


# Introduction to TypeScript

*A friendly guide for JavaScript developers*

## ❖❖ What is TypeScript?

- A superset of JavaScript
- Adds static types 
- Developed by Microsoft
- Compiles to plain JavaScript
- Catches errors early

## ❖❖ Why Use TypeScript?

- **Type safety:** Find bugs before runtime
- **Better IDE support:** Autocomplete & refactoring
- **Readable & maintainable code**
- Popular in **large projects**

## ❖❖ Basic Types

```
let isDone: boolean = false;  
let age: number = 25;  
let name: string = "Alice";  
let numbers: number[] = [1, 2, 3];  
let tuple: [string, number] = ["Alice", 30];  
let anyValue: any = "can be anything";  
let unknownValue: unknown = "safer than any";  
let neverValue: never; // function that never returns
```

- `boolean` → true/false
- `number` → integers & floats
- `string` → text
- `array` → list of values
- `tuple` → fixed-length array
- `any` → opt out of type checking

## Functions with Types

```
function greet(name: string): string {  
    return `Hello, ${name}!`;  
}  
  
// Arrow functions  
const multiply = (a: number, b: number): number => a * b;  
  
// Function types  
type MathFunc = (x: number, y: number) => number;  
const add: MathFunc = (a, b) => a + b;  
  
console.log(greet("Bob"));  
console.log(multiply(5, 3));  
console.log(add(10, 20));
```

- Parameters have **types**
- Functions can have **return types**
- Function types for reusable signatures

## ❖❖ Interfaces

```
interface Person {  
  name: string;  
  age: number;  
  email?: string; // optional property  
  readonly id: number; // read-only property  
}  
  
interface Employee extends Person {  
  department: string;  
  salary: number;  
}  
  
let user: Person = { name: "Alice", age: 30, id: 1 };  
let employee: Employee = {  
  name: "Bob",  
  age: 25,  
  id: 2,  
  department: "IT",  
  salary: 50000,  
};
```

## ?? Type Aliases

```
type Point = {  
  x: number;  
  y: number;  
};  
  
type Status = "loading" | "success" | "error"; // union type  
type ID = string | number; // union type  
  
type Coordinates = Point & { z: number }; // intersection type  
  
let position: Point = { x: 10, y: 20 };  
let status: Status = "loading";  
let id: ID = "user123";  
let coords: Coordinates = { x: 10, y: 20, z: 30 };
```

- Type aliases for complex types
- Union types with |

## ✨ Optional & Default Parameters

```
function greet(name: string, age?: number, greeting: string = "Hello") {  
    console.log(`${greeting}, ${name}, age ${age ?? "unknown"}`);  
}  
  
// Rest parameters  
function sum(...numbers: number[]): number {  
    return numbers.reduce((total, num) => total + num, 0);  
}  
  
greet("Alice"); // Hello, Alice, age unknown  
greet("Bob", 25); // Hello, Bob, age 25  
greet("Charlie", 30, "Hi"); // Hi, Charlie, age 30  
console.log(sum(1, 2, 3, 4, 5)); // 15
```

- `?` → optional parameter
- `=` → default value
- Rest parameters with `...`



## Type Inference

```
let message = "Hello TypeScript"; // inferred as string
let numbers = [1, 2, 3]; // inferred as number[]
let mixed = [1, "hello", true]; // inferred as (number | string | boolean)[]

// Contextual typing
const names = ["Alice", "Bob", "Charlie"];
names.forEach((name) => console.log(name.toUpperCase())); // name inferred as string
```

- TypeScript can **guess types**
- **Contextual typing** in callbacks
- Explicit typing is optional

# Generics

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

// Generic interface
interface Container<T> {
  value: T;
  getValue(): T;
}

// Generic class
class Stack<T> {
  private items: T[] = [];

  push(item: T): void {
    this.items.push(item);
  }

  pop(): T | undefined {
    return this.items.pop();
  }
}

let stringStack = new Stack<string>();
stringStack.push("hello");
stringStack.push("world");
console.log(stringStack.pop()); // "world"
```

## Type Guards & Narrowing

```
function isString(value: unknown): value is string {
    return typeof value === "string";
}

function processValue(value: string | number) {
    if (typeof value === "string") {
        console.log(value.toUpperCase()); // TypeScript knows it's a string
    } else {
        console.log(value.toFixed(2)); // TypeScript knows it's a number
    }
}

// Custom type guard
interface User {
    name: string;
    age: number;
}

function isUser(obj: unknown): obj is User {
    return (
        typeof obj === "object" && obj !== null && "name" in obj && "age" in obj
    );
}
```

# Enums

```
enum Color {  
  Red = "RED",  
  Green = "GREEN",  
  Blue = "BLUE",  
}  
  
enum Status {  
  Pending,  
  Approved,  
  Rejected,  
}  
  
let favoriteColor: Color = Color.Blue;  
let currentStatus: Status = Status.Pending;  
  
console.log(Color.Red); // "RED"  
console.log(Status.Approved); // 1 (auto-incremented)
```

- **Enums** for named constants



# Classes

```
class Animal {
  protected name: string;

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

  move(distance: number = 0): void {
    console.log(`${this.name} moved ${distance}m.`);
  }
}

class Dog extends Animal {
  bark(): void {
    console.log(`${this.name} barks!`);
  }

  move(distance: number = 5): void {
    console.log(`${this.name} runs ${distance}m.`);
    super.move(distance);
  }
}

let dog = new Dog("Rex");
dog.bark(); // Rex barks!
dog.move(10); // Rex runs 10m.
```

## ?? Utility Types

```
interface User {  
  id: number;  
  name: string;  
  email: string;  
  age: number;  
}  
  
// Make all properties optional  
type PartialUser = Partial<User>;  
  
// Make all properties required  
type RequiredUser = Required<User>;  
  
// Pick specific properties  
type UserName = Pick<User, "name" | "email">;  
  
// Omit specific properties  
type UserWithoutId = Omit<User, "id">;  
  
// Record for object with specific key/value types  
type UserMap = Record<string, User>;  
  
// ReturnType for function return type  
type GreetReturn = ReturnType<typeof greet>;
```

## Advanced Types

```
// Conditional types
type NonNullable<T> = T extends null | undefined ? never : T;

// Mapped types
type Readonly<T> = {
  readonly [P in keyof T]: T[P];
};

// Template literal types
type EmailLocale = "en" | "es" | "fr";
type EmailTemplate = `welcome_${EmailLocale}`;

// Index access types
type UserName = User["name"];
type UserKeys = keyof User;

// Conditional types with inference
type ArrayElement<T> = T extends (infer U)[] ? U : never;
type StringArrayElement = ArrayElement<string[]>; // string
```

## TypeScript vs JavaScript

Feature	JavaScript	TypeScript
Static Types	✗	✓
Compile-time checks	✗	✓
Object-oriented features	✗	✓
IDE Autocomplete	Limited	Excellent
Generics	✗	✓
Interfaces	✗	✓
Enums	✗	✓
Utility Types	✗	✓



## ❖❖ Getting Started

1. Install Node.js (includes npm)
2. Install TypeScript:

```
npm install -g typescript
```

3. Create tsconfig.json:

```
tsc --init
```

4. Compile a file:

```
tsc app.ts
```

5. Run JavaScript:

```
node app.js
```

## tsconfig.json Essentials

```
{
  "compilerOptions": {
    "target": "ES2020",
    "module": "commonjs",
    "strict": true,
    "esModuleInterop": true,
    "skipLibCheck": true,
    "forceConsistentCasingInFileNames": true,
    "outDir": "./dist",
    "rootDir": "./src"
  },
  "include": ["src/**/*.ts"],
  "exclude": ["node_modules", "dist"]
}
```

- **target:** JavaScript version to compile to
- **strict:** Enable all strict type checking options
- **outDir:** Output directory for compiled files




## Best Practices

- Use strict mode for better type safety
- Prefer interfaces over type aliases for objects
- Use generics for reusable components
- Leverage type inference when types are obvious
- Use utility types for type transformations
- Write custom type guards for complex validation
- Use enums for related constants
- Document complex types with comments

## ❖❖ Resources

- [TypeScript Docs](#)
- [TypeScript Handbook](#)
- [TypeScript Playground](#)
- [TypeScript Utility Types](#)
- [TypeScript Design Patterns](#)

# Summary

- TypeScript = JavaScript + Types 
- **Interfaces & Type Aliases** for object shapes
- **Generics** for reusable components
- **Type Guards** for runtime safety
- **Utility Types** for type transformations
- **Classes & Enums** for OOP features
- **Advanced Types** for complex scenarios
- **Strict mode** for maximum type safety

Happy typing! 