# TypeScript

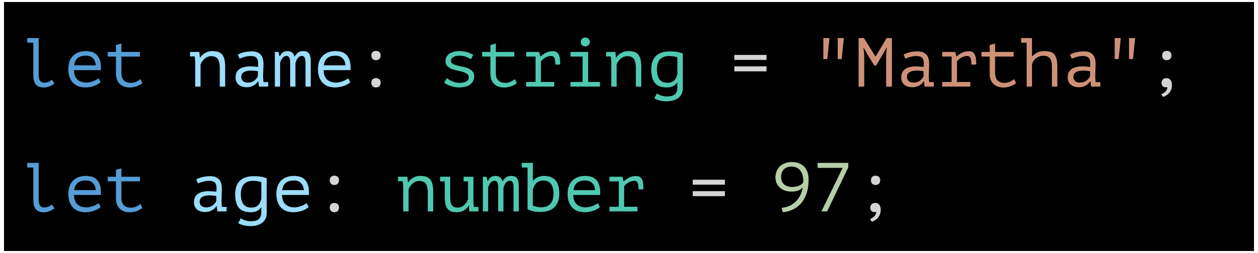
# TypeScript

TypeScript is a strongly typed, object-oriented, compiled language.

Think of TypeScript as C# or Java for JavaScript developers.

# TypeScript is Strongly-Typed

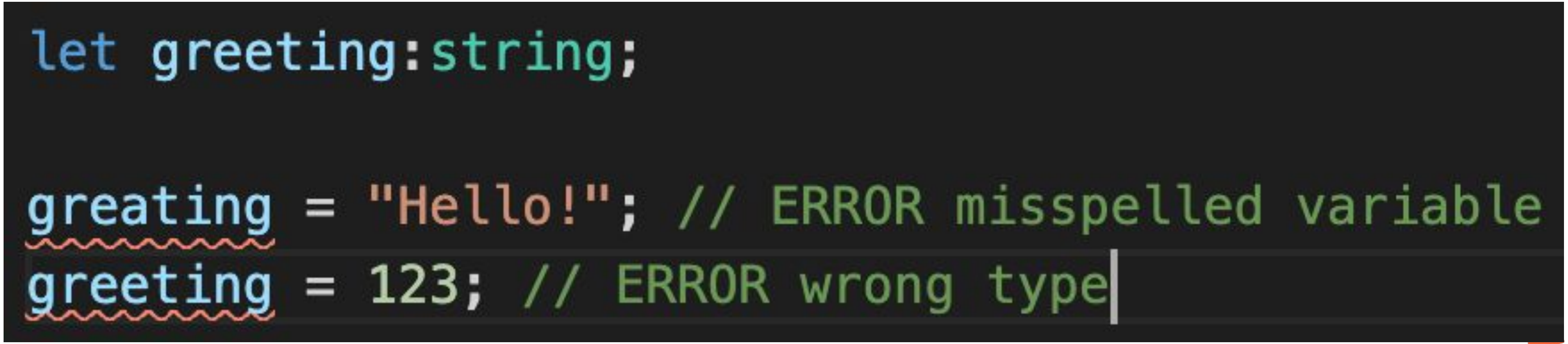
Variables and functions have pre-set, unchanging types in the code. When a variable is declared, a type is specified, such as string, number, or boolean.



```
let name: string = "Martha";
let age: number = 97;
```

# TypeScript is Strongly-Typed

This helps you catch typos and other errors as you type your code!



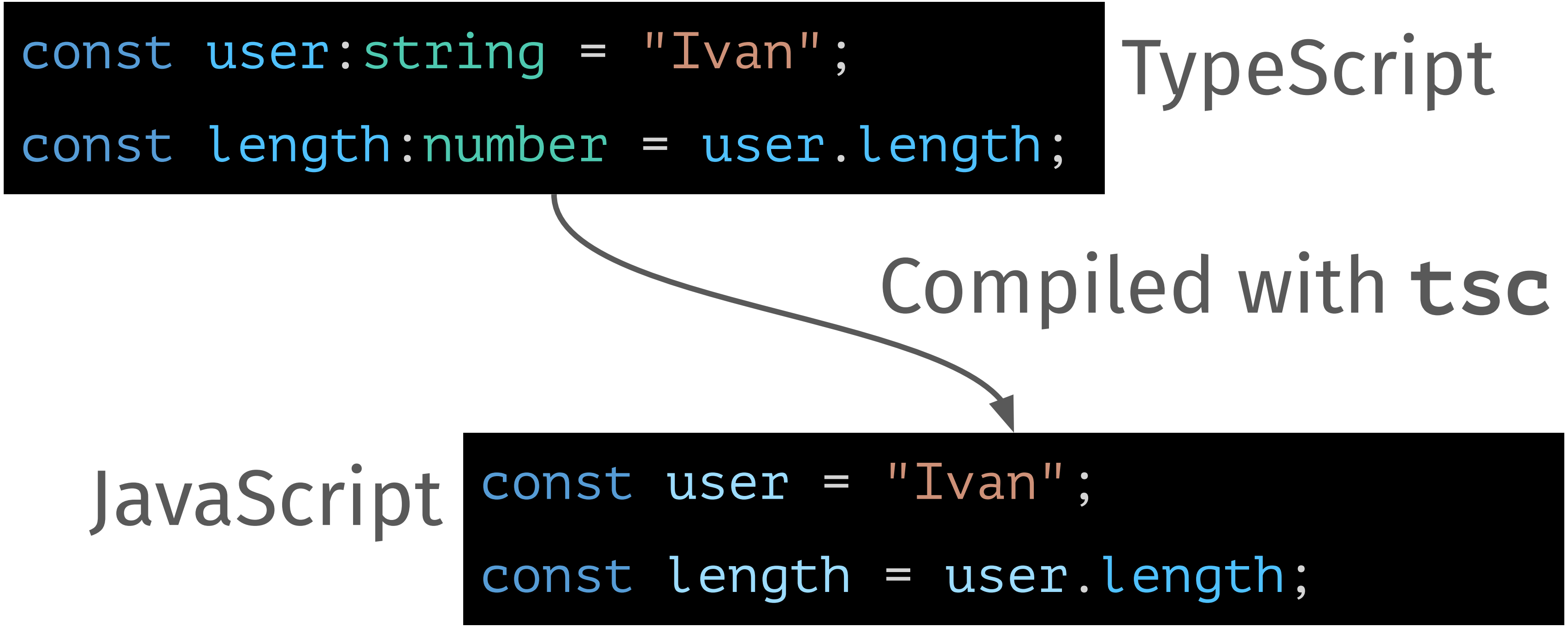
```
let greeting:string;

greating = "Hello!"; // ERROR misspelled variable
greeting = 123; // ERROR wrong type
```

# TypeScript is Compiled

TypeScript cannot be run in the browser or directly with Node.js.

It must be compiled to JavaScript using the **`tsc`** (TypeScript Compiler) command.

# Compiled to JavaScript



```
const user:string = "Ivan";
const length:number = user.length;
```

TypeScript

Compiled with **`tsc`**

JavaScript

```
const user = "Ivan";
const length = user.length;
```

# ts-node

There are also tools like `ts-node` that can run TypeScript directly.

# TypeScript Project Setup

# TypeScript Project Setup

Follow the steps in this guide to set up a project on your computer with TypeScript.

# Run TypeScript Code

Two options:

1. Run once:

   ```
   npm start
   ```

2. Start running and re-run every time a change is saved. (To stop this running, press CTRL+C.)

   ```
   npm start:dev
   ```

# Build TypeScript

To compile TypeScript files to JavaScript, run the tsc command. But this is not something we'll usually need to do in this class.

```
npx tsc
```

# TypeScript: Type Annotations

# Type Annotations

Type annotations are used to define the intended data type for variables, function parameters, the intended number of parameters for a function, as well as what data type a function should return.

# Variables

Specify type with colon after variable name.

```
let firstName: string = "Martha";
let age: number = 97;
let retired: boolean = true;


retired = "Heck, Yeah!"; // ERROR, wrong type
```

# Arrays

Specify array with element type and brackets.

```
let names: string[] = [ "Martha", "Barry", "Tim" ];
let ages: number[] = [ 97, 23, 2 ];


names.push("Lakshmi"); // OK
ages.push("four"); // ERROR wrong element type
```

# Function Parameters

Parameter types are the same as variables.

```
function find(names: string[], maxLen: number) {
  ...
}

find(["a", "an", "the"], 2); // OK
find([1, 2, 3], 3); // ERROR wrong array type
```

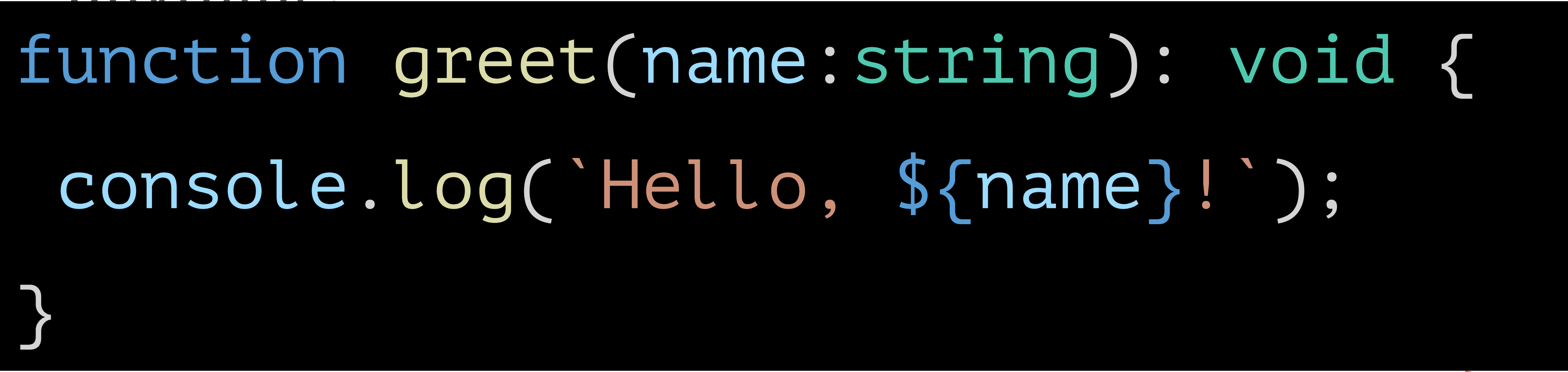
# Function Return Type

Annotation after function parameters.

```
function countLetters(word: string): number {
  ...
}

let count:number = countLetters("ABC"); // OK
let x:string = countLetters("ABC"); // ERROR
```

# Void Return Type

Use **void** if a function does not return anything.



```
function greet(name:string): void {
 console.log(`Hello, ${name}!`);
}
```

# Arrow Functions

Arrow function syntax is similar.

```
const countLetters = (word: string): number =>
{
  ...
}
```

# Optional Parameters

If a parameter is optional, add a question mark.

```
function greet(name: string, title?: string) {
 ...
}

greet("Velma");
greet("Isaac Newton", "Sir");
```

# Default Parameters

A parameter can also be optional by adding a default value.

```
function add(a: number, b: number = 1) {
 return a + b;
}

add(2, 3); // 5
add(7);    // 8
```

# Basic Types

| Type | Annotation | Description |
|---|---|---|
| Boolean | `let done: boolean = false` | Same as in JavaScript. |
| Number | `let num: number = 10` | Same as in JavaScript. |
| String | `let word: string = 'Hi'` | Same as in JavaScript. |
| Array | `let nums: number[] = [1,2]` | An Array of a specific type of element. |

# Basic Types

| Type | Annotation | Description |
|---|---|---|
| Any | `let something: any = 1;`<br>`something = 'hi'` | Allows for dynamic type of a variable. |
| Void | `const print(): void =>`<br>`console.log('something')` | Used with functions that return nothing. |
| (or) | `let pet: string\|null;`<br>`let age: string\|number;` | Allow multiple types. |

Find more information on types here.

# Interfaces

An interface is an outline for an Object.

Using the **`interface`** keyword allows an Object's properties, methods, and types to be defined.

An interface looks like an object literal except properties are not separated by commas, but by semicolons.

```
interface Person {
 firstName: string;
 lastName: string;
}
```

# Interfaces

Add this interface to our greeter example and see how that changes the type annotations.

```
interface Person {
 firstName: string;
 lastName: string;
}

const greeter = (person: Person): string =>
   `Hello ${person.firstName} ${person.lastName}`;

const user: Person = { firstName: 'Ivan', lastName: 'Herndon' };

console.log(greeter(user));
```

# Interfaces

When using an interface as a type annotation, all previous benefits remain the same.

If the function argument or variable is missing a property or it is of the wrong type, TypeScript will throw an error during compilation to assist in prevent runtime errors.

# TypeScript: Null & Undefined

# Null & Undefined Not Allowed

If a variable is specified as a string, it must always contain an actual string, **not null or undefined**. The same is true for any type, e.g. number, etc.

```
let pet: string;

pet = "Muffins";
pet = null; // ERROR
pet = undefined; // ERROR
```

# Type Annotations: Nullable Variables

If a variable should be able to be null or undefined, specify the option with a pipe (|).

```
let vendor: string|undefined;
let pet: string|null;

pet = "Muffins";
pet = null; // OK!
```

# Required Properties on Interfaces

Every property on an interface is required by default.

```
interface Airplane {
 pilot: string;
 copilot: string;
}

// ERROR! copilot is missing.
let myPlane: Airplane = { pilot: "Snoopy "};
```

# Optional Properties on Interfaces

But properties may be specified as optional by adding a question mark.

```
interface Airplane {
 pilot: string;
 copilot?: string;
}

let myPlane: Airplane = { pilot: "Snoopy "};
let yourPlane: Airplane = { pilot: "Snoopy",
                            copilot: "Woodstock" };
```

# Dealing with Nullable & Optional

TypeScript is very careful about nullable variables and optional properties. You may run into errors related to this when you try to use these variables.

# Examples of Errors

```
const words = [ "Apple", "Berry", "Chip", "Dip" ];
const word: string|undefined =
        words.find(aWord => aWord.startsWith("J"));

// ERROR: Object is possibly 'undefined'.
console.log(word.length);

// ERROR: Argument of type 'string | undefined' is
not assignable to parameter of type 'string'.
"Apple Pie".indexOf(word);
```

# Solutions

Here are some situations. Each has a different solution.

1. We are certain it will actually not be null or undefined.
2. We want to provide a backup "default" value in case it is null or undefined.
3. We need different logic if it is null or undefined.
4. We're accessing a property, and it's okay if either the object or the property is null or undefined.

# Solution 1: It's Not Null

If we are certain it will actually not be null or undefined, use the "non-null assertion operator", which is an exclamation point after the variable.

```
console.log(word!.length);

"Apple Pie".indexOf(word!);
```

# Solution 2: Provide a Default

If we want to provide a backup "default" value, use the "nullish coalescing operator" (??). The value after the operator is the backup value.

```
"Apple Pie".indexOf(word ?? "None");
```

# Solution 3: Different Logic

If we need different logic when it is null or undefined, use an if/else or ternary

```
if (word !== undefined) {
 "Apple Pie".indexOf(word);
} else {
 console.log("Word not found.");
}
```

# Solution 4: Null Object is Okay

If we're accessing a property of an object that might be null or undefined, the "optional chaining operator" (?.) will stop and return null/undefined rather than attempting to access the property and crashing the code.

```
console.log(word?.length);
```

# Import & Export

# ES6 Modules

In Node.js programs, we've been using **`require()`** and **`module.exports`** to use other modules. This is part of the CommonJS module system.

TypeScript prefers the ES6 Module System. The systems are similar, but the syntax is a bit different.

# Individual Exports

Export individual items like this.

```
export const city = "Detroit";
export const state = "MI";
```

And import them in another file like this.

```
import { city, state } from "./first-file";
console.log(city + ", " + state); // Detroit, MI
```

# Export Variables, Interfaces, etc.

```
export let planet = "Earth";
export interface Person {
 name: string;
 age: number;
}
export function birthday(person: Person):void {
 person.age++;
}
```

# Default Export

Each file can also export one default item.

```
const PI = 3.14159265;
export default PI;
```

Import it in another file like this.

```
import PI from "./pi";
console.log(PI); // 3.14159265
```

# Default & Individual Exports

It's possible to combine both.

```
export default interface Person {
 name: string;
 age: number;
}
export function birthday(person: Person):void {
 person.age++;
}
```

```
import Person, { birthday } from './Person';
```

# TypeScript Reference

Read more about TypeScript at typescriptlang.org.

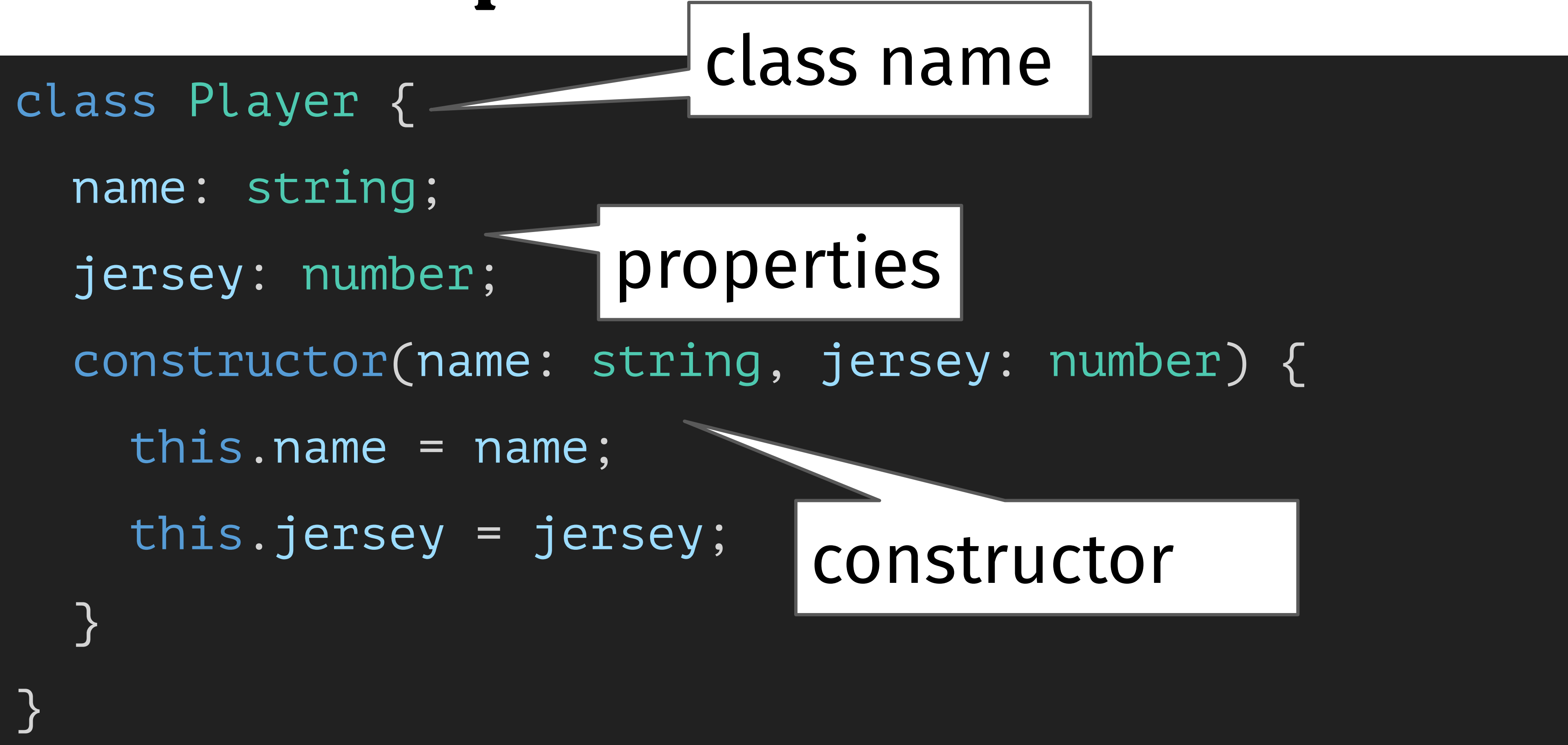
For import/export, see the section on Modules.

# Classes

# Classes

- TypeScript classes are similar to Java classes.
- Fields are called properties and are public by default. We don't usually use getters and setters in TypeScript or JavaScript.

# Class Example



```
class Player {
  name: string;
  jersey: number;
  constructor(name: string, jersey: number) {
    this.name = name;
    this.jersey = jersey;
  }
}
```

# Class Instances

Use the **new** keyword to create objects from the class blueprint. These are called **instances**.

```
let mike: Player = new Player("Michael Jordan", 23);
let p1: Player = new Player("Isiah Thomas", 11);
let p2: Player = new Player("Lionel Messi", 10);
```

# Property Initial Value

Properties should either have their value set in the constructor or given an initial value.

```
class Timer {
 name: string;
 time: number = 0; // value starts at 0
 constructor (name: string) {
   this.name = name;
 }
```

# Methods

```
class Circle {
 radius: number;
 constructor(radius: number) {
   this.radius = radius;
 }

 getArea(): number {
   return Math.PI * this.radius * this.radius;
 }
 getCircumference(): number {
   return 2 * Math.PI * this.radius;
 }
}
```

classes can have methods just like Java

# `this` Keyword

**`this.`** must **always** be used inside the class to refer to properties and methods of the current instance. Unlike Java, it is never optional.

```
constructor(name: string, jersey: number) {
   this.name = name;
   this.jersey = jersey;
}
```

# Modifiers

- **public** - a property/method can be used anywhere (this is the default)
- **private** - a property/method cannot be used outside of this class
- **readonly** - a property cannot be changed

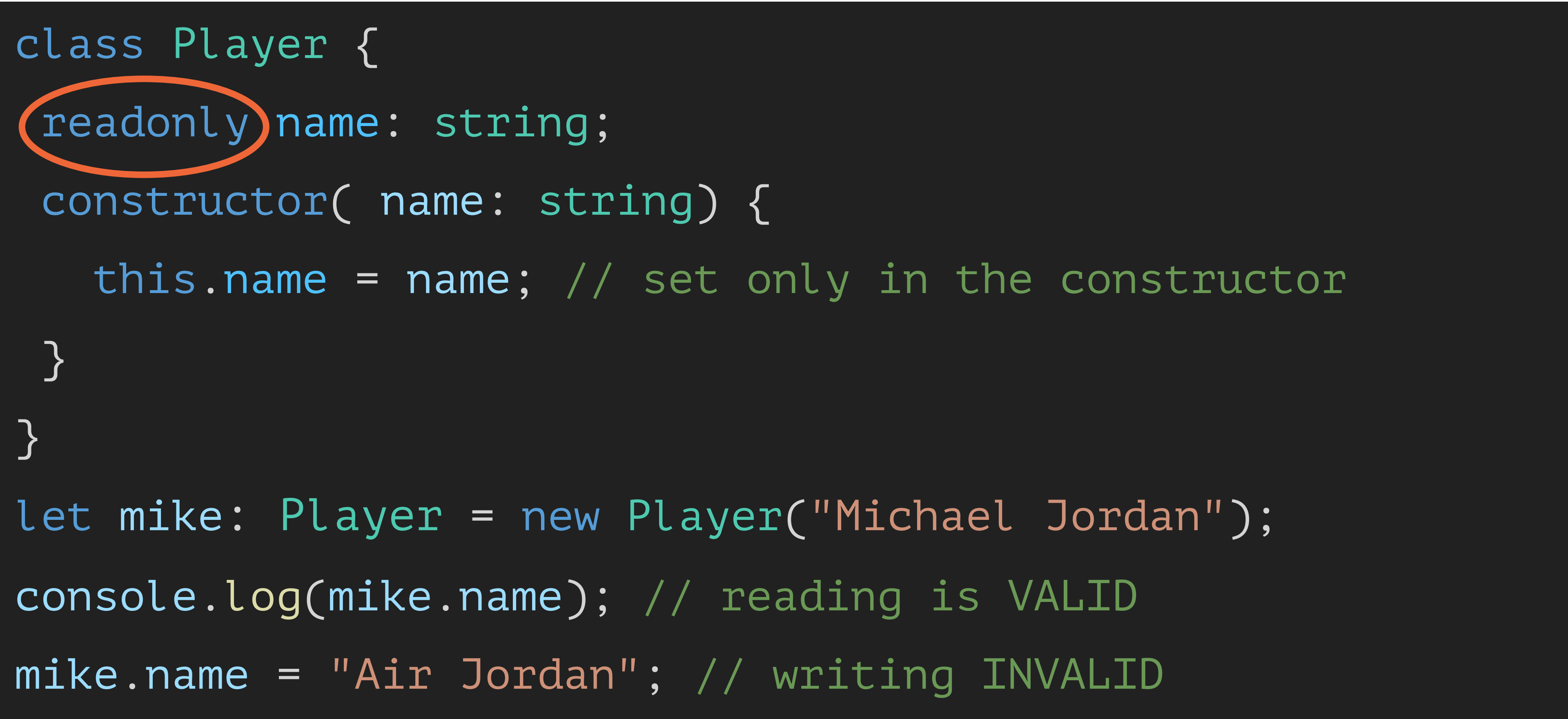
# Public

```
class Player {
  public name: string; // public is the default
  constructor(name: string) {
    this.name = name; // VALID inside
  }
}
let mike: Player = new Player("Michael Jordan");
console.log(mike.name); // also VALID outside
```

# Private

```
class Player {
  private name: string;
  constructor(name: string) {
    this.name = name; // VALID inside
  }
}
let mike: Player = new Player("Michael Jordan");
console.log(mike.name); // INVALID outside
```

# Readonly



```
class Player {
 readonly name: string;
 constructor( name: string) {
   this.name = name; // set only in the constructor
 }
}
let mike: Player = new Player("Michael Jordan");
console.log(mike.name); // reading is VALID
mike.name = "Air Jordan"; // writing INVALID
```

# Parameter Properties

Add a modifier to a constructor parameter to indicate that it is a property. This allows us to define and set the property all in one place. It is essentially a shortcut.

# Parameter Properties

For example, these two classes are equivalent.

```
class Player {
  constructor(
    public name: string) {}
}
```

Adding a modifier makes this a parameter property.

```
class Player {
  name: string;
  constructor(name: string) {
    this.name = name;
  }
}
```

# TypeScript Classes Reference

Read more at typescriptlang.org.

# Array Methods

# Array Methods

The following slides cover some important methods for working with arrays. All of these apply to both TypeScript and JavaScript.

- Adding to an array (**push**)
- Removing from an array (**splice**)
- Replacing or modify an item in an array ([] syntax)
- Search an array for a single match (**find**)
- Search an array to get the index (**findIndex**)
- Search an array for all matches (**filter**)

# Add to an array

```
let colors = [ "orange", "yellow", "green", "blue" ];

// add to end
colors.push("violet");
// add to beginning
colors.unshift("red");
```

# Remove from an array

```
let colors = [ "red", "green", "cobalt", "blue" ];

// remove cobalt
// (index = 2, number of elements to remove = 1)
colors.splice(2, 1);
```

# Replace an item

```
let colors = [ "red", "green", "blue" ];


// replace green with white
colors[1] = "white";
```

# Search for single match (find)

.find() takes a callback function. It runs that function for every element and finds the first one that returns true.

```
let meals: Meal[] = [ { name: "spaghetti", price: 6 },
                      { name: "lasagnia", price: 12 },
                      { name: "pizza", price: 10 }     ];

// returns { name: "pizza", price: 10 }
meals.find(meal => meal.name === "pizza");
// returns undefined
meals.find(meal => meal.name === "curry");
```

# Search for index (findIndex)

.findIndex() is the same as .find() but it returns the index of the element rather than the element itself.

```
let meals: Meal[] = [ { name: "spaghetti", price: 6 },
                      { name: "lasagnia", price: 12 },
                      { name: "pizza", price: 10 }      ];

// returns 2
meals.findIndex(meal => meal.name === "pizza");
// returns -1
meals.findIndex(meal => meal.name === "curry");
```

# Search for all matches (filter)

.filter() returns an array of all elements for which the callback function returns true.

```
let meals: Meal[] = [ { name: "spaghetti", price: 6 },
                      { name: "lasagnia", price: 12 },
                      { name: "pizza", price: 10 }     ];

// returns [ { name: "spaghetti", price: 6 },
             { name: "pizza", price: 10 } ]
meals.filter(meal => meal.price <= 10 );
// returns []
meals.filter(meal => meal.name === "curry");
```

# Recap

- Write code in TypeScript.
- Annotate variables and function with types.
- Create and use interfaces to define object structures.
- Integrate multiple TypeScript files using export and import.
- Create and use classes with properties, constructor, and methods.
- Manipulate arrays using array methods.