TypeScript Fundamentals

.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

TypeScript –

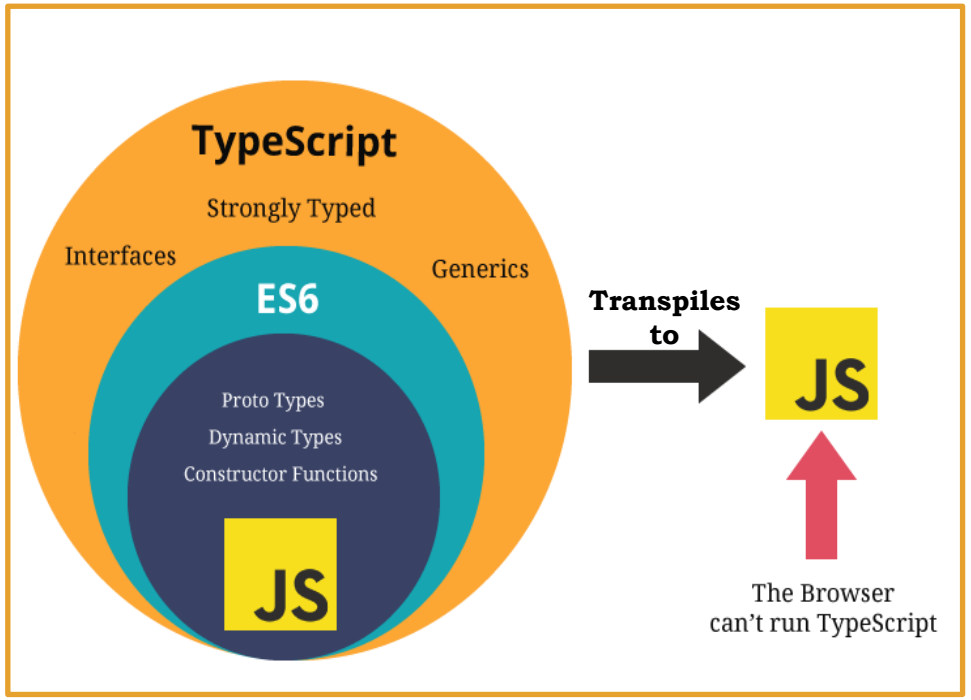
https://www.typescriptlang.org/docs/handbook/typescript-from-scratch.html
https://angular.io/guide/glossary

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

TypeScript checks JavaScript programs for errors before execution. It does so based on the *kinds (types) of values. TypeScript is* a **static type checker.**

TypeScript is a ***typed superset*** of JavaScript. This means that it 'transpiles' to plain JavaScript.

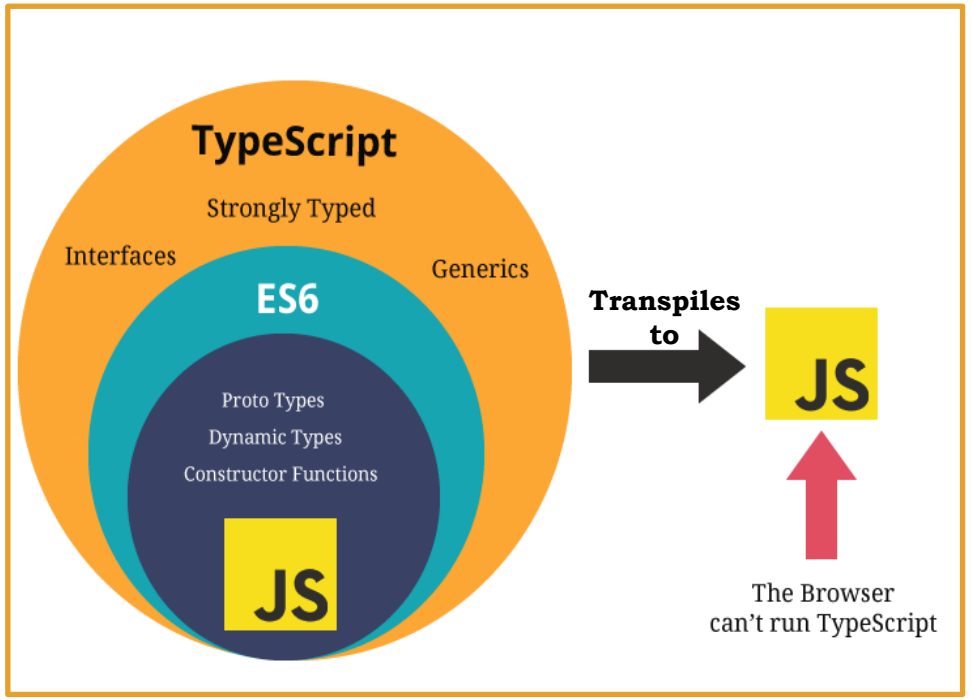
TypeScript enforces strict ***typing*** along with other rules. It has classes, modules, ***type*** checking, and interfaces. TypeScript must be ***transpiled*** into JavaScript code to be run.



TypeScript – 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.



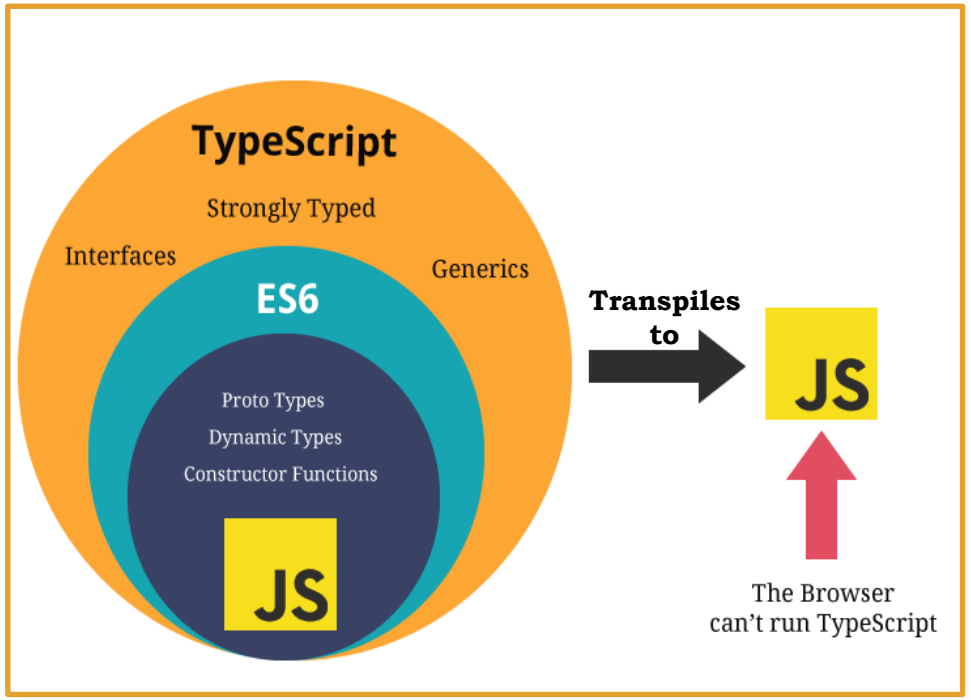
*Dynamic Type Checking is when type checking is done at runtime

TypeScript – 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

"Transpiling" vs. "Compiling"

- ***Compiling*** is the term for taking source code written in one language and transforming it into another, more basic, language.
- ***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 – Types

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

TypeScript adds rules about how different value ***types*** can be used. TypeScript 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 will see ***type*** errors that are legitimate problems with the code. It could also 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

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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): void
{
    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

- **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.

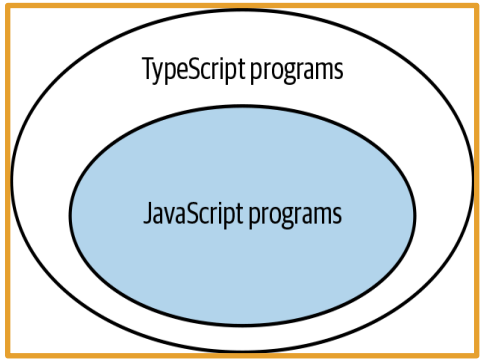
```
interface User {
  name: string;
  id: number;
}

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.

TypeScript

```typescript
// @showEmit
function greet(person: string, date: Date) {
  console.log(`Hello ${person}, today is ${date.toDateString()}!`);
}

greet("Maddison", new Date());
```

JavaScript

```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
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

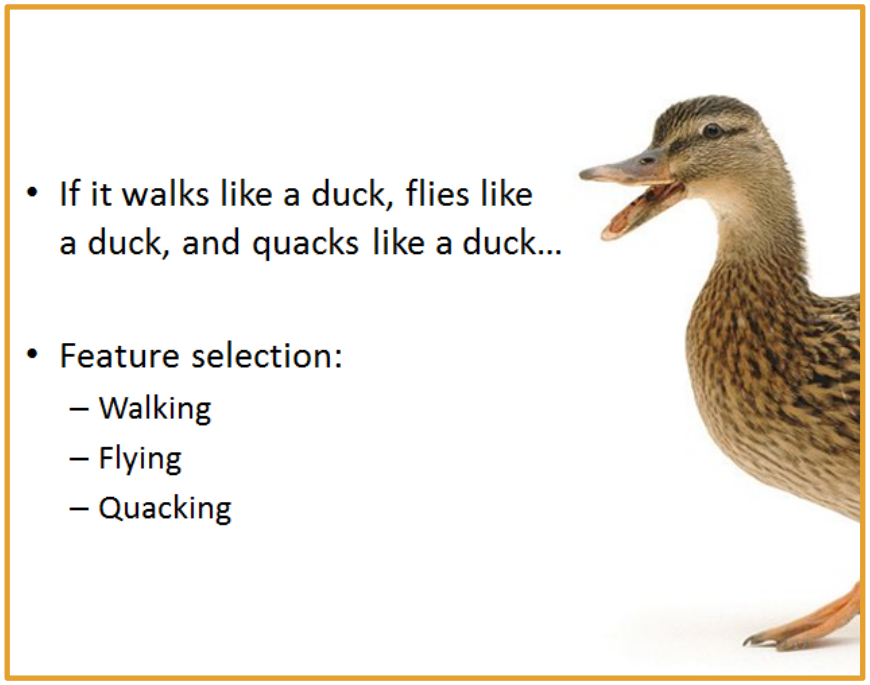
Duck-Typing (Structural Type System)

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

'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.



TypeScript – Structural Type System

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

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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	typeof myString === “string”
number	typeof myNum === “number”
boolean	typeof myBool === “boolean”
undefined	typeof undef === “undefined”
function	typeof myFunc === “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;
  }
}
```

*Often used in a if-else comparison.

TypeScript Interfaces and Class Types

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

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

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 members can be ***private***.
- 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

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

- 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

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

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

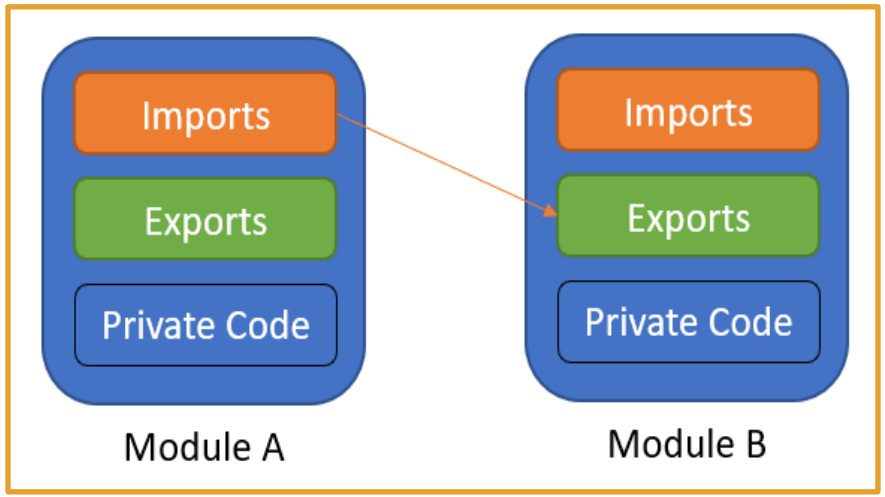
TypeScript shares the JavaScript concept of ***Modules***. ***Modules*** in TypeScript have their own scope. A module must be explicitly exported to make its members visible.

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 JavaScript, a TypeScript 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

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

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 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 TypeScripts 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.