

Step 1 – Types of languages

1. Strongly typed vs loosely typed

The terms **strongly typed** and **loosely typed** refer to how programming languages handle types, particularly how strict they are about type conversions and type safety.

Strongly typed languages

1. Examples – Java, C++, C, Rust
2. Benefits –

1. Lesser runtime errors
2. Stricter codebase
3. Easy to catch errors at compile time

Loosely typed languages

1. Examples – Python, Javascript, Perl, php
2. Benefits

1. Easy to write code
2. Fast to bootstrap
3. Low learning curve

Code doesn't work



```
#include <iostream>

int main() {
    int number = 10;
    number = "text";
```

Code does work

```
function main() {
    let number = 10;
    number = "text";
    return number;
}
```

```
return 0;  
}
```

People realised that javascript is a very power language, but lacks types. **TypeScript** was introduced as a new language to add **types** on top of javascript.

Step 2 – What is Typescript

What is typescript?

TypeScript is a programming language developed and maintained by Microsoft.

It is a strict **syntactical superset** of JavaScript and adds optional static typing to the language.

Where/How does typescript code run?

Typescript code never runs in your browser. Your browser can only understand **javascript**.

1. Javascript is the runtime language (the thing that actually runs in your browser/nodejs runtime)
2. Typescript is something that compiles down to javascript
3. When typescript is compiled down to javascript, you get **type checking** (similar to C++). If there is an error, the conversion to Javascript fails.

TypeScript compiler

`tsc` is the official TypeScript compiler that you can use to convert **TypeScript** code into **Javascript**

There are many other famous compilers/transpilers for converting TypeScript to Javascript. Some famous ones are -

1. esbuild
2. swc

Step 3 – The tsc compiler

Let's bootstrap a simple Typescript Node.js application locally on our machines

Step 1 – Install tsc/typescript globally

```
npm install -g typescript
```



Step 2 – Initialize an empty Node.js project with typescript

```
mkdir node-app  
cd node-app  
npm init -y  
npx tsc --init
```



These commands should initialize two files in your project

Step 3 – Create a a.ts file

```
const x: number = 1;  
console.log(x);
```



Step 4 - Compile the ts file to js file

tsc -b



Step 5 - Explore the newly generated index.js file

Notice how there is no typescript code in the javascript file. It's a plain old js file with no `types`

Step 7 - Delete `a.js`

Step 6 - Try assigning x to a string

Make sure you convert the `const` to `let`

```
let x: number = 1;  
x = "harkirat"  
console.log(x);
```



Step 7 - Try compiling the code again



```
tsc -b
```

Notice all the errors you see in the console. This tells you there are **type** errors in your codebase.

Also notice that no `index.js` is created anymore

This is the high level benefit of typescript. It lets you catch **type** errors at **compile time**

Step 4 – Basic Types in TypeScript

TypeScript provides you some basic types

`number`, `string`, `boolean`, `null`, `undefined`.

Let's create some simple applications using these types –

Problem 1 – Hello world



Thing to learn – How to give types to arguments of a function

Write a function that greets a user given their first name.

Argument – `firstName`

Logs – `Hello {firstName}`

Doesn't return anything

► Solution

Problem 2 – Sum function



Thing to learn – How to assign a return type to a function

Write a function that calculates the sum of two functions

► Code

Problem 3 – Return true or false based on if

a user is 18+



Thing to learn – Type inference

Function name – isLegal

► Code

Problem 4 –

Create a function that takes another function as input, and runs it after 1 second.

► Code

Step 5 – The `tsconfig` file

The `tsconfig` file has a bunch of options that you can change to change the compilation process.

Some of these include

1. target

The `target` option in a `tsconfig.json` file specifies the ECMAScript target version to which the TypeScript compiler will compile the TypeScript code.

To try it out, try compiling the following code for target being `ES5` and `es2020`

```
const greet = (name: string) => `Hello, ${name}!`;
```



- ▶ Output for ES5
- ▶ Output for ES2020

2. rootDir

Where should the compiler look for `.ts` files. Good practise is for this to be the `src` folder

3. outDir

Where should the compiler look for spit out the `.js` files.

4. noImplicitAny

Try enabling it and see the compilation errors on the following code –



```
const greet = (name) => `Hello, ${name}!`;
```

Then try disabling it

5. removeComments

Weather or not to include comments in the final `js` file

Step 6 – Interfaces

1. What are interfaces

How can you assign types to objects? For example, a user object that looks like this -

```
const user = {  
    firstName: "harkirat",  
    lastName: "singh",  
    email: "email@gmail.com".  
    age: 21,  
}
```

To assign a type to the `user` object, you can use `interfaces`

```
interface User {  
    firstName: string;  
    lastName: string;  
    email: string;  
    age: number;  
}
```

Assignment #1 - Create a function `isLegal` that returns true or false if a user is above 18. It takes a user as an input.

► Solution

Assignment #2 - Create a React component that takes todos as an input and renders them



Select typescript when initialising the react project using
`npm create vite@latest`

► Solution

2. Implementing interfaces

Interfaces have another special property. You can **implement** interfaces as a class.

Let's say you have an person **interface** -

```
interface Person {  
    name: string;  
    age: number;  
    greet(phrase: string): void;  
}
```



You can create a class which **implements** this interface.

```
class Employee implements Person {  
    name: string;  
    age: number;  
  
    constructor(n: string, a: number) {  
        this.name = n;  
        this.age = a;  
    }  
  
    greet(phrase: string) {  
        console.log(` ${phrase} ${this.name}`);  
    }  
}
```



This is useful since now you can create multiple **variants** of a person (Manager, CEO ...)

Summary

1. You can use **interfaces** to aggregate data
2. You can use interfaces to implement classes from



Abstract classes let you do something similar (not TS related)

```
abstract class Shape {  
    abstract name: string;  
  
    abstract calculateArea(): number;  
  
    describe(): void {  
        console.log(`This shape is a ${this.name} with an area of ${this.ca  
    }  
}
```



Rectangle and Circle classes

```
class Rectangle extends Shape {  
    name = "Rectangle";  
  
    constructor(public width: number, public height: number) {  
        super();  
    }  
  
    // Implement the abstract method  
    calculateArea(): number {  
        return this.width * this.height;  
    }  
}  
  
// Another subclass implementing the abstract class  
class Circle extends Shape {  
    name = "Circle";  
  
    constructor(public radius: number) {  
        super();  
    }  
  
    // Implement the abstract method  
    calculateArea(): number {
```

```
    return Math.PI * this.radius * this.radius;  
}  
}
```

Step 7 - Types

What are types?

Very similar to `interfaces`, types let you `aggregate` data together.

```
type User = {  
    firstName: string;  
    lastName: string;  
    age: number  
}
```

But they let you do a few other things.

1. Unions

Let's say you want to print the `id` of a user, which can be a number or a string.



You can not do this using `interfaces`

```
type StringOrNumber = string | number;  
  
function printId(id: StringOrNumber) {  
    console.log(`ID: ${id}`);  
}  
  
printId(101); // ID: 101  
printId("202"); // ID: 202
```

2. Intersection

What if you want to create a type that has every property of multiple types / interfaces



You can not do this using interfaces

```
type Employee = {  
    name: string;  
    startDate: Date;  
};  
  
type Manager = {  
    name: string;  
    department: string;  
};  
  
type TeamLead = Employee & Manager;  
  
const teamLead: TeamLead = {  
    name: "harkirat",  
    startDate: new Date(),  
    department: "Software developer"  
};
```

Step 8 – Arrays in TS

If you want to access arrays in typescript, it's as simple as adding a `[]` annotation next to the type

Example 1

Given an array of positive integers as input, return the maximum value in the array

► Solution

Example 2

Given a list of users, filter out the users that are legal (greater than 18 years of age)

```
interface User {  
    firstName: string;  
    lastName: string;  
    age: number;  
}
```

► Solution

Step 9 – Enums

Enums (short for enumerations) in TypeScript are a feature that allows you to define a set of named constants.

The concept behind an enumeration is to create a human-readable way to represent a set of constant values, which might otherwise be represented as numbers or strings.

Example 1 – Game

Let's say you have a game where you have to perform an action based on whether the user has pressed the `up` arrow key, `down` arrow key, `left` arrow key or `right` arrow key.

```
function doSomething(keyPressed) {  
    // do something.  
}
```

What should the `type` of `keyPressed` be?

Should it be a string? (`UP`, `DOWN`, `LEFT`, `RIGHT`)?

Should it be numbers? (`1`, `2`, `3`, `4`)?

The best thing to use in such a case is an `enum`.

```
enum Direction {  
    Up,  
    Down,  
    Left,  
    Right  
}
```

```
function doSomething(keyPressed: Direction) {  
    // do something.
```

```
}
```

```
doSomething(Direction.Up)
```

This makes code slightly **cleaner** to read out.



The final value stored at `runtime` is still a number (0, 1, 2, 3).

2. What values do you see at runtime for `Direction.UP` ?

Try logging `Direction.Up` on screen

► Code

This tells you that by default, `enums` get values as 0 , 1 , 2 ...

3. How to change values?

```
enum Direction {  
    Up = 1,  
    Down, // becomes 2 by default  
    Left, // becomes 3  
    Right // becomes 4  
}
```

```
function doSomething(keyPressed: Direction) {  
    // do something.  
}
```

```
doSomething(Direction.Down)
```

► Solution

4. Can also be strings

```
enum Direction {  
    Up = "UP",  
    Down = "Down",  
    Left = "Left",  
    Right = 'Right'  
}  
  
function doSomething(keyPressed: Direction) {  
    // do something.  
}  
  
doSomething(Direction.Down)
```

5. Common usecase in express

```
enum ResponseStatus {  
    Success = 200,  
    NotFound = 404,  
    Error = 500  
}  
  
app.get("/", (req, res) => {  
    if (!req.query.userId) {  
        res.status(ResponseStatus.Error).json({})  
    }  
    // and so on...  
    res.status(ResponseStatus.Success).json({});  
})
```


Step 10 – Generics

Generics are a **language independent** concept (exist in C++ as well)

Let's learn it via an example

1. Problem Statement

Let's say you have a function that needs to return the first element of an array. Array can be of type either string or integer.

How would you solve this problem?

- ▶ Solution

What is the problem in this approach?

- ▶ User can send different types of values in inputs, without any type errors
- ▶ Typescript isn't able to infer the right type of the return type

2. Solution – **Generics**

Generics enable you to create components that work with any data type while still providing compile-time type safety.

Simple example –

- ▶ Code

3. Solution to original problem

Can you modify the code of the original problem now to include generics in it?

```
function getFirstElement<T>(arr: T[]) {  
    return arr[0];  
}  
  
const el = getFirstElement(["harkiratSingh", "ramanSingh"]);  
console.log(el.toLowerCase())
```



Did the issues go away?

- User can send different types of values in inputs, without any type errors
- Typescript isn't able to infer the right type of the return type

Step 11 – Exporting and importing modules

TypeScript follows the ES6 module system, using `import` and `export` statements to share code between different files. Here's a brief overview of how this works:

1. Constant exports

math.ts

```
export function add(x: number, y: number): number {  
    return x + y;  
}  
  
export function subtract(x: number, y: number): number {  
    return x - y;  
}
```

main.ts

```
import { add } from "./math"  
  
add(1, 2)
```

2. Default exports

```
export default class Calculator {  
    add(x: number, y: number): number {  
        return x + y;  
    }  
}
```

calculator.ts



```
import Calculator from './Calculator';

const calc = new Calculator();
console.log(calc.add(10, 5));
```

