsis is also used in the type of the function with ***Rest*** parameters.

```
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

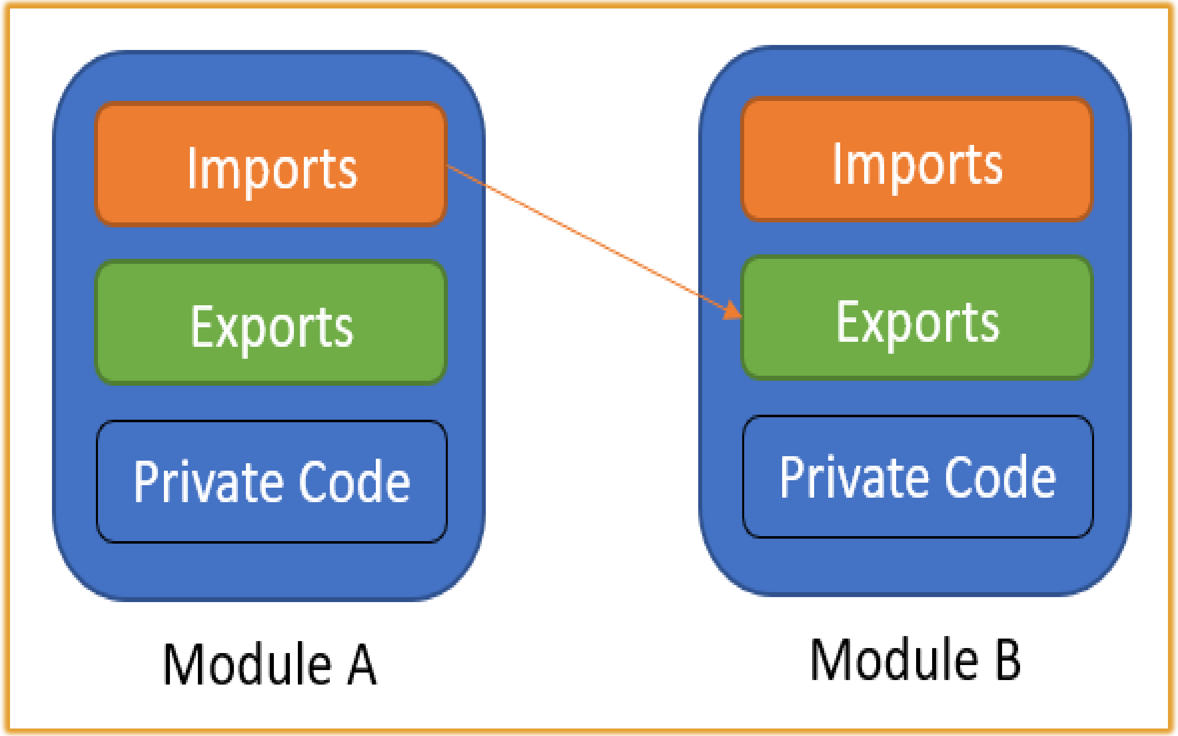
TS shares the *JS* concept of ***Modules***.

Modules in *TS* have their own scope. Anything declared inside a ***module*** is not visible outside that ***module*** unless it is explicitly ***exported***.

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 *TS*, any file containing a top-level ***import*** or ***export*** is considered a ***module***. A file without any top-level ***import*** or ***export*** declarations is treated as a script whose contents are available in the global scope (and therefore in ***modules*** as well).



TypeScript - Exporting a Declaration

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

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

- First, use the ***export*** keyword to make a class, function, or variable available to other ***modules*** from within the ***module*** (***component***).
- Second, ***import*** the class, function, or variable into the ***module*** (***component***) where you want to implement it.

```
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

Export Statements allow you to rename the statement you want to export.

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

TypeScript Imports

https://www.typescriptlang.org/docs/handbook/modules.html#import

```
import { ZipCodeValidator } from "./ZipCodeValidator";

let myValidator = new ZipCodeValidator();
```

Imports can also be renamed.

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

Create a TS version of GuessingGame Setup

https://www.valentinog.com/blog/typescript/
https://www.typescriptlang.org/docs/handbook/asp-net-core.html

1. Create a new folder for this project in your repo2.
2. Make sure you have Node.js with node –v in Command Line. If not, go to 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 (what is –save-dev?) to install a ***TS*** dependency via ***npm*** (this installs for just this program).
5. Configure the node script to compile with ***tsc***. In the new ***package.json*** file, include “scripts”;{ “tsc”: “tsc”},
6. Run npm run tsc -- --init 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.
7. Replace all the original content of the ***tsconfig.json*** file with { "compilerOptions": { "target": "es5", "strict": true } } ***ES5*** is the newest JS release. “Strict” enforces ***TS’s*** highest level of strictness and ***tsc*** will insert “use strict” atop each ***JS*** file.
8. Compile and run with npm run tsc in Command Line. This will transpile the TS code to JS code and create a file in the same folder.
9. Complete the Migrating from JavaScript tutorial.
10. Make sure to use <script> to include the new .js file.