

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";
    return 0;
}
```

Code does work ✅

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

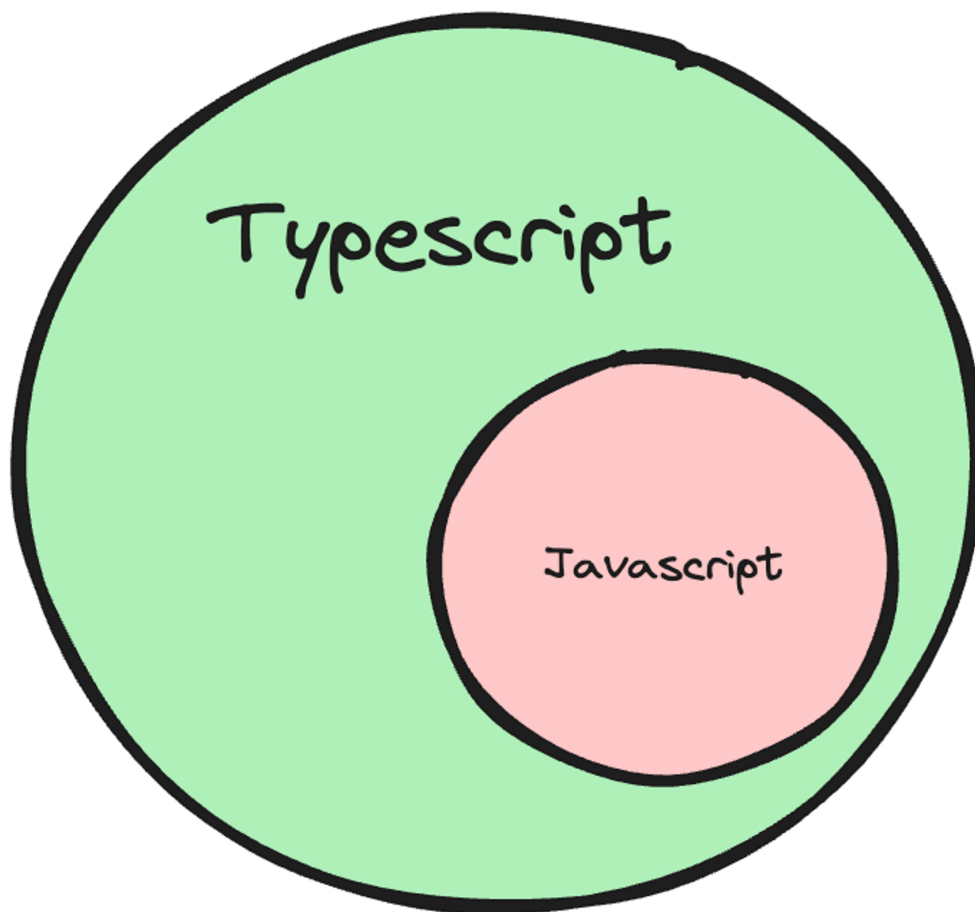
People realised that javascript is a very power language, but lacks types. **Typescript** was introduced as a new language to add **types** on top of javascript.

Step 2 - What is Typescript

What is typescript?

TypeScript is a programming language developed and maintained by Microsoft.

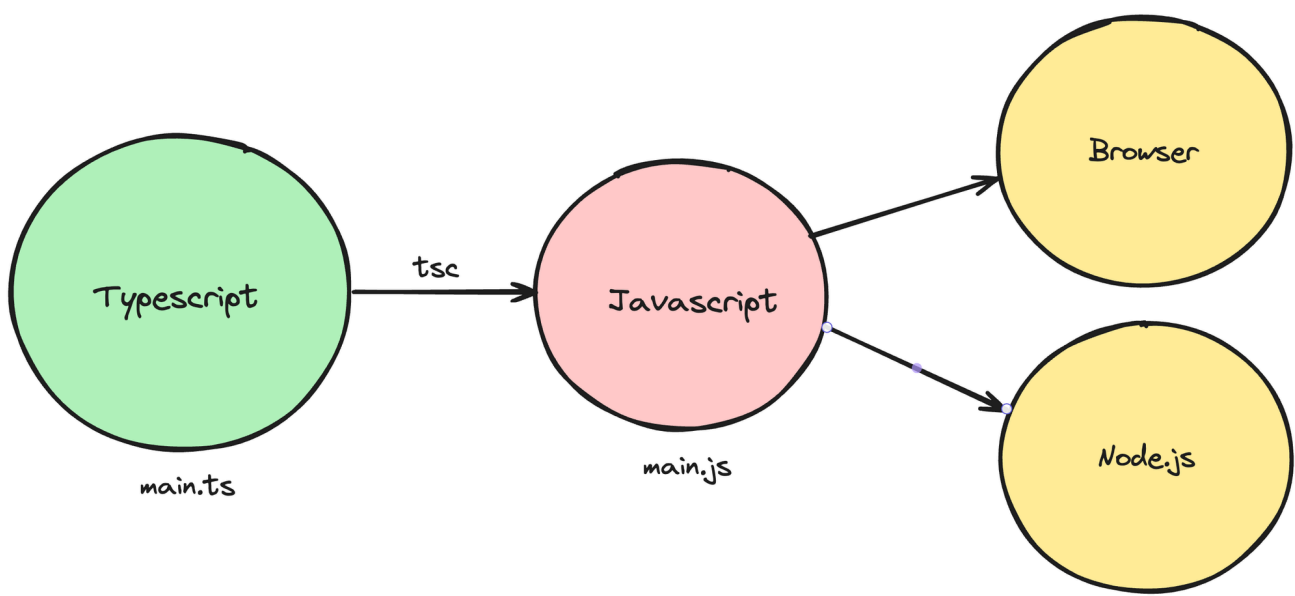
It is a strict **syntactical superset** of JavaScript and adds optional static typing to the language.



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

```
→ node-app ls  
package.json tsconfig.json
```

Step 3 - Create a a.ts file

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

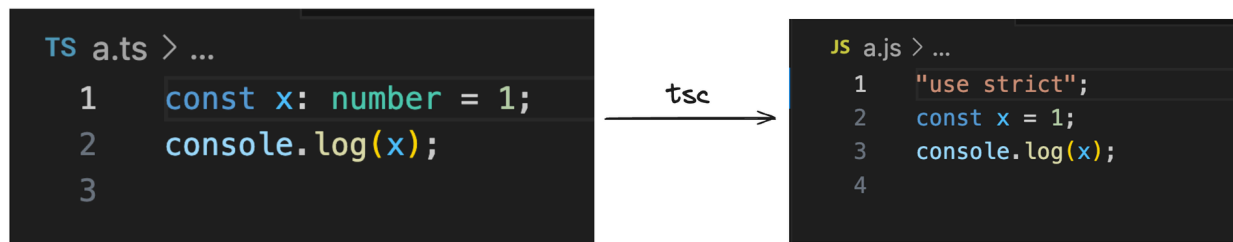


Step 4 - Compile the ts file to js file

```
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

```
→ node-app tsc -b
a.ts:2:1 - error TS2322: Type 'string' is not assignable to type 'number'.

2 x = "harkirat"
  ~

Found 1 error.
```

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

```
function greet(firstName: string) {  
    console.log("Hello " + firstName);  
}  
  
greet("harkirat");
```



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

```
function sum(a: number, b: number): number {  
    return a + b;  
}  
  
console.log(sum(2, 3));
```



Problem 3 - Return true or false based on if a user is 18+



Thing to learn - Type inference

Function name - isLegal

▼ Code

```
function isLegal(age: number) {  
  if (age > 18) {  
    return true;  
  } else {  
    return false  
  }  
}  
  
console.log(isLegal(2));
```

```
TS a.ts > isLegal  
1 function isL  
2   if (age  
3     retu  
4   } else {  
5     retu  
6   }  
7 }  
8  
9 console.log(isLegal(2));  
  
function isLegal(age: number): boolean  
function isLegal(age: number) {  
  if (age > 18) {  
    return true;  
  } else {  
    return false  
  }  
}
```

Problem 4 -

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

▼ Code

```
function delayedCall(fn: () => void) {  
  setTimeout(fn, 1000);  
}  
  
delayedCall(function() {  
  console.log("hi there");  
})
```


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

```
"use strict";  
var greet = function (name) { return "Hello, ".concat(name, "!"); };
```

▼ Output for ES2020

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

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



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


function isLegal(user: User) {
  if (user.age > 18) {
    return true
  } else {
    return false;
  }
}
```

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



```
// Todo.tsx
interface TodoType {
  title: string;
  description: string;
  done: boolean;
}

interface TodoInput {
  todo: TodoType;
}

function Todo({ todo }: TodoInput) {
  return <div>
    <h1>{todo.title}</h1>
    <h2>{todo.description}</h2>

    </div>
}
```

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

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

```
function maxValue(arr: number[]) {  
    let max = 0;  
    for (let i = 0; i < arr.length; i++) {  
        if (arr[i] > max) {  
            max = arr[i]  
        }  
    }  
    return max;  
}  
  
console.log(maxValue([1, 2, 3]));
```

Example 2

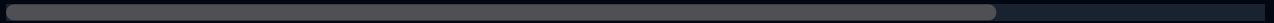
Given a list of users, filter out the users that are legal (greater than 18 years of age)

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

▼ Solution

```
interface User {  
    firstName: string;  
    lastName: string;  
    age: number;  
}  
  
function filteredUsers(users: User[]) {
```

```
    return users.filter(x => x.age >= 18);  
  }  
  
  console.log(filteredUsers([ {  
    firstName: "harkirat",  
    lastName: "Singh",  
    age: 21  
  }, {  
    firstName: "Raman",  
    lastName: "Singh",  
    age: 16  
  }, ]));
```



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 weather 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` ?

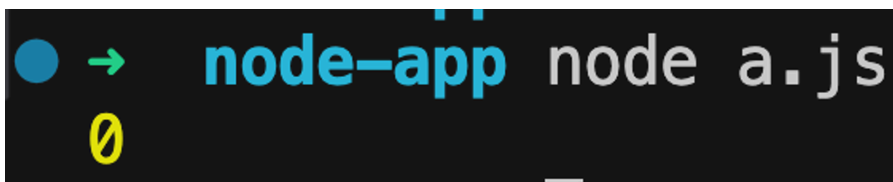
Try logging `Direction.Up` on screen

▼ Code

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

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

doSomething(Direction.Up)
console.log(Direction.Up)
```



```
node app node a.js
0
```

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

● → **node-app** node a.js
2

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

```
function getFirstElement(arr: (string | number)[]) {  
    return arr[0];  
}  
  
const el = getFirstElement([1, 2, 3]);
```

What is the problem in this approach?

▼ User can send different types of values in inputs, without any type errors

```
function getFirstElement(arr: (string | number)[]) {  
    return arr[0];  
}  
  
const el = getFirstElement([1, 2, '3']);
```

▼ Typescript isn't able to infer the right type of the return type

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

```

s a.tsx > ...
1 function getFirstElement(arr: T[]): T {
2   return arr[0];
3 }
4
5 const el = getFirstElement([1, 2, 3]);
6 console.log(el.toLowerCase());
7

```

Property 'toLowerCase' does not exist on type 'string | number'.

Property 'toLowerCase' does not exist on type 'number'. ts(2339)

any

[View Problem \(\F8\)](#) No quick fixes available

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

```

function identity<T>(arg: T): T {
  return arg;
}

let output1 = identity<string>("myString");
let output2 = identity<number>(100);

```

JavaScript ▼

```

function identity<T>(arg: T): T {
  return arg;
}

let output1 = identity<string>("myString");
let output2 = identity<number>(100);

```

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

```
function getFirstElement<T>(arr: T[]) {  
    return arr[0];  
}  
  
const el = getFirstElement<string>(["harkiratSingh", 2]);  
console.log(el.toLowerCase())
```

▼ Typescript isn't able to infer the right type of the return type

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


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));
```

