Section 2: TypeScript Basics & Basic Types

22 May 2025 13:10

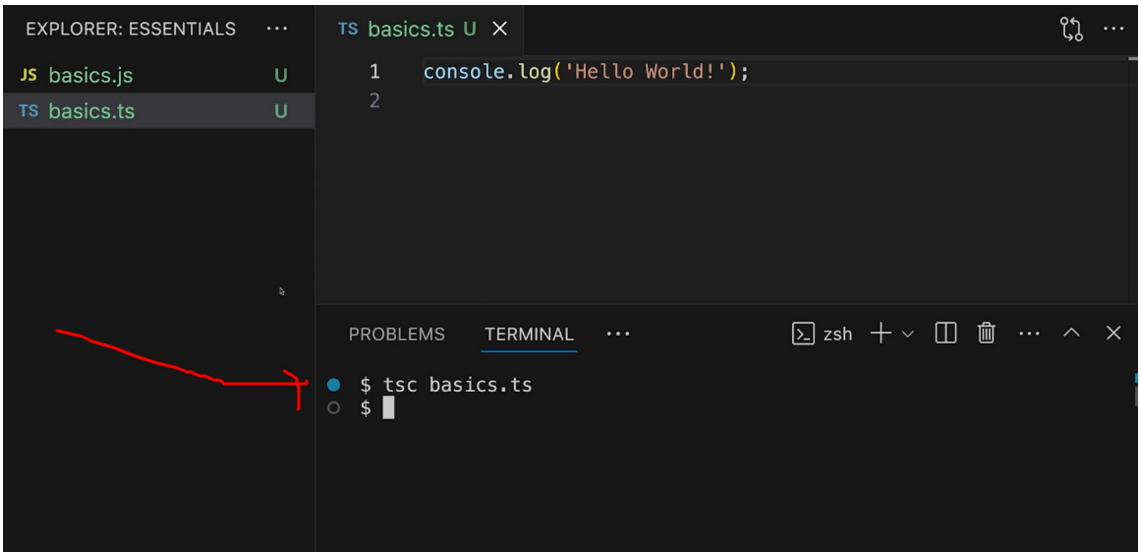
Using Node.js To Run JavaScript Code

In this and many other sections, I'll occasionally run compiled code with Node.js - simply to save us the hassle of building a (demo) website that loads and executes that code.

You can install the Node.js runtime from https://nodejs.org/en (it's available for all operating systems).
This runtime allows you to run JavaScript code right on your system (via the `node` command) instead of requiring a website.
So when you see me run `node app.js` (or some other file), that's me using Node.js to execute the code.

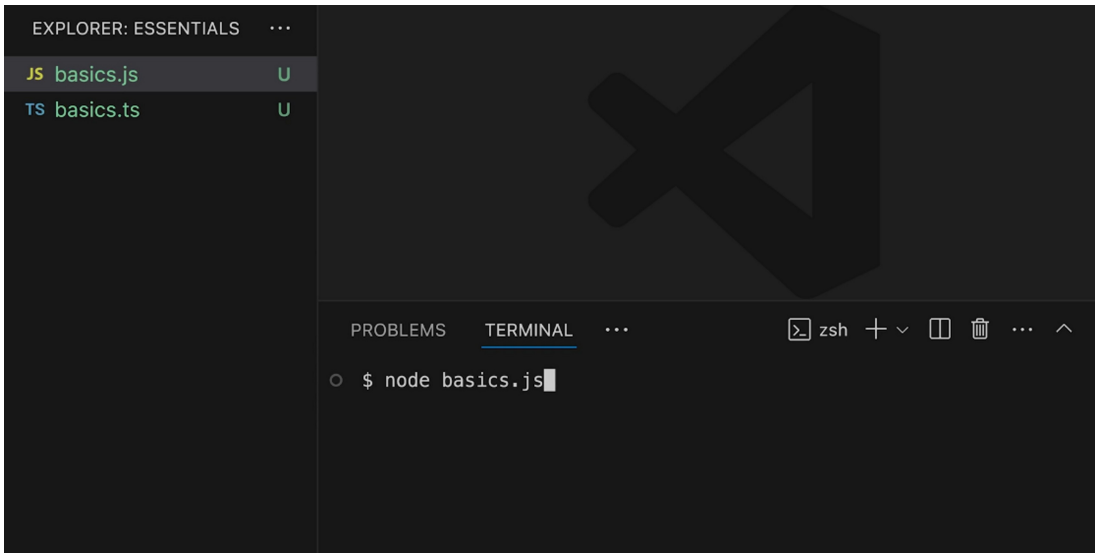
Project Setup

We are not going to build a website or anything like that. Instead we will write our typescript code in simple typescript files and we will execute them with node.js



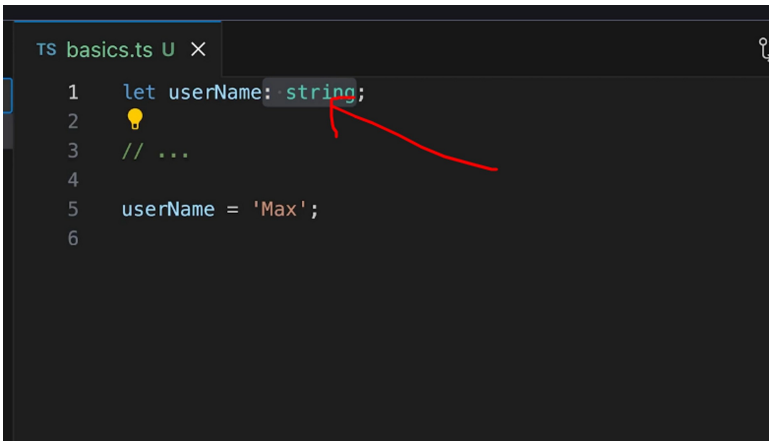
Now let's execute javascript file

"node basics.js"



Working with Types & Exploring Built-in Types

Vanilla JavaScript has Types too!



💡 **What's being said?**
You're talking about **type assignments** in **TypeScript**, like this:

ts

let myName: string = "Khalid";

🧠 **Key Points:**
✅ **1. Type assignments like : string, : number, : boolean are TypeScript-specific**
In JavaScript, you don't do this kind of stuff. TypeScript lets you **declare types** for variables, which helps with:

- Code safety 🚨
- Better IntelliSense in editors 💻
- Fewer bugs 👻

🚨 **2. "string" should be lowercase**

ts
let myName: string; ✅
let myName: String; ❌
Why? Because string is a **primitive type**, while String (uppercase) refers to a class — not what you want 99.9% of the time.
So always use lowercase for:

- string
- number
- boolean
- object
- undefined
- null

🔍 **3. JS vs TS — What's the difference?**

Feature	JavaScript	TypeScript
Type assignment (: string)	❌	✅
Runtime value types	✅	✅

Compile-time safety ❌ ✅

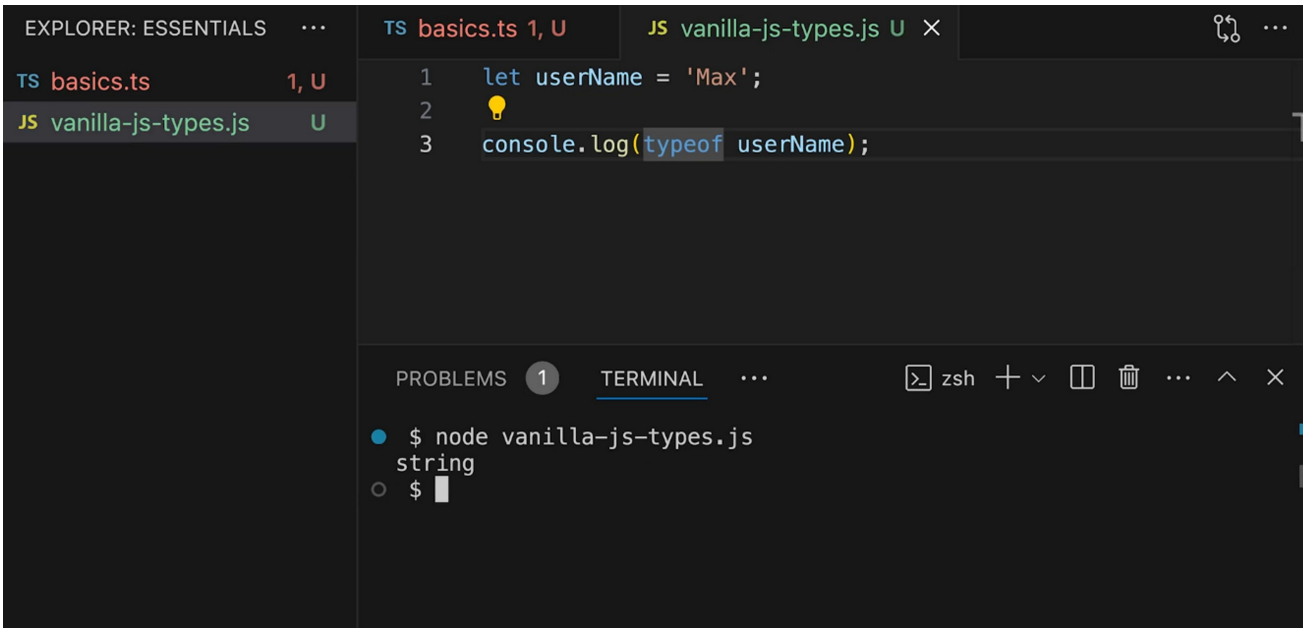
Even JavaScript understands **value types**, like when you do:

```
js
const age = 25;
console.log(typeof age); // "number"
```

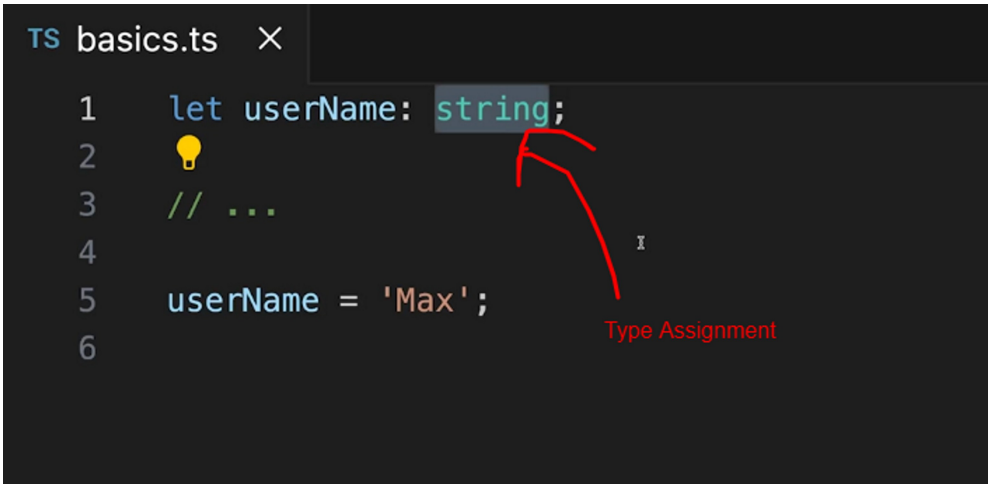
But JS doesn't let you **enforce** that age must be a number — that's where TypeScript comes in and slaps on a type rule 😤

✨ **In Summary:**

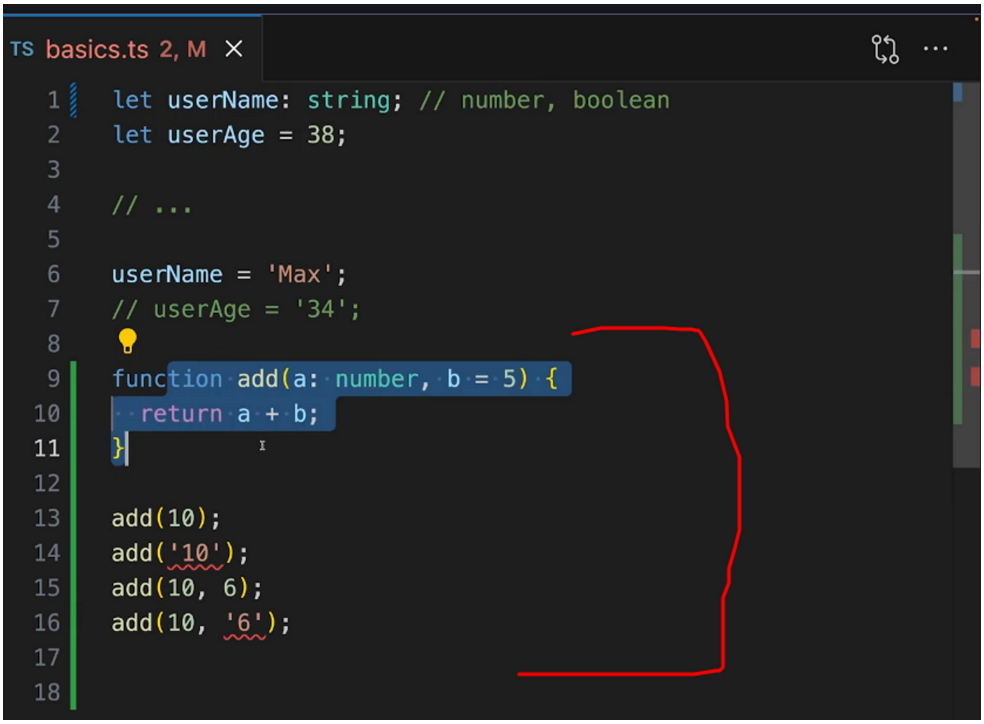
- : string, : number = TypeScript magic 💫
- Use lowercase (string, not String) — always
- JavaScript knows value types too, but doesn't **enforce** them like TypeScript



Type Inference vs Type Assignment



Assigning Types to Function Parameters



The "any" type

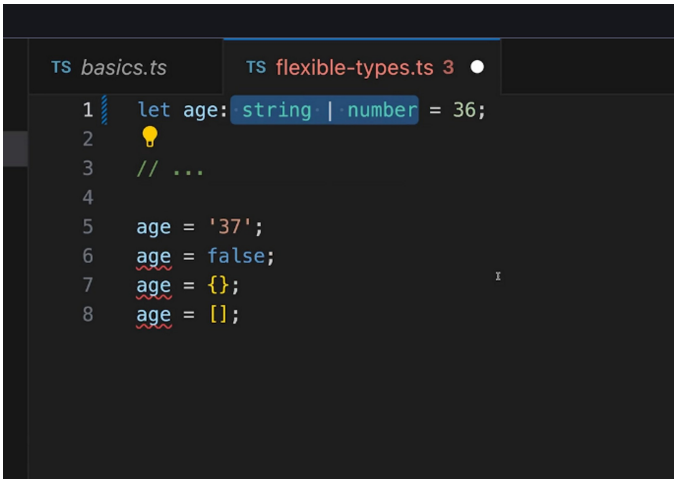
We always worked with exactly one type, one kind of value. Uesrname must be string, user age must be a number.

But you sometimes have situations where you need more flexibility and that's why typescript also offeres more flexible types.

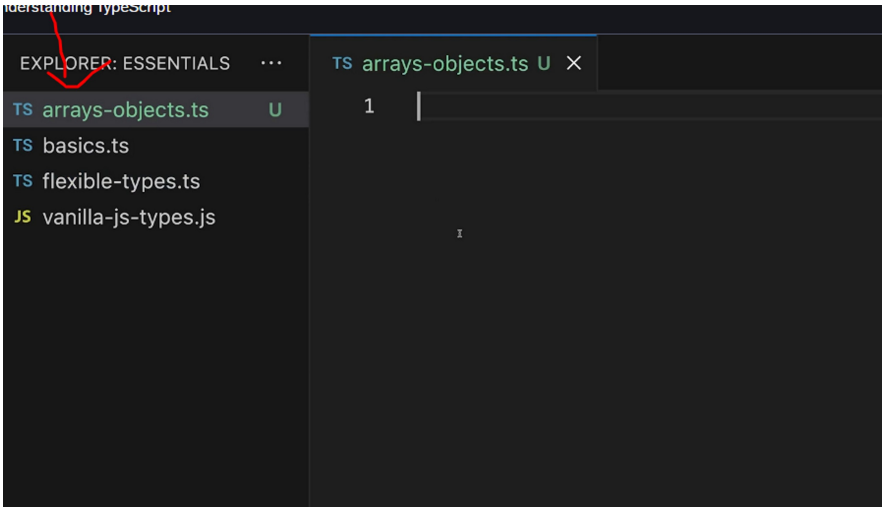
With 'any' we are allowing anything.

Understanding Union Types

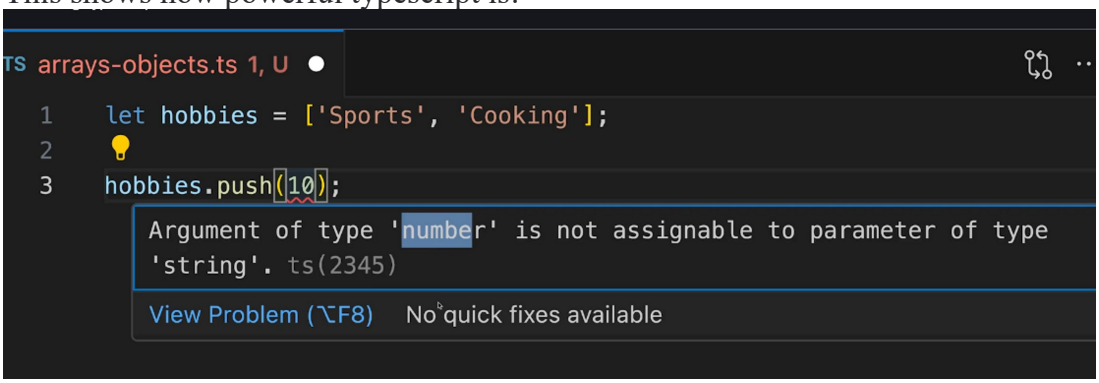
With any type we are basically allowing anything which defeats the purpose of typescript.



Arrays & Types

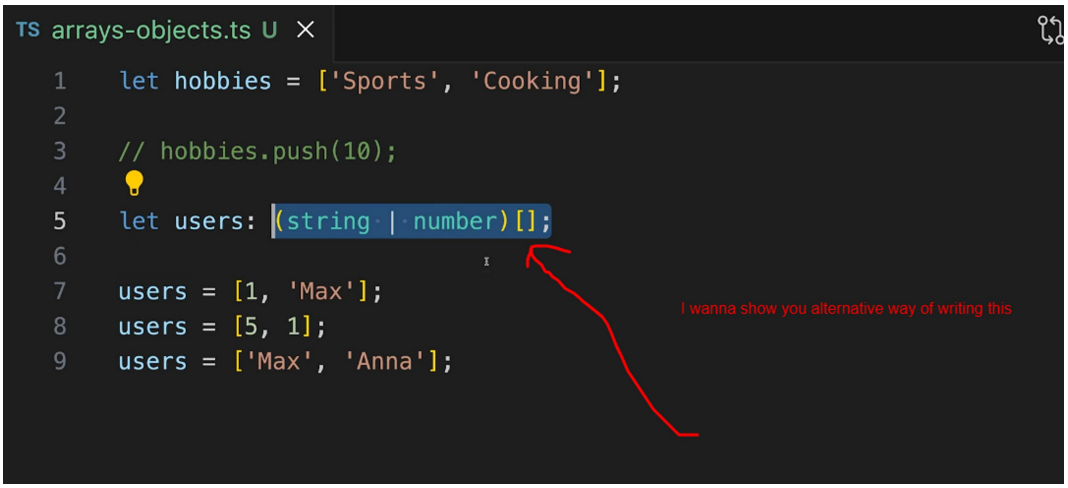


This shows how powerful typescript is!



Advanced Array Types

A First Glimpse At Generic Types - Alternative Array Type Declaration

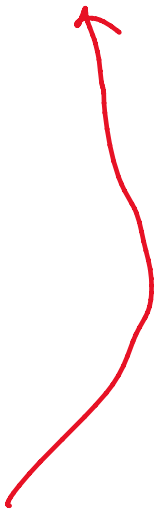


```
let hobbies = ['Sports', 'Cooking'];

// hobbies.push(10);

// let users: (string | number)[];
let users: Array<string | number>;

users = [1, 'Max'];
users = [5, 1];
users = ['Max', 'Anna'];
```



This is so called generic type. You could also use this. We will learn more on generic later in this course.

Generic type => combination of multiple type.

Making Sense of Tuples

There is also another kind of array type.

There is so called tuple type.

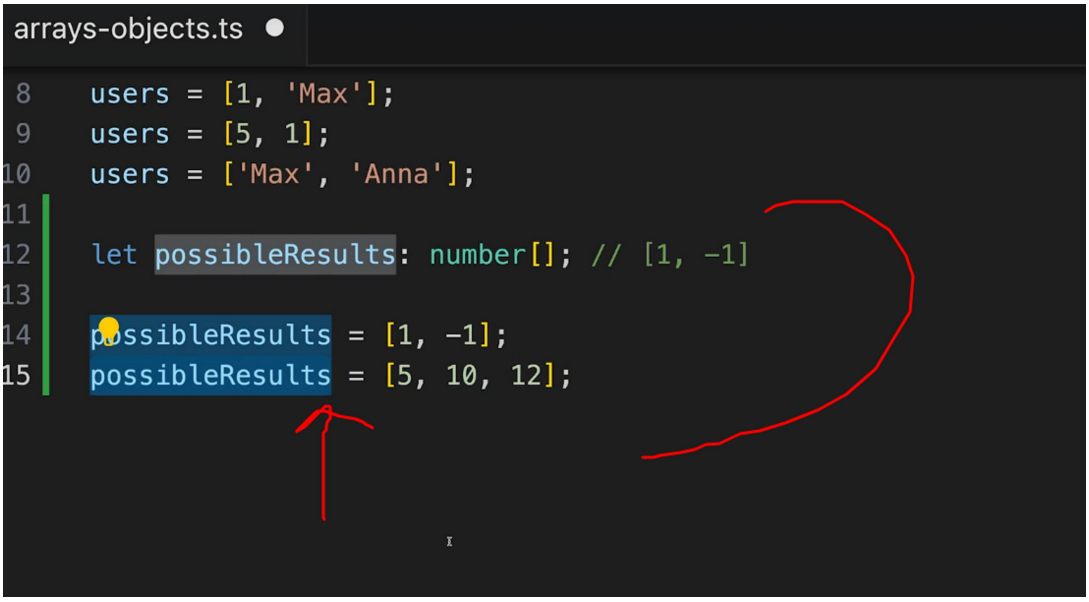
```ts
let users: Array<string | number>;

users = [1, 'Max'];
users = [5, 1];
users = ['Max', 'Anna'];

```

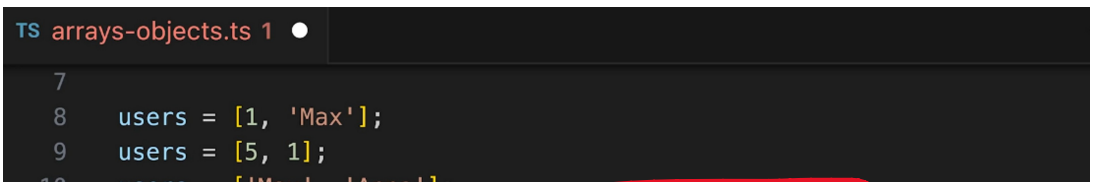
Let's assume we want to just store two values in a array. Not more other than that.

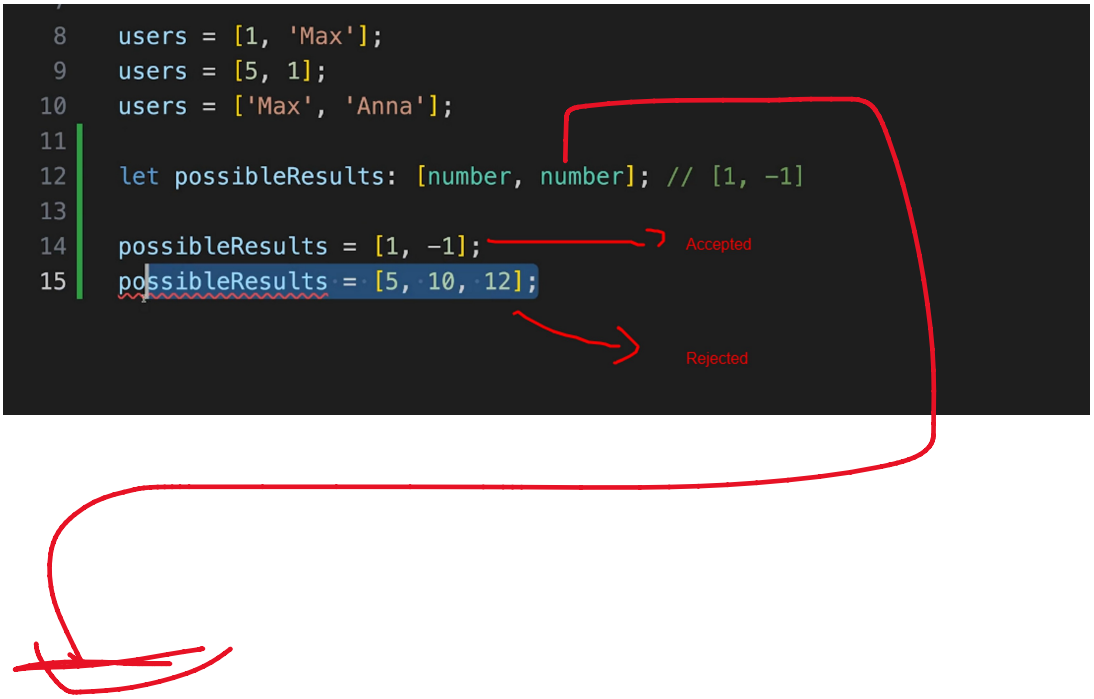
So, we could define the array like this



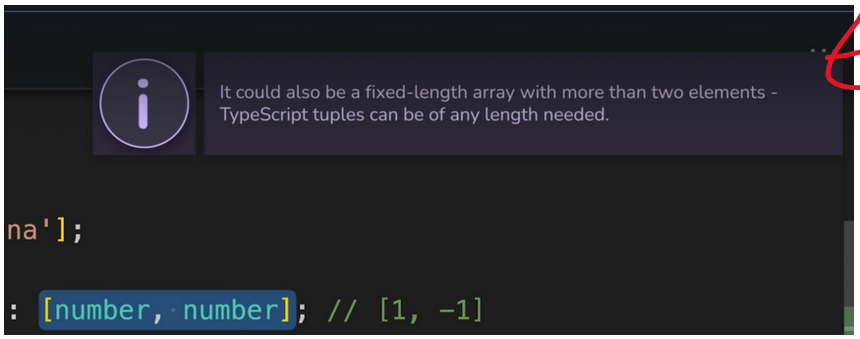
You might wonder why would I do that? But imagine you are working in a big team and not all colleagues are aware of it!

That's where 'tuple' comes into place.



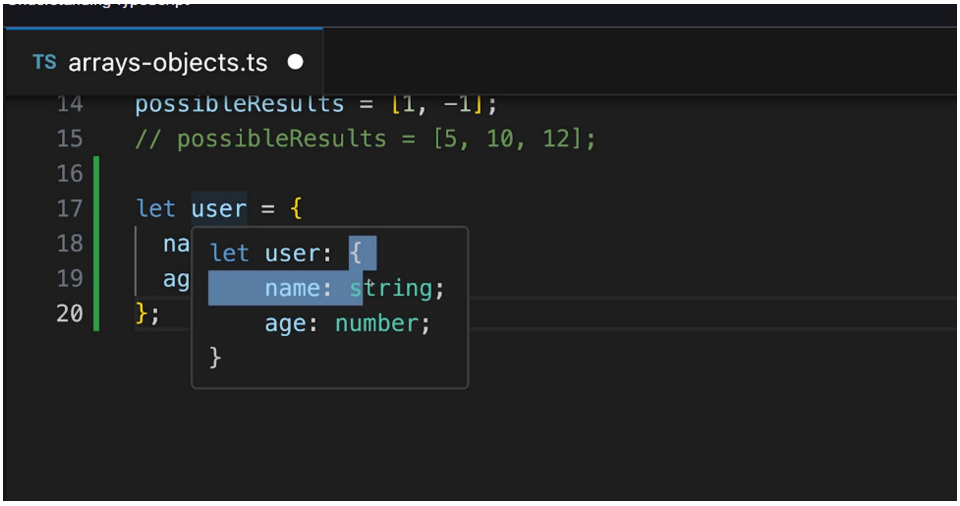


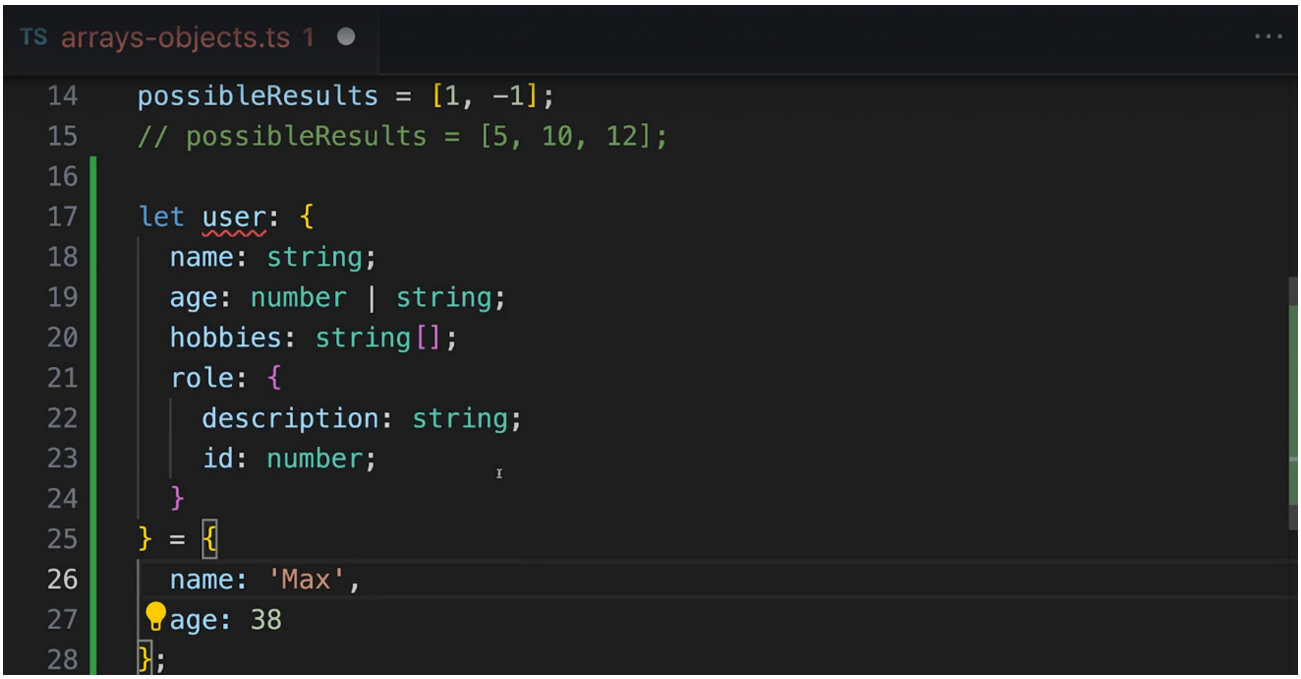
By doing it, you are telling typescript that possible results is a tuple with exactly two values, where the first value will be if type number which is why this value here is accepted. Second value is rejected



Object Types

Inferred Object


TS arrays-objects.ts
14 possibleResults = [1, -1];
15 // possibleResults = [5, 10, 12];
16
17 let user = {
18 na
19 ag
20 };
let user: {
name: string;
age: number;
}


TS arrays-objects.ts 1
14 possibleResults = [1, -1];
15 // possibleResults = [5, 10, 12];
16
17 let user: {
18 name: string;
19 age: number | string;
20 hobbies: string[];
21 role: {
22 description: string;
23 id: number;
24 }
25 } = {
26 name: 'Max',
27 age: 38
28 };

```ts
let user: {
  name: string;
  age: number | string;
  hobbies: string[];
  role: {
    description: string;
    id: number;
  }
} = {
  name: 'Max',
  age: 38
};
```

```ts
// arrays-objects.ts
let user: {
  name: string;
  age: number | string;
  hobbies: string[];
  role: {
    description: string;
    id: number;
  }
} = {
  name: 'Max',
  age: 38,
  hobbies: ['Sports', 'Cooking'],
  role: {
    description: 'admin',
    id: 5
  }
};
```

Tricky: The "Must Not Be Null" type

🧩 The Confusing Part: {} as a Type

💉 Example:

ts
CopyEdit
let val: {} = "hello";
You'd think this should throw an error, right? Like…

"Bro, val is supposed to be an object, how tf is a string okay?"

But TypeScript just shrugs and says:

"Cool, whatever bro." 😎

🤯 Why This Happens?

Because in **TypeScript**, when you use {} *as a type*, it actually **does NOT mean "empty object"**.

❗ **It actually means:**

"any non-null, non-undefined value"

So:

ts

CopyEdit

```
let val: {} = "hello";       // ✅ allowed
let val: {} = 123;           // ✅ allowed
let val: {} = false;         // ✅ allowed
let val: {} = [];            // ✅ allowed
let val: {} = {};            // ✅ allowed
let val: {} = null;          // ❌ error
let val: {} = undefined;     // ❌ error
```

🤯 **What {} does NOT mean:**

It does **not** mean:

ts

CopyEdit

```
{
  // no properties allowed
}
```

That's what most people (including us devs from a C-like background) **expect**, but TypeScript ain't doing that here 😤

💡 **So What Should You Use Instead?**

If you *actually* want to allow only real object types (like objects with keys/props), you should use:

ts

CopyEdit

```
let val: object; // ✅ only accepts object types, not primitives like string/number
```

Or if you want a real empty object type:

ts

CopyEdit

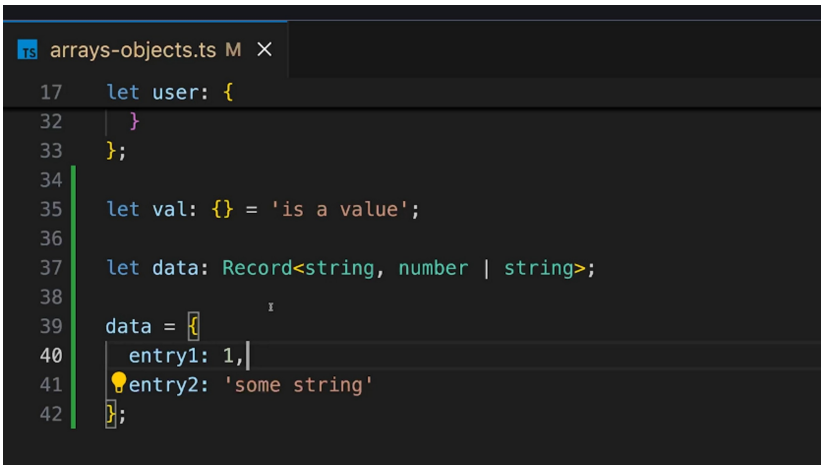
```
let val: { [key: string]: any }; // ✅ allows any key-value pairs
let val: Record<string, any>;    // ✅ same thing, cleaner syntax
```

⚠️ **Summary (Sticky Notes Style):**

Type	What it really means	Allows
{}	Anything **except** null or undefined	string, number, boolean, array, object ✅
object	Real JS object types only	{}, [], { name: "Khalid" } ✅ "hello", 123 ❌
Record<string, any>	Key-value object with string keys	{ name: "Khalid" } ✅

🗣️ **Real Talk Tip:**
If you're ever confused by TypeScript types — run them through the TS Playground and see what happens. That thing is a blessing 😇

Flexible Objects with the Record Type



🎯 **The Scenario**

You wanna make a variable (data) that holds an object with **unknown keys**, like:

ts

```
const data = {
  name: "Khalid",
  age: 25,
  email: "khalid@email.com",
};
```

But here's the twist:

> You don’t know yet which keys will be in the object — just that it will be *some object*, and the keys will be strings, and the values will be of a certain type.

❌ **Why this won’t work:**

ts

```
let data: {} = {};
```

This just means: **"any value that’s not null or undefined"**
So it’s *too loose*, and doesn't actually restrict data to be a proper object.

✅ **Use Record<KeyType, ValueType>**
💉 **Example:**

ts

```
let data: Record<string, string | number> = {};
```

This says:

- All keys must be **strings** 🔑
- All values must be **string or number** 🗨️🔢

Now you can do:

ts

```
data["name"] = "Khalid";    // ✅
data["age"] = 25;           // ✅
data["email"] = "yo@abc.com"; // ✅
data["isActive"] = true;    // ❌ Error: `boolean` not allowed
```

🎯 **Real-life Use Case (Alumni Website 👨‍🎓)**
Let’s say you’re building a students object:

ts

```
const students: Record<string, { name: string, gradYear: number }> = {};
```

Then you can dynamically add students:

ts

```
students["student001"] = { name: "Khalid", gradYear: 2020 };
students["student002"] = { name: "Rafi", gradYear: 2022 };
```

Boom! You’ve got type safety *and* flexibility. 😎

🤖 **Behind the Scenes (Generics)**
When you see this:

ts
CopyEdit
Record<string, number>
You're using a **generic type**. Record is a generic, meaning it's like a function for types — you plug in:

- What kind of keys you want (string, number)
- What kind of values you want (string, boolean, object, whatever)

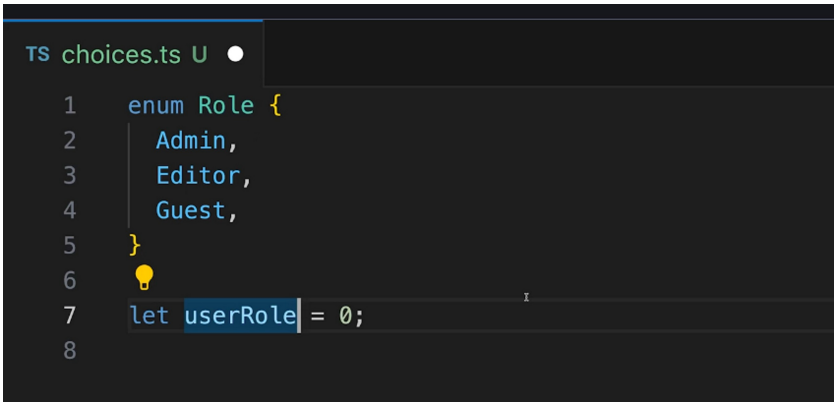
And it builds the type *on the fly*.

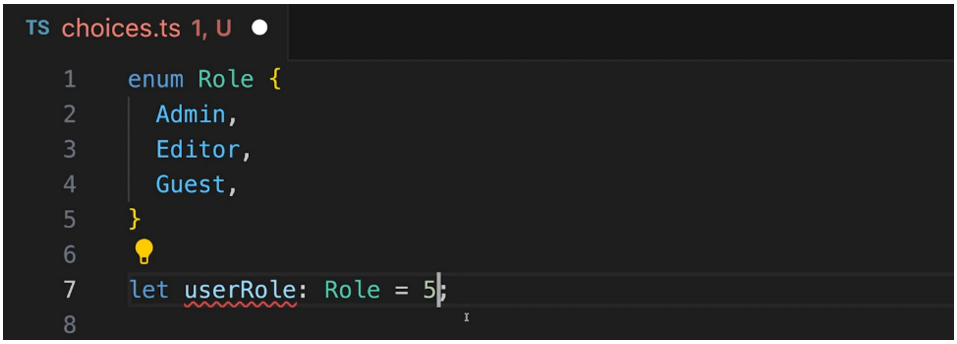
🧠 **TL;DR Summary**

Concept	What it means
{} as type	Any value except null/undefined (not ideal)
object as type	Only object values, no primitives
Record<K, V>	Keys of type K, values of type V
Record<string, any>	Object with unknown string keys & any values

If you're building anything dynamic or key-based (like a dictionary, a settings object, a student registry, etc), **Record is your best friend** 👭💙

Working with Enums





If I compile this .ts file

```ts
enum Role {
  Admin,
  Editor,
  Guest,
}
```

```
PROBLEMS  DEBUG CONSOLE  TERMINAL  ...  zsh
$ tsc choices.ts
```

This is our compiled js code

```js
var Role;
(function (Role) {
    Role[Role["Admin"] = 0] = "Admin";
    Role[Role["Editor"] = 1] = "Editor";
    Role[Role["Guest"] = 2] = "Guest";
})(Role || (Role = {}));
var userRole = Role.Admin;
// ...
userRole = Role.Guest;
```

You can also store string

```ts
enum Role {
  Admin = 'Admin',
  Editor = 'Editor',
  Guest = 'Guest',
}
```

📌 **The Problem**
You're tracking **user roles** like this:

ts
CopyEdit
let userRole = 0; // 0 = admin, 1 = editor, 2 = guest
🧠 Sure, it works… but what the heck does 0 even mean without a comment? It's not readable, not safe, and *low-key* messy.

✅ **The Solution: enum**

🔥 **Declare it like a boss:**

ts
CopyEdit
enum Role {
  Admin,
  Editor,
  Guest,
}
Boom. Role is now a custom type with only **3 allowed values**: Role.Admin, Role.Editor, and Role.Guest.

🚀 **Use it like this:**

ts
CopyEdit
let userRole: Role;
userRole = Role.Admin; // ✅
userRole = Role.Guest; // ✅
userRole = 0;   // ✅ also works, because Admin = 0 internally
userRole = 5;   // ❌ not allowed, TypeScript will complain
So internally:

ts
CopyEdit
Role.Admin = 0
Role.Editor = 1
Role.Guest = 2
But *externally*, your code is now **self-documenting** and 🔒 type-safe.

😈 **Make it even clearer (Custom Values!)**

Let's say you want to **manually assign values**, like strings:

ts
CopyEdit
enum Role {
  Admin = "ADMIN",
  Editor = "EDITOR",
  Guest = "GUEST",
}
This is 💯 for APIs, databases, or configs where you care about **exact values**.

ts
CopyEdit
let userRole: Role = Role.Editor;
if (userRole === Role.Editor) {
  console.log("Welcome, editor!");
}

🧠 **TL;DR Cheat Sheet**

Feature	What it does

enum Role { ... }	Creates a new type with specific allowed values
Default enum values	Are numbers starting from 0
Custom values	You can use strings (or numbers) manually
Safer than constants	Prevents invalid assignments
Improves readability	Makes your code hella clean and descriptive ✅

👀 **Quick Example in a React Context:**

ts
CopyEdit
```
enum Theme {
  Light = "light",
  Dark = "dark",
}
const [theme, setTheme] = useState<Theme>(Theme.Light);
const toggleTheme = () => {
  setTheme(prev => prev === Theme.Light ? Theme.Dark : Theme.Light);
};
```
Super clean, type-safe, and 🔒 avoids accidental string mistakes.

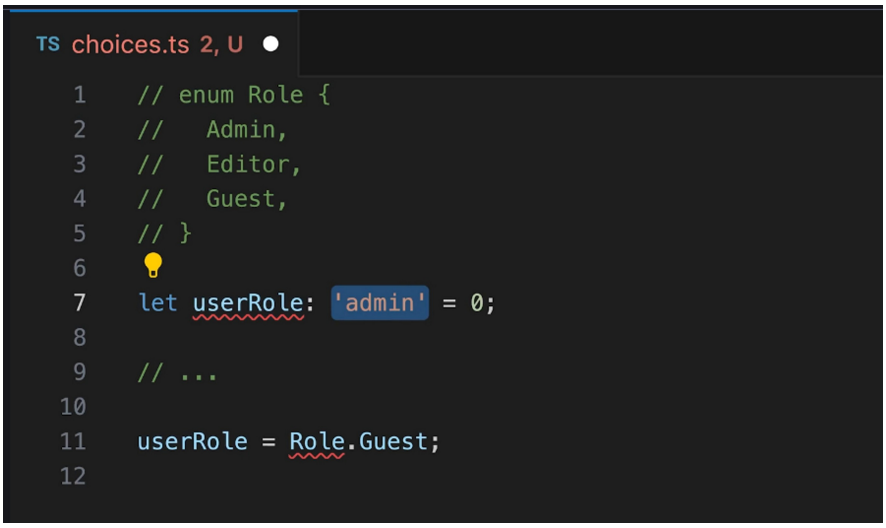
Being Specific With Literal Types

So this enum feature can be really useful if you have a set number of choices you want to use in your code. There also is an alternative to using an enum though, which arguably is a bit more popular. So you might find enums in certain code bases, but there also are developers who try to avoid them. In the end, it comes down to personal preferences, but it's important to know about the arguably more popular alternative to enums. So instead of defining such a role enum here, instead of using that,

you could also use a union type here
for the userRole variable

combined with another TypeScript feature
you haven't learned about yet: literal types.
Because in TypeScript you cannot just set up

general types like number or string, you could say,
but you can also define very specific values as types.
For example, you could set the string admin
as a type for userRole.



Now this might look very weird
because this very much looks like a string value,
and it would be if it were on the right side
of the equal sign.

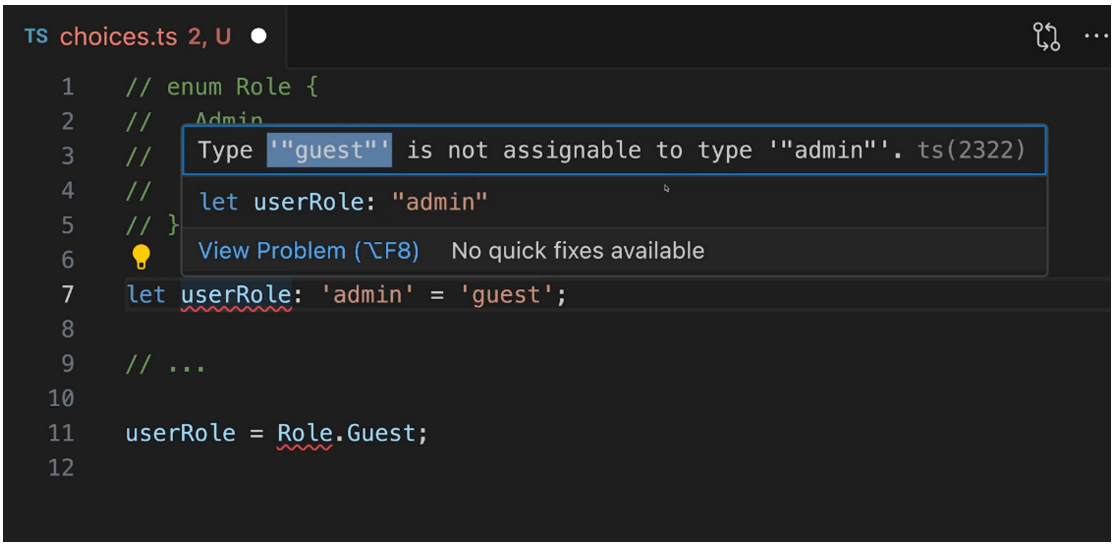
But here on the left side of the equal sign
after this colon, no matter if you're using it
on a variable or a parameter, in a function
or anywhere else, this thing here
is actually not a value but a type.

And it tells TypeScript that the allowed value
for userRole is this very specific string.

So if I were to store the string guest in there,
I would get an error that the type guest
is not assignable to this very specific string type.

Now you might wonder what the use of this
very specific string type is.
After all, this does not give us any flexibility at all.
Well, it gets more useful if you turn it into a union type

and you tell TypeScript that userRole
should either be the string admin or the string editor,
let's say, or the string guest.
Now we can initialize this to admin,
but later on, instead of using an enum,



And I'm even getting auto-completion in my IDE here
because it understands which options we have.
And that's another very convenient way
of working with options.

And as mentioned, it's arguably more popular
in the TypeScript community than using an enum.
But you can use both alternatives