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 -

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
```

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

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

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These commands should initialize two files in your project

Step 3 - Create a a.ts file

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

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Step 4 - Compile the ts file to js file

```
tsc -b
```
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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);
```
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Step 7 - Try compiling the code again

```
tsc -b
```
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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

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

greet("harkirat");
```

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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));
```

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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));
```

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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");
})
```

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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}!`;
```
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▼ Output for ES5

```
"use strict";
var greet = function (name) { return "Hello, ".concat(na
```
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▼ Output for ES2020

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

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

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

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

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

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

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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>
}
```

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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;
}
```

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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}`);
    }
}
```

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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
}
```

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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
```

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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 = {
```

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```
  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;
```

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```
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;
}
```

Copy

▼ 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
}, ]));
```

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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.
}
```

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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)
```

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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)
```

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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)
```

Copy

▼ 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)
```

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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({});
})
```

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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]);
```

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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']);
```

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▼ 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())
```

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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);
```

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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())
```

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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())
```

Copy

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

```
function getFirstElement<T>(arr: T[]) {
    return arr[0];
}
```

Copy

```
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;
}
```

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main.ts

```
import { add } from "./math"

add(1, 2)
```

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2. Default exports

```
export default class Calculator {
    add(x: number, y: number): number {
```

Copy

```
    }
}
```

calculator.ts

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

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

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