

Typescript

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Chapter 1: Getting started with TypeScript

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Section 1.1: Installation and setup

Background

TypeScript is a typed superset of JavaScript that compiles directly to JavaScript code. TypeScript files commonly use the `.ts` extension. Many IDEs support TypeScript without any other setup required, but TypeScript can also be compiled with the TypeScript Node.JS package from the command line.

IDEs

Visual Studio

- Visual Studio **2015** includes TypeScript.
- Visual Studio **2013** Update **2** or later includes TypeScript, or you can [download TypeScript for earlier versions](#).

Visual Studio Code

- [Visual Studio Code](#) (vscode) provides contextual autocomplete as well as refactoring and debugging tools for TypeScript. vscode is itself implemented in TypeScript. Available for Mac OS X, Windows and Linux.

WebStorm

- [WebStorm 2016.2](#) comes with TypeScript and a built-in compiler. [WebStorm is not free]

IntelliJ IDEA

- [IntelliJ IDEA 2016.2](#) has support for TypeScript and a compiler via a [plugin](#) maintained by the JetBrains team. [IntelliJ is not free]

Atom & atom-typescript

- [Atom](#) supports TypeScript with the [atom-typescript](#) package.

Sublime Text

- [Sublime Text](#) supports TypeScript with the [TypeScript](#) package.

Installing the command line interface

Install [Node.js](#)

Install the npm package globally

You can install TypeScript globally to have access to it from any directory.

```
npm install -g typescript
```

or

Install the npm package locally

You can install TypeScript locally and save to package.json to restrict to a directory.

```
npm install typescript --save-dev
```

Installation channels

You can install from:

- Stable channel: `npm install typescript`
- Beta channel: `npm install typescript@beta`
- Dev channel: `npm install typescript@next`

Compiling TypeScript code

The `tsc` compilation command comes with `typescript`, which can be used to compile code.

```
tsc my-code.ts
```

This creates a `my-code.js` file.

Compile using `tsconfig.json`

You can also provide compilation options that travel with your code via a [tsconfig.json](#) file. To start a new TypeScript project, cd into your project's root directory in a terminal window and run `tsc --init`. This command will generate a `tsconfig.json` file with minimal configuration options, similar to below.

```
{
  "compilerOptions": {
    "module": "commonjs",
    "target": "es5",
    "noImplicitAny": false,
    "sourceMap": false,
    "pretty": true
  },
  "exclude": [
    "node_modules"
  ]
}
```

With a `tsconfig.json` file placed at the root of your TypeScript project, you can use the `tsc` command to run the compilation.

Section 1.2: Basic syntax

TypeScript is a typed superset of JavaScript, which means that all JavaScript code is valid TypeScript code. TypeScript adds a lot of new features on top of that.

TypeScript makes JavaScript more like a strongly-typed, object-oriented language akin to C# and Java. This means that TypeScript code tends to be easier to use for large projects and that code tends to be easier to understand and maintain. The strong typing also means that the language can (and is) precompiled and that variables cannot be assigned values that are out of their declared range. For instance, when a TypeScript variable is declared as a number, you cannot assign a text value to it.

This strong typing and object orientation makes TypeScript easier to debug and maintain, and those were two of the weakest points of standard JavaScript.

Type declarations

You can add type declarations to variables, function parameters and function return types. The type is written after a colon following the variable name, like this: `var num: number = 5;` The compiler will then check the types (where possible) during compilation and report type errors.

```
var num: number = 5;
num = "this is a string"; // error: Type 'string' is not assignable to type 'number'.
```

The basic types are :

- `number` (both integers and floating point numbers)
- `string`
- `boolean`
- `Array`. You can specify the types of an array's elements. There are two equivalent ways to define array types: `Array<T>` and `T[]`. For example:
 - `number[]` - array of numbers
 - `Array<string>` - array of strings
- `Tuples`. Tuples have a fixed number of elements with specific types.
 - `[boolean, string]` - tuple where the first element is a boolean and the second is a string.
 - `[number, number, number]` - tuple of three numbers.

- `{}` - object, you can define its properties or indexer
 - `{name: string, age: number}` - object with name and age attributes
 - `{[key: string]: number}` - a dictionary of numbers indexed by string
- `enum` - `{ Red = 0, Blue, Green }` - enumeration mapped to numbers
- Function. You specify types for the parameters and return value:
 - `(param: number) => string` - function taking one number parameter returning string
 - `() => number` - function with no parameters returning an number.
 - `(a: string, b?: boolean) => void` - function taking a string and optionally a boolean with no return value.
- `any` - Permits any type. Expressions involving `any` are not type checked.
- `void` - represents "nothing", can be used as a function return value. Only `null` and `undefined` are part of the `void` type.
- `never`
 - `let foo: never;` -As the type of variables under type guards that are never true.
 - `function error(message: string): never { throw new Error(message); }` - As the return type of functions that never return.
- `null` - type for the value `null`. `null` is implicitly part of every type, unless strict null checks are enabled.

Casting

You can perform explicit casting through angle brackets, for instance:

```
var derived: MyInterface;
(<ImplementingClass>derived).someSpecificMethod();
```

This example shows a derived class which is treated by the compiler as a `MyInterface`. Without the casting on the second line the compiler would throw an exception as it does not understand `someSpecificMethod()`, but casting through `<ImplementingClass>derived` suggests the compiler what to do.

Another way of casting in TypeScript is using the `as` keyword:

```
var derived: MyInterface;
(derived as ImplementingClass).someSpecificMethod();
```

Since TypeScript 1.6, the default is using the `as` keyword, because using `<>` is ambiguous in `.jsx` files. This is mentioned in [TypeScript official documentation](#).

Classes

Classes can be defined and used in TypeScript code. To learn more about classes, see the [Classes documentation page](#).

Section 1.3: Hello World

```
class Greeter {
  greeting: string;

  constructor(message: string) {
    this.greeting = message;
  }
  greet(): string {
    return this.greeting;
  }
};
```

```
let greeter = new Greeter("Hello, world!");
console.log(greeter.greet());
```

Here we have a class, Greeter, that has a constructor and a greet method. We can construct an instance of the class using the **new** keyword and pass in a string we want the greet method to output to the console. The instance of our Greeter class is stored in the greeter variable which we then use to call the greet method.

Section 1.4: Running TypeScript using ts-node

[ts-node](#) is an npm package which allows the user to run typescript files directly, without the need for precompilation using tsc. It also provides [REPL](#).

Install ts-node globally using

```
npm install -g ts-node
```

ts-node does not bundle typescript compiler, so you might need to install it.

```
npm install -g typescript
```

Executing script

To execute a script named *main.ts*, run

```
ts-node main.ts
```

```
// main.ts
console.log("Hello world");
```

Example usage

```
$ ts-node main.ts
Hello world
```

Running REPL

To run REPL run command ts-node

Example usage

```
$ ts-node
> const sum = (a, b): number => a + b;
undefined
> sum(2, 2)
4
> .exit
```

To exit REPL use command **.exit** or press CTRL+C twice.

Section 1.5: TypeScript REPL in Node.js

For use TypeScript REPL in Node.js you can use [tsun package](#)

Install it globally with

```
npm install -g tsun
```

and run in your terminal or command prompt with tsun command

Usage example:

```
$ tsun
TSUN : TypeScript Upgraded Node
type in TypeScript expression to evaluate
type :help for commands in repl
$ function multiply(x, y) {
  ..return x * y;
  ..}
undefined
$ multiply(3, 4)
12
```

Chapter 2: Why and when to use TypeScript

If you find the arguments for type systems persuasive in general, then you'll be happy with TypeScript.

It brings many of the advantages of type system (safety, readability, improved tooling) to the JavaScript ecosystem. It also suffers from some of the drawbacks of type systems (added complexity and incompleteness).

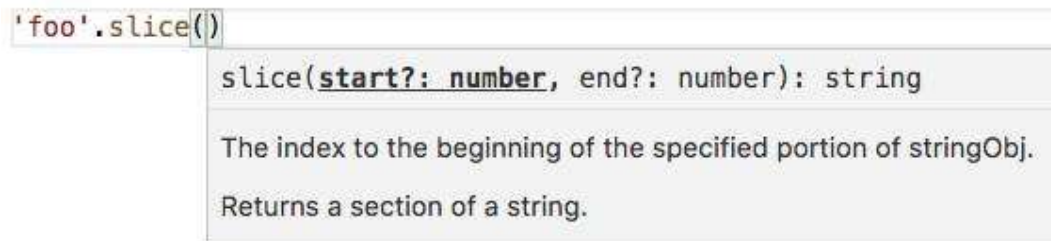
Section 2.1: Safety

TypeScript catches type errors early through static analysis:

```
function double(x: number): number {  
    return 2 * x;  
}  
double('2');  
//    ~~~ Argument of type '"2"' is not assignable to parameter of type
```

Section 2.2: Readability

TypeScript enables editors to provide contextual documentation:



```
'foo'.slice()  
slice(start?: number, end?: number): string  
The index to the beginning of the specified portion of stringObj.  
Returns a section of a string.
```

You'll never forget whether String.prototype.slice takes (start, stop) or (start, length) again!

Section 2.3: Tooling

TypeScript allows editors to perform automated refactors which are aware of the rules of the languages.

```
let foo = '123';  
  
{  
    const foo = (x: number) => {  
        return 2 * x;  
    }  
  
    foo(2);  
}
```

Here, for instance, Visual Studio Code is able to rename references to the inner foo without altering the outer foo. This would be difficult to do with a simple find/replace.

Chapter 3: TypeScript Core Types

Section 3.1: String Literal Types

String literal types allow you to specify the exact value a string can have.

```
let myFavoritePet: "dog";
myFavoritePet = "dog";
```

Any other string will give an error.

```
// Error: Type "'rock'" is not assignable to type "'dog'".
// myFavoritePet = "rock";
```

Together with Type Aliases and Union Types you get a enum-like behavior.

```
type Species = "cat" | "dog" | "bird";

function buyPet(pet: Species, name: string) : Pet { /*...*/ }

buyPet(myFavoritePet /* "dog" as defined above */, "Rocky");

// Error: Argument of type "'rock'" is not assignable to parameter of type "'cat' | 'dog' | 'bird'".Type "'rock'" is not assignable to type "'bird'".
// buyPet("rock", "Rocky");
```

String Literal Types can be used to distinguish overloads.

```
function buyPet(pet: Species, name: string) : Pet;
function buyPet(pet: "cat", name: string): Cat;
function buyPet(pet: "dog", name: string): Dog;
function buyPet(pet: "bird", name: string): Bird;
function buyPet(pet: Species, name: string) : Pet { /*...*/ }

let dog = buyPet(myFavoritePet /* "dog" as defined above */, "Rocky");
// dog is from type Dog (dog: Dog)
```

They work well for User-Defined Type Guards.

```
interface Pet {
  species: Species;
  eat();
  sleep();
}

interface Cat extends Pet {
  species: "cat";
}

interface Bird extends Pet {
  species: "bird";
  sing();
}

function petIsCat(pet: Pet): pet is Cat {
  return pet.species === "cat";
}
```

```

function petIsBird(pet: Pet): pet is Bird {
    return pet.species === "bird";
}

function playWithPet(pet: Pet){
    if(petIsCat(pet)) {
        // pet is now from type Cat (pet: Cat)
        pet.eat();
        pet.sleep();
    } else if(petIsBird(pet)) {
        // pet is now from type Bird (pet: Bird)
        pet.eat();
        pet.sing();
        pet.sleep();
    }
}

```

Full example code

```

let myFavoritePet: "dog"; myFavoritePet
= "dog";

```

```

// Error: Type "'rock'" is not assignable to type "'dog'".
// myFavoritePet = "rock";

```

```

type Species = "cat" | "dog" | "bird";

```

```

interface Pet {
    species: Species;
    name: string;
    eat();
    walk();
    sleep();
}

```

```

interface Cat extends Pet {
    species: "cat";
}

```

```

interface Dog extends Pet {
    species: "dog";
}

```

```

interface Bird extends Pet {
    species: "bird";
    sing();
}

```

```

// Error: Interface 'Rock' incorrectly extends interface 'Pet'. Types of property 'species' are
incompatible. Type "'rock'" is not assignable to type "'cat' | 'dog' | 'bird'". Type "'rock'"
is not assignable to type "'bird'".

```

```

// interface Rock extends Pet {
//     type: "rock";
// }

```

```

function buyPet(pet: Species, name: string) : Pet;
function buyPet(pet: "cat", name: string): Cat;
function buyPet(pet: "dog", name: string): Dog;
function buyPet(pet: "bird", name: string): Bird;
function buyPet(pet: Species, name: string) : Pet {
    if(pet === "cat") {

```

```

    return {
      species: "cat",
      name: name,
      eat: function () {
        console.log(`${this.name} eats.`);
      }, walk: function () {
        console.log(`${this.name} walks.`);
      }, sleep: function () {
        console.log(`${this.name} sleeps.`);
      }
    } as Cat;
  } else if(pet === "dog") {
    return {
      species: "dog",
      name: name,
      eat: function () {
        console.log(`${this.name} eats.`);
      }, walk: function () {
        console.log(`${this.name} walks.`);
      }, sleep: function () {
        console.log(`${this.name} sleeps.`);
      }
    } as Dog;
  } else if(pet === "bird") {
    return {
      species: "bird",
      name: name,
      eat: function () {
        console.log(`${this.name} eats.`);
      }, walk: function () {
        console.log(`${this.name} walks.`);
      }, sleep: function () {
        console.log(`${this.name} sleeps.`);
      }, sing: function () {
        console.log(`${this.name} sings.`);
      }
    } as Bird;
  } else {
    throw `Sorry we do not have a ${pet}. Would you like to buy a dog?`;
  }
}

function petIsCat(pet: Pet): pet is Cat {
  return pet.species === "cat";
}

function petIsDog(pet: Pet): pet is Dog {
  return pet.species === "dog";
}

function petIsBird(pet: Pet): pet is Bird {
  return pet.species === "bird";
}

function playWithPet(pet: Pet) {
  console.log(`Hey ${pet.name}, lets play.`);

  if(petIsCat(pet)) {
    // pet is now from type Cat (pet: Cat)

    pet.eat();
    pet.sleep();
  }
}

```

```

    // Error: Type "'bird'" is not assignable to type "'cat'".
    // pet.type = "bird";

    // Error: Property 'sing' does not exist on type 'Cat'.
    // pet.sing();

} else if(petIsDog(pet)) {
    // pet is now from type Dog (pet: Dog)

    pet.eat();
    pet.walk();
    pet.sleep();

} else if(petIsBird(pet)) {
    // pet is now from type Bird (pet: Bird)

    pet.eat();
    pet.sing();
    pet.sleep();
} else {
    throw "An unknown pet. Did you buy a rock?";
}
}

let dog = buyPet(myFavoritePet /* "dog" as defined above */, "Rocky");
// dog is from type Dog (dog: Dog)

// Error: Argument of type "'rock'" is not assignable to parameter of type "'cat' | 'dog' | 'bird'". Type "'rock'" is not assignable to type "'bird'".
// buyPet("rock", "Rocky");

playWithPet(dog);
// Output: Hey Rocky, lets play.
//         Rocky eats.
//         Rocky walks.
//         Rocky sleeps.

```

Section 3.2: Tuple

Array type with known and possibly different types:

```

let day: [number, string];
day = [0, 'Monday']; // valid
day = ['zero', 'Monday']; // invalid: 'zero' is not numeric
console.log(day[0]); // 0
console.log(day[1]); // Monday

day[2] = 'Saturday'; // valid: [0, 'Saturday']
day[3] = false; // invalid: must be union type of 'number | string'

```

Section 3.3: Boolean

A boolean represents the most basic datatype in TypeScript, with the purpose of assigning true/false values.

```

// set with initial value (either true or false)
let isTrue: boolean = true;

// defaults to 'undefined', when not explicitly set
let unsetBool: boolean;

```



```
// can also be set to 'null' as well
let nullableBool: boolean = null;
```

Section 3.4: Intersection Types

A Intersection Type combines the member of two or more types.

```
interface Knife {
    cut();
}

interface BottleOpener{
    openBottle();
}

interface Screwdriver{
    turnScrew();
}

type SwissArmyKnife = Knife & BottleOpener & Screwdriver;

function use(tool: SwissArmyKnife){
    console.log("I can do anything!");

    tool.cut();
    tool.openBottle();
    tool.turnScrew();
}
```

Section 3.5: Types in function arguments and return value. Number

When you create a function in TypeScript you can specify the data type of the function's arguments and the data type for the return value

Example:

```
function sum(x: number, y: number): number {
    return x + y;
}
```

Here the syntax `x: number, y: number` means that the function can accept two arguments `x` and `y` and they can only be numbers and `(...): number {` means that the return value can only be a number

Usage:

```
sum(84 + 76) // will be return 160
```

Note:

You can not do so

```
function sum(x: string, y: string): number {
    return x + y;
}
```

or

```
function sum(x: number, y: number): string {
    return x + y;
}
```

it will receive the following errors:

error TS2322: Type 'string' is not assignable to type 'number' and error TS2322: Type 'number' is not assignable to type 'string' respectively

Section 3.6: Types in function arguments and return value. String

Example:

```
function hello(name: string): string {
    return `Hello ${name}!`;
}
```

Here the syntax `name: string` means that the function can accept one name argument and this argument can only be string and `(...): string {` means that the return value can only be a string

Usage:

```
hello('StackOverflow Documentation') // will be return Hello StackOverflow Documentation!
```

Section 3.7: const Enum

A const Enum is the same as a normal Enum. Except that no Object is generated at compile time. Instead, the literal values are substituted where the const Enum is used.

// TypeScript: A const Enum can be defined like a normal Enum (with start value, specific values, etc.)

```
const enum NinjaActivity {
    Espionage,
    Sabotage,
    Assassination
}
```

// JavaScript: But nothing is generated

// TypeScript: Except if you use it

```
let myFavoriteNinjaActivity = NinjaActivity.Espionage;
console.log(myFavoritePirateActivity); // 0
```

// JavaScript: Then only the number of the value is compiled into the code

```
// var myFavoriteNinjaActivity = 0 /* Espionage */;
// console.log(myFavoritePirateActivity); // 0
```

// TypeScript: The same for the other constant example

```
console.log(NinjaActivity["Sabotage"]); // 1
```

// JavaScript: Just the number and in a comment the name of the value

```
// console.log(1 /* "Sabotage" */); // 1
```

// TypeScript: But without the object none runtime access is possible

```
// Error: A const enum member can only be accessed using a string literal.
// console.log(NinjaActivity[myFavoriteNinjaActivity]);
```

For comparison, a normal Enum

```
// TypeScript: A normal Enum
enum PirateActivity {
    Boarding,
    Drinking,
    Fencing
}

// JavaScript: The Enum after the compiling
// var PirateActivity;
// (function (PirateActivity) {
//     PirateActivity[PirateActivity["Boarding"] = 0] = "Boarding";
//     PirateActivity[PirateActivity["Drinking"] = 1] = "Drinking";
//     PirateActivity[PirateActivity["Fencing"] = 2] = "Fencing";
// })(PirateActivity || (PirateActivity = {}));

// TypeScript: A normal use of this Enum
let myFavoritePirateActivity = PirateActivity.Boarding; console.log(myFavoritePirateActivity);
// 0

// JavaScript: Looks quite similar in JavaScript
// var myFavoritePirateActivity = PirateActivity.Boarding;
// console.log(myFavoritePirateActivity); // 0

// TypeScript: And some other normal use
console.log(PirateActivity["Drinking"]); // 1

// JavaScript: Looks quite similar in JavaScript
// console.log(PirateActivity["Drinking"]); // 1

// TypeScript: At runtime, you can access an normal enum
console.log(PirateActivity[myFavoritePirateActivity]); // "Boarding"

// JavaScript: And it will be resolved at runtime
// console.log(PirateActivity[myFavoritePirateActivity]); // "Boarding"
```

Section 3.8: Number

Like JavaScript, numbers are floating point values.

```
let pi: number = 3.14;           // base 10 decimal by
let hexadecimal: number = 0xFF;  // 255 in decimal
```

ECMAScript 2015 allows binary and octal.

```
let binary: number = 0b10;      // 2 in decimal
let octal: number = 0o755;      // 493 in decimal
```

Section 3.9: String

Textual data type:

```
let singleQuotes: string = 'single';
let doubleQuotes: string = "double";
let templateString: string = `I am ${singleQuotes}`; // I am single
```

Section 3.10: Array

An array of values:

```
let threePigs: number[] = [1, 2, 3];
let genericStringArray: Array<string> = ['first', '2nd', '3rd'];
```

Section 3.11: Enum

A type to name a set of numeric values:

Number values default to 0:

```
enum Day { Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday };
let bestDay: Day = Day.Saturday;
```

Set a default starting number:

```
enum TenPlus { Ten = 10, Eleven, Twelve }
```

or assign values:

```
enum MyOddSet { Three = 3, Five = 5, Seven = 7, Nine = 9 }
```

Section 3.12: Any

When unsure of a type, any is available:

```
let anything: any = 'I am a string'; anything
= 5; // but now I am the number 5
```

Section 3.13: Void

If you have no type at all, commonly used for functions that do not return anything:

```
function log(): void {
    console.log('I return nothing');
}
```

void types Can only be assigned **null** or **undefined**.

Chapter 4: Arrays

Section 4.1: Finding Object in Array

Using find()

```
const inventory = [
  {name: 'apples', quantity: 2},
  {name: 'bananas', quantity: 0},
  {name: 'cherries', quantity: 5}
];

function findCherries(fruit) {
  return fruit.name === 'cherries';
}

inventory.find(findCherries); // { name: 'cherries', quantity: 5 }

/* OR */

inventory.find(e => e.name === 'apples'); // { name: 'apples', quantity: 2 }
```

Chapter 5: Enums

Section 5.1: Enums with explicit values

By default all `enum` values are resolved to numbers. Let's say if you have something like

```
enum MimeType {  
    JPEG ,  
    PNG  
    ,  
    PDF  
}
```

the real value behind e.g. `MimeType.PDF` will be 2.

But some of the time it is important to have the enum resolve to a different type. E.g. you receive the value from backend / frontend / another system which is definitely a string. This could be a pain, but luckily there is this method:

```
enum MimeType {  
    JPEG =  
    <any>'image/jpeg', PNG =  
    <any>'image/png',  
    PDF = <any>'application/pdf'  
}
```

This resolves the `MimeType.PDF` to `application/pdf`.

Since TypeScript 2.4 it's possible to declare [string enums](#):

```
enum MimeType {  
    JPEG = 'image/jpeg',  
    PNG = 'image/png',  
    PDF = 'application/pdf',  
}
```

You can explicitly provide numeric values using the same method

```
enum MyType {  
    Value = 3 ,  
    ValueEx = 30 ,  
    ValueEx2 = 300  
}
```

Fancier types also work, since non-const enums are real objects at runtime, for example

```
enum FancyType {  
    OneArr =  
    <any>[1],  
    TwoArr = <any>[2, 2],  
    ThreeArr = <any>[3, 3],  
}
```

becomes

```
var FancyType;  
(function (FancyType)  
{  
    FancyType[FancyType["OneArr"] = [1]] = "OneArr";  
    FancyType[FancyType["TwoArr"] = [2, 2]] = "TwoArr";  
})
```

```
FancyType[FancyType["ThreeArr"] = [3, 3, 3]] = "ThreeArr";
})(FancyType || (FancyType = {}));
```

Section 5.2: How to get all enum values

```
enum SomeEnum { A, B }

let enumValues: Array<string>= [];

for(let value in SomeEnum) {
  if(typeof SomeEnum[value] === 'number') {
    enumValues.push(value);
  }
}

enumValues.forEach(v=> console.log(v))
//A
//B
```

Section 5.3: Extending enums without custom enum implementation

```
enum SourceEnum {
  value1 = <any>'value1',
  value2 = <any>'value2'
}

enum AdditionToSourceEnum {
  value3 = <any>'value3',
  value4 = <any>'value4'
}

// we need this type for TypeScript to resolve the types correctly
type TestEnumType = SourceEnum | AdditionToSourceEnum;
// and we need this value "instance" to use values
let TestEnum = Object.assign({}, SourceEnum, AdditionToSourceEnum);
// also works fine the TypeScript 2 feature
// let TestEnum = { ...SourceEnum, ...AdditionToSourceEnum };

function check(test: TestEnumType) {
  return test === TestEnum.value2;
}

console.log(TestEnum.value1);
console.log(TestEnum.value2 === <any>'value2');
console.log(check(TestEnum.value2));
console.log(check(TestEnum.value3));
```

Section 5.4: Custom enum implementation: extends for enums

Sometimes it is required to implement Enum on your own. E.g. there is no clear way to extend other enums. Custom implementation allows this:

```
class Enum {
  constructor(protected value: string) {}

  public toString() {
    return String(this.value);
  }
}
```

```

}

public is(value: Enum | string) {
    return this.value == value.toString();
}
}

class SourceEnum extends Enum {
    public static value1 = new SourceEnum('value1');
    public static value2 = new SourceEnum('value2');
}

class TestEnum extends SourceEnum {
    public static value3 = new TestEnum('value3');
    public static value4 = new TestEnum('value4');
}

function check(test: TestEnum) {
    return test === TestEnum.value2;
}

let value1 = TestEnum.value1;

console.log(value1 + 'hello');
console.log(value1.toString() === 'value1');
console.log(value1.is('value1'));
console.log(!TestEnum.value3.is(TestEnum.value3));
console.log(check(TestEnum.value2));
// this works but perhaps your TSLint would complain
// attention! does not work with ===
// use .is() instead
console.log(TestEnum.value1 == <any>'value1');

```


Chapter 6: Functions

Section 6.1: Optional and Default Parameters

Optional Parameters

In TypeScript, every parameter is assumed to be required by the function. You can add a `?` at the end of a parameter name to set it as optional.

For example, the `lastName` parameter of this function is optional:

```
function buildName(firstName: string, lastName?: string) {  
    // ...  
}
```

Optional parameters must come after all non-optional parameters:

```
function buildName(firstName?: string, lastName: string) // Invalid
```

Default Parameters

If the user passes `undefined` or doesn't specify an argument, the default value will be assigned. These are called *default-initialized* parameters.

For example, "Smith" is the default value for the `lastName` parameter.

```
function buildName(firstName: string, lastName = "Smith") {  
    // ...  
}  
buildName('foo', 'bar');           // firstName == 'foo', lastName == 'bar'  
buildName('foo');                 // firstName == 'foo', lastName ==  
                                  'Smith'  
buildName('foo', undefined);      // firstName == 'foo', lastName ==  
                                  'Smith'
```

Section 6.2: Function as a parameter

Suppose we want to receive a function as a parameter, we can do it like this:

```
function foo(otherFunc: Function): void {  
    ...  
}
```

If we want to receive a constructor as a parameter:

```
function foo(constructorFunc: { new(): any }) {  
    new constructorFunc();  
}  
function foo(constructorWithParamsFunc: { new(num: number): any }) {  
    new constructorWithParamsFunc(1);  
}
```

Or to make it easier to read we can define an interface describing the constructor:

```
interface IConstructor {  
    new(): any;  
}
```

```

}

function foo(constructorFunc: IConstructor) {
    new constructorFunc();
}

```

Or with parameters:

```

interface INumberConstructor {
    new(num: number);
}

function foo(constructorFunc: INumberConstructor) {
    new constructorFunc(1);
}

```

Even with generics:

```

interface IConstructor<T, U> {
    new(item: T): U;
}

function foo<T, U>(constructorFunc: IConstructor<T, U>, item: T): U {
    return new constructorFunc(item);
}

```

If we want to receive a simple function and not a constructor it's almost the same:

```

function foo(func: { (): void }) {
    func();
}

function foo(constructorWithParamsFunc: { (num: number): void }) {
    new constructorWithParamsFunc(1);
}

```

Or to make it easier to read we can define an interface describing the function:

```

interface IFunction {
    (): void;
}

function foo(func: IFunction ) {
    func();
}

```

Or with parameters:

```

interface INumberFunction {
    (num: number): string;
}

function foo(func: INumberFunction ) {
    func(1);
}

```

Even with generics:

```
interface ITFunc<T, U> {
  (item: T): U;
}

function foo<T, U>(constructorFunc: ITFunc<T, U>, item: T): U {
  return func(item);
}
```

Section 6.3: Functions with Union Types

A TypeScript function can take in parameters of multiple, predefined types using union types.

```
function whatTime(hour:number|string, minute:number|string):string{
  return hour+':' +minute;
}

whatTime(1,30)           // '1:30'
whatTime('1',30)         // '1:30'
whatTime(1,'30')         // '1:30'
whatTime('1','30')       // '1:30'
```

TypeScript treats these parameters as a single type that is a union of the other types, so your function must be able to handle parameters of any type that is in the union.

```
function addTen(start:number|string):number{
  if(typeof number === 'string'){
    return parseInt(number)+10;
  }else{
    else return number+10;
  }
}
```

Section 6.4: Types of Functions

Named functions

```
function multiply(a, b) {
  return a * b;
}
```

Anonymous functions

```
let multiply = function(a, b) { return a * b; };
```

Lambda / arrow functions

```
let multiply = (a, b) => { return a * b; };
```

Chapter 7: Classes

TypeScript, like ECMAScript 6, support object-oriented programming using classes. This contrasts with older JavaScript versions, which only supported prototype-based inheritance chain.

The class support in TypeScript is similar to that of languages like Java and C#, in that classes may inherit from other classes, while objects are instantiated as class instances.

Also similar to those languages, TypeScript classes may implement interfaces or make use of generics.

Section 7.1: Abstract Classes

```
abstract class Machine {
  constructor(public manufacturer: string) {
  }

  // An abstract class can define methods of its own, or...
  summary(): string {
    return `${this.manufacturer} makes this machine.`;
  }

  // Require inheriting classes to implement methods
  abstract moreInfo(): string;
}

class Car extends Machine {
  constructor(manufacturer: string, public position: number, protected speed: number) {
    super(manufacturer);
  }

  move() {
    this.position += this.speed;
  }

  moreInfo() {
    return `This is a car located at ${this.position} and going ${this.speed}mph!`;
  }
}

let myCar = new Car("Konda", 10, 70);
myCar.move(); // position is now 80
console.log(myCar.summary()); // prints "Konda makes this machine."
console.log(myCar.moreInfo()); // prints "This is a car located at 80 and going 70mph!"
```

Abstract classes are base classes from which other classes can extend. They cannot be instantiated themselves (i.e. you **cannot** do `new Machine("Konda")`).

The two key characteristics of an abstract class in TypeScript are:

1. They can implement methods of their own.
2. They can define methods that inheriting classes **must** implement.

For this reason, abstract classes can conceptually be considered a **combination of an interface and a class**.

Section 7.2: Simple class

```
class Car {
```

```

    public position: number = 0;
    private speed: number = 42;

    move() {
        this.position += this.speed;
    }
}

```

In this example, we declare a simple class `Car`. The class has three members: a private property `speed`, a public property `position` and a public method `move`. Note that each member is public by default. That's why `move()` is public, even if we didn't use the `public` keyword.

```

var car = new Car();           // create an instance of
Carcar.move();                 // call a method
console.log(car.position);     // access a public
                                // member

```

Section 7.3: Basic Inheritance

```

class Car {
    public position: number = 0;
    protected speed: number = 42;

    move() {
        this.position += this.speed;
    }
}

class SelfDrivingCar extends Car {

    move() {
        // start moving around :-)
        super.move();
        super.move();
    }
}

```

This examples shows how to create a very simple subclass of the `Car` class using the `extends` keyword. The `SelfDrivingCar` class overrides the `move()` method and uses the base class implementation using `super`.

Section 7.4: Constructors

In this example we use the constructor to declare a public property `position` and a protected property `speed` in the base class. These properties are called *Parameter properties*. They let us declare a constructor parameter and a member in one place.

One of the best things in TypeScript, is automatic assignment of constructor parameters to the relevant property.

```

class Car {
    public position: number;
    protected speed: number;

    constructor(position: number, speed: number) {
        this.position = position;
        this.speed = speed;
    }

    move() {
        this.position += this.speed;
    }
}

```

```

    }
}

```

All this code can be resumed in one single constructor:

```

class Car {
    constructor(public position: number, protected speed: number) {}

    move() {
        this.position += this.speed;
    }
}

```

And both of them will be transpiled from TypeScript (design time and compile time) to JavaScript with same result, but writing significantly less code:

```

var Car = (function () {
    function Car(position, speed) {
        this.position = position;
        this.speed = speed;
    }
    Car.prototype.move = function () {
        this.position += this.speed;
    };
    return Car;
})();

```

Constructors of derived classes have to call the base class constructor with `super()`.

```

class SelfDrivingCar extends Car {
    constructor(startAutoPilot: boolean) {
        super(0, 42);
        if (startAutoPilot) {
            this.move();
        }
    }
}

let car = new SelfDrivingCar(true);
console.log(car.position); // access the public property position

```

Section 7.5: Accessors

In this example, we modify the "Simple class" example to allow access to the `speed` property. TypeScript accessors allow us to add additional code in getters or setters.

```

class Car {
    public position: number = 0;
    private _speed: number = 42;
    private _MAX_SPEED = 100;

    move() {
        this.position += this._speed;
    }

    get speed(): number {
        return this._speed;
    }
}

```

```

    set speed(value: number) {
        this._speed = Math.min(value, this._MAX_SPEED);
    }
}

let car = new Car();
car.speed = 120;
console.log(car.speed); // 100

```

Section 7.6: Transpilation

Given a class `SomeClass`, let's see how the TypeScript is transpiled into JavaScript.

TypeScript source

```

class SomeClass {

    public static SomeStaticValue: string = "hello";
    public someMemberValue: number = 15;
    private somePrivateValue: boolean = false;

    constructor () {
        SomeClass.SomeStaticValue = SomeClass.getGoodbye();
        this.someMemberValue = this.getFortyTwo();
        this.somePrivateValue = this.getTrue();
    }

    public static getGoodbye(): string {
        return "goodbye!";
    }

    public getFortyTwo(): number {
        return 42;
    }

    private getTrue(): boolean {
        return true;
    }

}

```

JavaScript source

When transpiled using TypeScript v2.2.2, the output is like so:

```

var SomeClass = (function () {
    function SomeClass() {
        this.someMemberValue = 15;
        this.somePrivateValue = false;
        SomeClass.SomeStaticValue = SomeClass.getGoodbye();
        this.someMemberValue = this.getFortyTwo();
        this.somePrivateValue = this.getTrue();
    }
    SomeClass.getGoodbye = function () {
        return "goodbye!";
    };
    SomeClass.prototype.getFortyTwo = function () {
        return 42;
    };
    SomeClass.prototype.getTrue = function () {
        return true;
    };
}());

```

```
    return SomeClass;
  }());
  SomeClass.SomeStaticValue = "hello";
```

Observations

- The modification of the class' prototype is wrapped inside an [IIFE](#).
- Member variables are defined inside the main class **function**.
- Static properties are added directly to the class object, whereas instance properties are added to the prototype.

Section 7.7: Monkey patch a function into an existing class

Sometimes it's useful to be able to extend a class with new functions. For example let's suppose that a string should be converted to a camel case string. So we need to tell TypeScript, that String contains a function called `toCamelCase`, which returns a string.

```
interface String {
  toCamelCase(): string;
}
```

Now we can patch this function into the String implementation.

```
String.prototype.toCamelCase = function() : string {
  return this.replace(/^[^a-z ]/ig, "")
    .replace(/(?:^|w|([A-Z])|b|w|s+)/g, (match: any, index: number) => {
      return +match === 0 ? "" : match[index === 0 ? 'toLowerCase' : 'toUpperCase']();
    });
}
```

If this extension of String is loaded, it's usable like this:

```
"This is an example".toCamelCase(); // =>
```


Chapter 8: Class Decorator

Parameter	Details
target	The class being decorated

Section 8.1: Generating metadata using a class decorator

This time we are going to declare a class decorator that will add some metadata to a class when we applied to it:

```
function addMetadata(target: any) {  
  
    // Add some metadata  
    target.__customMetadata = {  
        someKey: "someValue"  
    };  
  
    // Return target  
    return target;  
  
}
```

We can then apply the class decorator:

```
@addMetadata  
class Person {  
    private _name: string;  
    public constructor(name: string) {  
        this._name = name;  
    }  
    public greet() {  
        return this._name;  
    }  
}  
  
function getMetadataFromClass(target: any) {  
    return target.__customMetadata;  
}  
  
console.log(getMetadataFromClass(Person));
```

The decorator is applied when the class is declared not when we create instances of the class. This means that the metadata is shared across all the instances of a class:

```
function getMetadataFromInstance(target: any) {  
    return target.constructor.__customMetadata;  
}  
  
let person1 = new Person("John");  
let person2 = new Person("Lisa");  
  
console.log(getMetadataFromInstance(person1));  
console.log(getMetadataFromInstance(person2));
```

Section 8.2: Passing arguments to a class decorator

We can wrap a class decorator with another function to allow customization:

```
function addMetadata(metadata: any) {
  return function log(target: any) {

    // Add metadata
    target.__customMetadata = metadata;

    // Return target
    return target;

  }
}
```

The `addMetadata` takes some arguments used as configuration and then returns an unnamed function which is the actual decorator. In the decorator we can access the arguments because there is a closure in place.

We can then invoke the decorator passing some configuration values:

```
@addMetadata({ guid: "417c6ec7-ec05-4954-a3c6-73a0d7f9f5bf" })
class Person {
  private _name: string;
  public constructor(name: string) {
    this._name = name;
  }
  public greet() {
    return this._name;
  }
}
```

We can use the following function to access the generated metadata:

```
function getMetadataFromClass(target: any) {
  return target.__customMetadata;
}

console.log(getMetadataFromInstance(Person));
```

If everything went right the console should display:

```
{ guid: "417c6ec7-ec05-4954-a3c6-73a0d7f9f5bf" }
```

Section 8.3: Basic class decorator

A class decorator is just a function that takes the class as its only argument and returns it after doing something with it:

```
function log<T>(target: T) {

  // Do something with target
  console.log(target);

  // Return target
  return target;

}
```

We can then apply the class decorator to a class:

```
@log
class Person {
    private _name: string;
    public constructor(name: string) {
        this._name = name;
    }
    public greet() {
        return this._name;
    }
}
```

Chapter 9: Interfaces

An interface specifies a list of fields and functions that may be expected on any class implementing the interface. Conversely, a class cannot implement an interface unless it has every field and function specified on the interface.

The primary benefit of using interfaces, is that it allows one to use objects of different types in a polymorphic way. This is because any class implementing the interface has at least those fields and functions.

Section 9.1: Extending Interface

Suppose we have an interface:

```
interface IPerson {  
    name: string;  
    age: number;  
  
    breath(): void;  
}
```

And we want to create more specific interface that has the same properties of the person, we can do it using the `extends` keyword:

```
interface IManager extends IPerson {  
    managerId: number;  
  
    managePeople(people: IPerson[]): void;  
}
```

In addition it is possible to extend multiple interfaces.

Section 9.2: Class Interface

Declare public variables and methods type in the interface to define how other typescript code can interact with it.

```
interface ISampleClassInterface {  
    sampleVariable: string;  
  
    sampleMethod(): void;  
  
    optionalVariable?: string;  
}
```

Here we create a class that implements the interface.

```
class SampleClass implements ISampleClassInterface {  
    public sampleVariable: string;  
    private answerToLifeTheUniverseAndEverything: number;  
  
    constructor() {  
        this.sampleVariable = 'string value';  
        this.answerToLifeTheUniverseAndEverything = 42;  
    }  
  
    public sampleMethod(): void {  
        // do nothing  
    }  
}
```

```
private answer(q: any): number {
    return this.answerToLifeTheUniverseAndEverything;
}
}
```

The example shows how to create an interface `ISampleClassInterface` and a class `SampleClass` that implements the interface.

Section 9.3: Using Interfaces for Polymorphism

The primary reason to use interfaces to achieve polymorphism and provide developers to implement on their own way in future by implementing interface's methods.

Suppose we have an interface and three classes:

```
interface Connector{
    doConnect(): boolean;
}
```

This is connector interface. Now we will implement that for Wifi communication.

```
export class WifiConnector implements Connector{

    public doConnect(): boolean{
        console.log("Connecting via wifi");
        console.log("Get password");
        console.log("Lease an IP for 24 hours");
        console.log("Connected");
        return true
    }

}
```

Here we have developed our concrete class named `WifiConnector` that has its own implementation. This is now type `Connector`.

Now we are creating our `System` that has a component `Connector`. This is called dependency injection.

```
export class System {
    constructor(private connector: Connector){ #inject Connector type
        connector.doConnect()
    }
}
```

`constructor(private connector: Connector)` this line is very important here. `Connector` is an interface and must have `doConnect()`. As `Connector` is an interface this class `System` has much more flexibility. We can pass any Type which has implemented `Connector` interface. In future developer achieves more flexibility. For example, now developer want to add Bluetooth Connection module:

```
export class BluetoothConnector implements Connector{

    public doConnect(): boolean{
        console.log("Connecting via Bluetooth");
        console.log("Pair with PIN");
        console.log("Connected");
        return true
    }

}
```

```
}
```

See that Wifi and Bluetooth have its own implementation. Their own different way to connect. However, hence both have implemented Type Connector the are now Type Connector. So that we can pass any of those to System class as the constructor parameter. This is called polymorphism. The class System is now not aware of whether it is Bluetooth / Wifi even we can add another Communication module like Infrared, Bluetooth5 and whatsoever by just implementing Connector interface.

This is called [Duck typing](#). Connector type is now dynamic as doConnect() is just a placeholder and developer implement this as his/her own.

if at constructor(private connector: WifiConnector) where WifiConnector is a concrete class what will happen? Then System class will tightly couple only with WifiConnector nothing else. Here interface solved our problem by polymorphism.

Section 9.4: Generic Interfaces

Like classes, interfaces can receive polymorphic parameters (aka Generics) too.

Declaring Generic Parameters on Interfaces

```
interface IStatus<U> {  
    code: U;  
}  
  
interface IEvents<T> {  
    list: T[];  
    emit(event: T): void;  
    getAll(): T[];  
}
```

Here, you can see that our two interfaces take some generic parameters, **T** and **U**.

Implementing Generic Interfaces

We will create a simple class in order to implements the interface **IEvents**.

```
class State<T> implements IEvents<T> {  
  
    list: T[];  
  
    constructor() {  
        this.list = [];  
    }  
  
    emit(event: T): void {  
        this.list.push(event);  
    }  
  
    getAll(): T[] {  
        return this.list;  
    }  
}
```

Let's create some instances of our **State** class.

In our example, the State class will handle a generic status by using IStatus<T>. In this way, the interface

`IEvent<T>` will also handle a `IStatus<T>`.

```
const s = new State<IStatus<number>>>();

// The 'code' property is expected to be a number, so:
s.emit({ code: 200 }); // works
s.emit({ code: '500' }); // type error

s.getAll().forEach(event => console.log(event.code));
```

Here our `State` class is typed as `IStatus<number>`.

```
const s2 = new State<IStatus<Code>>>();

//We are able to emit code as the type Code
s2.emit({ code: { message: 'OK', status: 200 } });

s2.getAll().map(event => event.code).forEach(event => {
  console.log(event.message);
  console.log(event.status);
});
```

Our `State` class is typed as `IStatus<Code>`. In this way, we are able to pass more complex type to our `emit` method.

As you can see, generic interfaces can be a very useful tool for statically typed code.

Section 9.5: Add functions or properties to an existing interface

Let's suppose we have a reference to the `JQuery` type definition and we want to extend it to have additional functions from a plugin we included and which doesn't have an official type definition. We can easily extend it by declaring functions added by plugin in a separate interface declaration with the same `JQuery` name:

```
interface JQuery {
  pluginFunctionThatDoesNothing(): void;

  // create chainable function
  manipulateDOM(HTMLElement): JQuery;
}
```

The compiler will merge all declarations with the same name into one - see [declaration merging](#) for more details.

Section 9.6: Implicit Implementation And Object Shape

TypeScript supports interfaces, but the compiler outputs JavaScript, which doesn't. Therefore, interfaces are effectively lost in the compile step. This is why type checking on interfaces relies on the *shape* of the object - meaning whether the object supports the fields and functions on the interface - and not on whether the interface is actually implemented or not.

```
interface IKickable {
  kick(distance: number): void;
}

class Ball {
  kick(distance: number): void {
    console.log("Kicked", distance, "meters!");
  }
}
```

```

}
let kickable: IKickable = new Ball();
kickable.kick(40);

```

So even if Ball doesn't explicitly implement IKickable, a Ball instance may be assigned to (and manipulated as) an IKickable, even when the type is specified.

Section 9.7: Using Interfaces to Enforce Types

One of the core benefits of TypeScript is that it enforces data types of values that you are passing around your code to help prevent mistakes.

Let's say you're making a pet dating application.

You have this simple function that checks if two pets are compatible with each other...

```

checkCompatible(petOne, petTwo) {
  if (petOne.species === petTwo.species &&
    Math.abs(petOne.age - petTwo.age) <= 5) {
    return true;
  }
}

```

This is completely functional code, but it would be far too easy for someone, especially other people working on this application who didn't write this function, to be unaware that they are supposed to pass it objects with 'species' and 'age' properties. They may mistakenly try `checkCompatible(petOne.species, petTwo.species)` and then be left to figure out the errors thrown when the function tries to access `petOne.species.species` or `petOne.species.age`!

One way we can prevent this from happening is to specify the properties we want on the pet parameters:

```

checkCompatible(petOne: {species: string, age: number}, petTwo: {species: string, age: number}) {
  //...
}

```

In this case, TypeScript will make sure everything passed to the function has 'species' and 'age' properties (it is okay if they have additional properties), but this is a bit of an unwieldy solution, even with only two properties specified. With interfaces, there is a better way!

First we define our interface:

```

interface Pet {
  species: string;
  age: number;
  //We can add more properties if we choose.
}

```

Now all we have to do is specify the type of our parameters as our new interface, like so...

```

checkCompatible(petOne: Pet, petTwo: Pet) {
  //...
}

```

... and TypeScript will make sure that the parameters passed to our function contain the properties specified in the Pet interface!

Chapter 10: Generics

Section 10.1: Generic Interfaces

Declaring a generic interface

```
interface IResult<T> {  
    wasSuccessful: boolean;  
    error: T;  
}  
  
var result: IResult<string> = ....  
var error: string = result.error;
```

Generic interface with multiple type parameters

```
interface IRunnable<T, U>  
    { run(input: T): U;  
}  
  
var runnable: IRunnable<string, number> = ...  
var input: string;  
var result: number = runnable.run(input);
```

Implementing a generic interface

```
interface IResult<T>{  
    wasSuccessful: boolean;  
    error: T;  
  
    clone(): IResult<T>;  
}
```

Implement it with generic class:

```
class Result<T> implements IResult<T> {  
    constructor(public result: boolean, public error: T) {  
    }  
  
    public clone(): IResult<T> {  
        return new Result<T>(this.result, this.error);  
    }  
}
```

Implement it with non generic class:

```
class StringResult implements IResult<string> { constructor(public  
    result: boolean, public error: string) {  
    }  
  
    public clone(): IResult<string> {  
        return new StringResult(this.result, this.error);  
    }  
}
```

Section 10.2: Generic Class

```
class Result<T> {
```

```

    constructor(public wasSuccessful: boolean, public error: T) {
    }

    public clone(): Result<T> {
        ...
    }
}

let r1 = new Result(false, 'error: 42'); // Compiler infers T to string
let r2 = new Result(false, 42); // Compiler infers T to number
let r3 = new Result<string>(true, null); // Explicitly set T to string
let r4 = new Result<string>(true, 4); // Compilation error because 4 is not a string

```

Section 10.3: Type parameters as constraints

With TypeScript 1.8 it becomes possible for a type parameter constraint to reference type parameters from the same type parameter list. Previously this was an error.

```

function assign<T extends U, U>(target: T, source: U): T {
    for (let id in source) {
        target[id] = source[id];
    }
    return target;
}

let x = { a: 1, b: 2, c: 3, d: 4 };
assign(x, { b: 10, d: 20 });
assign(x, { e: 0 }); // Error

```

Section 10.4: Generics Constraints

Simple constraint:

```

interface IRunnable {
    run(): void;
}

interface IRunner<T extends IRunnable> {
    runSafe(runnable: T): void;
}

```

More complex constraint:

```

interface IRunnable<U> {
    {run(): U;
}

interface IRunner<T extends IRunnable<U>, U> {
    runSafe(runnable: T): U;
}

```

Even more complex:

```

interface IRunnable<V> {
    run(parameter: U): V;
}

interface IRunner<T extends IRunnable<U, V>, U, V> {

```

```
runSafe(runnable: T, parameter: U):  
}
```

Inline type constraints:

```
interface IRunnable<T extends { run(): void }> {  
    runSafe(runnable: T): void;  
}
```

Section 10.5: Generic Functions

In interfaces:

```
interface IRunner {  
    runSafe<T extends IRunnable>(runnable: T): void;  
}
```

In classes:

```
class Runner implements IRunner {  
  
    public runSafe<T extends IRunnable>(runnable: T): void {  
        try {  
            runnable.run();  
        } catch(e) {  
        }  
    }  
}
```

Simple functions:

```
function runSafe<T extends IRunnable>(runnable: T): void {  
    try {  
        runnable.run();  
    } catch(e) {  
    }  
}
```

Section 10.6: Using generic Classes and Functions:

Create generic class instance:

```
var stringRunnable = new Runnable<string>();
```

Run generic function:

```
function runSafe<T extends Runnable<U>, U>(runnable: T);  
  
// Specify the generic types:  
runSafe<Runnable<string>, string>(stringRunnable);  
  
// Let typescript figure the generic types by himself:  
runSafe(stringRunnable);
```

Chapter 11: Strict null checks

Section 11.1: Strict null checks in action

By default, all types in TypeScript allow `null`:

```
function getId(x: Element) {  
    return x.id;  
}  
getId(null); // TypeScript does not complain, but this is a runtime error.
```

TypeScript 2.0 adds support for strict null checks. If you set `--strictNullChecks` when running `tsc` (or set this flag in your `tsconfig.json`), then types no longer permit `null`:

```
function getId(x: Element) {  
    return x.id;  
}  
getId(null); // error: Argument of type 'null' is not assignable to parameter of type 'Element'
```

You must permit `null` values explicitly:

```
function getId(x: Element | null) {  
    return x.id; // error TS2531: Object is possibly 'null'.  
}  
getId(null);
```

With a proper guard, the code type checks and runs correctly:

```
function getId(x: Element | null) {  
    if (x) {  
        return x.id; // In this branch, x's type is Element  
    } else {  
        return null; // In this branch, x's type is null.  
    }  
}  
getId(null);
```

Section 11.2: Non-null assertions

The non-null assertion operator, `!`, allows you to assert that an expression isn't `null` or `undefined` when the TypeScript compiler can't infer that automatically:

```
type ListNode = { data: number; next?: ListNode; };  
  
function addNext(node: ListNode) {  
    if (node.next === undefined) {  
        node.next = {data: 0};  
    }  
}  
  
function setNextValue(node: ListNode, value: number) {  
    addNext(node);  
  
    // Even though we know `node.next` is defined because we just called `addNext`,  
    // TypeScript isn't able to infer this in the line of code below:  
    node.next.data = value;
```

```
// So, we can use the non-null assertion operator, !,  
// to assert that node.next isn't undefined and silence the compiler  
warning
```

```
}
```

Chapter 12: User-defined Type Guards

Section 12.1: Type guarding functions

You can declare functions that serve as type guards using any logic you'd like.

They take the form:

```
function functionName(variableName: any): variableName is DesiredType {  
    // body that returns boolean  
}
```

If the function returns true, TypeScript will narrow the type to DesiredType in any block guarded by a call to the function.

For example ([try it](#)):

```
function isString(test: any): test is string {  
    return typeof test === "string";  
}  
  
function example(foo: any) {  
    if (isString(foo)) {  
        // foo is type as a string in this block  
        console.log("it's a string: " + foo);  
    } else {  
        // foo is type any in this block  
        console.log("don't know what this is! [" + foo + "]");  
    }  
}  
  
example("hello world");           // prints "it's a string: hello"  
example({ something: "else" });   // prints "don't know what this is! [[object
```

A guard's function type predicate (the `foo is Bar` in the function return type position) is used at compile time to narrow types, the function body is used at runtime. The type predicate and function must agree, or your code won't work.

Type guard functions don't have to use `typeof` or `instanceof`, they can use more complicated logic.

For example, this code determines if you've got a jQuery object by checking for its version string.

```
function isjQuery(foo): foo is JQuery {  
    // test for jQuery's version string  
    return foo.jquery !== undefined;  
}  
  
function example(foo) {  
    if (isjQuery(foo)) {  
        // foo is typed JQuery here  
        foo.eq(0);  
    }  
}
```

Section 12.2: Using instanceof

`instanceof` requires that the variable is of type `any`.

This code ([try it](#)):

```
class Pet { }
class Dog extends Pet {
  bark() {
    console.log("woof");
  }
}
class Cat extends Pet {
  purr() {
    console.log("meow");
  }
}

function example(foo: any) {
  if (foo instanceof Dog) {
    // foo is type Dog in this block
    foo.bark();
  }

  if (foo instanceof Cat) {
    // foo is type Cat in this block
    foo.purr();
  }
}

example(new Dog());
example(new Cat());
```

prints

```
woof
meow
```

to the console.

Section 12.3: Using typeof

`typeof` is used when you need to distinguish between types `number`, `string`, `boolean`, and `symbol`. Other string constants will not error, but won't be used to narrow types either.

Unlike `instanceof`, `typeof` will work with a variable of any type. In the example below, `foo` could be typed as `number` | `string` without issue.

This code ([try it](#)):

```
function example(foo: any) {
  if (typeof foo === "number") {
    // foo is type number in this block
    console.log(foo + 100);
  }

  if (typeof foo === "string") {
```

```
// foo is type string in this block
console.log("not a number: " + foo);
    }
}

example(23);
example("foo");
```

prints

```
123
not a number: foo
```


Chapter 13: TypeScript basic examples

Section 13.1: 1 basic class inheritance example using extends and super keyword

A generic Car class has some car property and a description method

```
class Car{
    name:string;
    engineCapacity:string;

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

    describeCar(){
        console.log(`${this.name} car comes with ${this.engineCapacity} displacement`);
    }
}

new Car("maruti ciaz", "1500cc").describeCar();
```

HondaCar extends the existing generic car class and adds new property.

```
class HondaCar extends
    Car{
    seatingCapacity:number;

    constructor(name:string, engineCapacity:string, seatingCapacity:number){
        super(name, engineCapacity);
        this.seatingCapacity=seatingCapacity;
    }

    describeHondaCar(){
        super.describeCar();
        console.log(`${this} cars comes with seating capacity of ${this.seatingCapacity}`);
    }
}

new HondaCar("honda jazz", "1200cc", 4).describeHondaCar();
```

Section 13.2: 2 static class variable example - count how many time method is being invoked

here countInstance is a static class variable

```
class StaticTest{
    static countInstance : number= 0;
    constructor(){
        StaticTest.countInstance++;
    }
}

new StaticTest();
new StaticTest();
console.log(StaticTest.countInstance);
```

Chapter 14: Importing external libraries

Section 14.1: Finding definition files

for typescript 2.x:

definitions from [DefinitelyTyped](#) are available via [@types npm](#) package

```
npm i --save lodash
npm i --save-dev @types/lodash
```

but in case if you want use types from other repos then can be used old way:

for typescript 1.x:

[Typings](#) is an npm package that can automatically install type definition files into a local project. I recommend that you read the [quickstart](#).

```
npm install -global typings
```

Now we have access to the typings cli.

1. The first step is to search for the package used by the project

```
typings search lodash
```

NAME	SOURCE	DESCRIPTION
UPDATE		
D	dt http://lodash.com/	2
2016-07-20T00:13:09.000Z		
lodash	global	1
2016-07-01T20:51:07.000Z		
lodash	npm https://www.npmjs.com/package/lodash	1
2016-07-01T20:51:07.000Z		

2. Then decide which source you should install from. I use dt which stands for [DefinitelyTyped](#) a GitHub repo where the community can edit typings, it's also normally the most recently updated.
3. Install the typings files

```
typings install dt~lodash --global --save
```

Let's break down the last command. We are installing the DefinitelyTyped version of lodash as a global typings file in our project and saving it as a dependency in the typings.json. Now wherever we import lodash, typescript will load the lodash typings file.

4. If we want to install typings that will be used for development environment only, we can supply the --save-dev flag:

```
typings install chai --save-dev
```

Section 14.2: Importing a module from npm

If you have a type definition file (d.ts) for the module, you can use an `import` statement.

```
import _ = require('lodash');
```

If you don't have a definition file for the module, TypeScript will throw an error on compilation because it cannot find the module you are trying to import.

In this case, you can import the module with the normal runtime `require` function. This returns it as the any type, however.

```
// The _ variable is of type any, so TypeScript will not perform any type checking.  
const _: any = require('lodash');
```

As of TypeScript 2.0, you can also use a *shorthand ambient module declaration* in order to tell TypeScript that a module exists when you don't have a type definition file for the module. TypeScript won't be able to provide any meaningful typechecking in this case though.

```
declare module "lodash";  
  
// you can now import from lodash in any way you wish:  
import { flatten } from "lodash";  
import * as _ from "lodash";
```

As of TypeScript 2.1, the rules have been relaxed even further. Now, as long as a module exists in your `node_modules` directory, TypeScript will allow you to import it, even with no module declaration anywhere. (Note that if using the `--noImplicitAny` compiler option, the below will still generate a warning.)

```
// Will work if `node_modules/someModule/index.js` exists, or if  
`node_modules/someModule/package.json` has a valid "main" entry point  
import { foo } from "someModule";
```

Section 14.3: Using global external libraries without typings

Although modules are ideal, if the library you are using is referenced by a global variable (like `$` or `_`), because it was loaded by a script tag, you can create an ambient declaration in order to refer to it:

```
declare const _: any;
```

Section 14.4: Finding definition files with TypeScript 2.x

With the 2.x versions of TypeScript, typings are now available from the [npm @types repository](https://www.npmjs.com/@types). These are automatically resolved by the TypeScript compiler and are much simpler to use.

To install a type definition you simply install it as a dev dependency in your projects `package.json`

e.g.

```
npm i -S lodash  
npm i -D @types/lodash
```

after install you simply use the module as before

```
import * as _ from 'lodash'
```

Chapter 15: Modules - exporting and importing

Section 15.1: Hello world module

```
//hello.ts
export function hello(name: string){
    console.log(`Hello ${name}!`);
}
function helloES(name: string){
    console.log(`Hola ${name}!`);
}
export {helloES};
export default hello;
```

Load using directory index

If directory contains file named `index.ts` it can be loaded using only directory name (for `index.ts` filename is optional).

```
//welcome/index.ts
export function welcome(name: string){
    console.log(`Welcome ${name}!`);
}
```

Example usage of defined modules

```
import {hello, helloES} from "./hello"; // load specified elements
import defaultHello from "./hello";    // load default export into name
defaultHello                             // load all exports as Bundle
import * as Bundle from "./hello";

hello("World");                          // Hello
helloES("Mundo");                        // World!
defaultHello("World");                   // Hola Mundo!

Bundle.hello("World");                   // Hello
Bundle.helloES("Mundo");                 // World!

welcome("Human");                        // Welcome
```

Section 15.2: Re-export

TypeScript allow to re-export declarations.

```
//Operator.ts
interface Operator {
    eval(a: number, b: number): number;
}
export default Operator;

//Add.ts
import Operator from "./Operator";
export class Add implements Operator {
    eval(a: number, b: number): number {
        return a + b;
    }
}
```

```

}

//Mul.ts
import Operator from "./Operator";
export class Mul implements Operator {
  eval(a: number, b: number): number {
    return a * b;
  }
}

```

You can bundle all operations in single library

```

//Operators.ts
import {Add} from "./Add";
import {Mul} from "./Mul";

export {Add, Mul};

```

Named declarations can be re-exported using shorter syntax

```

//NamedOperators.ts
export {Add} from "./Add";
export {Mul} from "./Mul";

```

Default exports can also be exported, but no short syntax is available. Remember, only one default export per module is possible.

```

//Calculator.ts
export {Add} from "./Add";
export {Mul} from "./Mul";
import Operator from "./Operator";

export default Operator;

```

Possible is re-export of **bundled import**

```

//RepackedCalculator.ts
export * from "./Operators";

```

When re-exporting bundle, declarations may be overridden when declared explicitly.

```

//FixedCalculator.ts
export * from "./Calculator"
import Operator from "./Calculator"; export
class Add implements Operator {
  eval(a: number, b: number): number {
    return 42;
  }
}

```

Usage example

```

//run.ts
import {Add, Mul} from "./FixedCalculator";

const add = new Add();
const mul = new Mul();

```

```
console.log(add.eval(1, 1)); // 42
console.log(mul.eval(3, 4)); // 12
```

Section 15.3: Exporting/Importing declarations

Any declaration (variable, const, function, class, etc.) can be exported from module to be imported in other module.

TypeScript offer two export types: named and default.

Named export

```
// adams.ts
export function hello(name: string){
  console.log(`Hello ${name}!`);
}
export const answerToLifeTheUniverseAndEverything = 42;
export const unused = 0;
```

When importing named exports, you can specify which elements you want to import.

```
import {hello, answerToLifeTheUniverseAndEverything} from "./adams";
hello(answerToLifeTheUniverseAndEverything); // Hello 42!
```

Default export

Each module can have one default export

```
// dent.ts
const defaultValue = 54;
export default defaultValue;
```

which can be imported using

```
import dentValue from "./dent";
console.log(dentValue); // 54
```

Bundled import

TypeScript offers method to import whole module into variable

```
// adams.ts
export function hello(name: string){
  console.log(`Hello ${name}!`);
}
export const answerToLifeTheUniverseAndEverything = 42;

import * as Bundle from "./adams";
Bundle.hello(Bundle.answerToLifeTheUniverseAndEverything); // Hello 42!
console.log(Bundle.unused); // 0
```

Chapter 16: Publish TypeScript definition files

Section 16.1: Include definition file with library on npm

Add typings to your package.json

```
{  
  ...  
  "typings": "path/file.d.ts"  
  ...  
}
```

Now whenever that library is imported typescript will load the typings file

Chapter 17: Using TypeScript with webpack

Section 17.1: webpack.config.js

install loaders `npm install --save-dev ts-loader source-map-loader`

tsconfig.json

```
{
  "compilerOptions": {
    "sourceMap": true,
    "noImplicitAny": true,
    "module": "commonjs",
    "target": "es5",
    "jsx": "react" // if you want to use react jsx
  }
}

module.exports = {
  entry: "./src/index.ts",
  output: {
    filename: "./dist/bundle.js",
  },

  // Enable sourcemaps for debugging webpack's output.
  devtool: "source-map",

  resolve: {
    // Add '.ts' and '.tsx' as resolvable extensions.
    extensions: [ "", ".webpack.js", ".web.js", ".ts", ".tsx", ".js" ]
  },

  module: {
    loaders: [
      // All files with a '.ts' or '.tsx' extension will be handled by 'ts-loader'.
      { test: /\.tsx?$/, loader: "ts-loader" }
    ],

    preLoaders: [
      // All output '.js' files will have any sourcemaps re-processed by 'source-map-loader'.
      { test: /\.js$/, loader: "source-map-loader" }
    ]
  },
  
  /*****
   * If you want to use react *
   *****/
  

  // When importing a module whose path matches one of the following, just
// assume a corresponding global variable exists and use that instead.
// This is important because it allows us to avoid bundling all of our
// dependencies, which allows browsers to cache those libraries between builds.
// externals: {
//   "react": "React",
//   "react-dom": "ReactDOM"
// },
};
```

Chapter 18: Mixins

Parameter	Description
derivedCtor	The class that you want to use as the composition class
baseCtors	An array of classes to be added to the composition class

Section 18.1: Example of Mixins

To create mixins, simply declare lightweight classes that can be used as "behaviours".

```
class Flies {  
  fly() {  
    alert('Is it a bird? Is it a plane?');  
  }  
}  
  
class Climbs {  
  climb() {  
    alert('My spider-sense is tingling.');  }  
}  
  
class Bulletproof {  
  deflect() {  
    alert('My wings are a shield of steel.');  }  
}
```

You can then apply these behaviours to a composition class:

```
class BeetleGuy implements Climbs, Bulletproof {  
  climb: () => void;  
  deflect: () => void;  
}  
applyMixins (BeetleGuy, [Climbs, Bulletproof]);
```

The applyMixins function is needed to do the work of composition.

```
function applyMixins(derivedCtor: any, baseCtors: any[]) {  
  baseCtors.forEach(baseCtor => {  
    Object.getOwnPropertyNames(baseCtor.prototype).forEach(name => {  
      if (name !== 'constructor') {  
        derivedCtor.prototype[name] = baseCtor.prototype[name];  
      }  
    });  
  });  
}
```

Chapter 19: How to use a JavaScript library without a type definition file

While some existing JavaScript libraries have [type definition files](#), there are many that don't.

TypeScript offers a couple patterns to handle missing declarations.

Section 19.1: Make a module that exports a default any

For more complicated projects, or in cases where you intend to gradually type a dependency, it may be cleaner to create a module.

Using JQuery (although it [does have typings available](#)) as an example:

```
// place in
jquery.d.ts declare
let $: any; export
default $;
```

And then in any file in your project, you can import this definition with:

```
// some other .ts file
import $ from "jquery";
```

After this import, \$ will be typed as any.

If the library has multiple top-level variables, export and import by name instead:

```
// place in jquery.d.ts
declare module "jquery" {
  let $: any;
  let jQuery: any;

  export { $ };
  export { jQuery };
}
```

You can then import and use both names:

```
// some other .ts file
import { $, jQuery } from "jquery";

$.doThing();
jQuery.doOtherThing();
```

Section 19.2: Declare an any global

It is sometimes easiest to just declare a global of type any, especially in simple projects.

If JQuery didn't have type declarations ([it does](#)), you could put

```
declare var $: any;
```

Now any use of \$ will be typed any.

Section 19.3: Use an ambient module

If you just want to indicate the *intent* of an import (so you don't want to declare a global) but don't wish to bother with any explicit definitions, you can import an ambient module.

```
// in a declarations file (like declarations.d.ts)  
declare module "jquery";    // note that there are no defined exports
```

You can then import from the ambient module.

```
// some other .ts file  
import {$, jQuery} from "jquery";
```

Anything imported from the declared module (like \$ and jQuery) above will be of type any

Chapter 20: TypeScript installing typescript and running the typescript compiler tsc

How to install TypeScript and run the TypeScript compiler against a .ts file from the command line.

Section 20.1: Steps

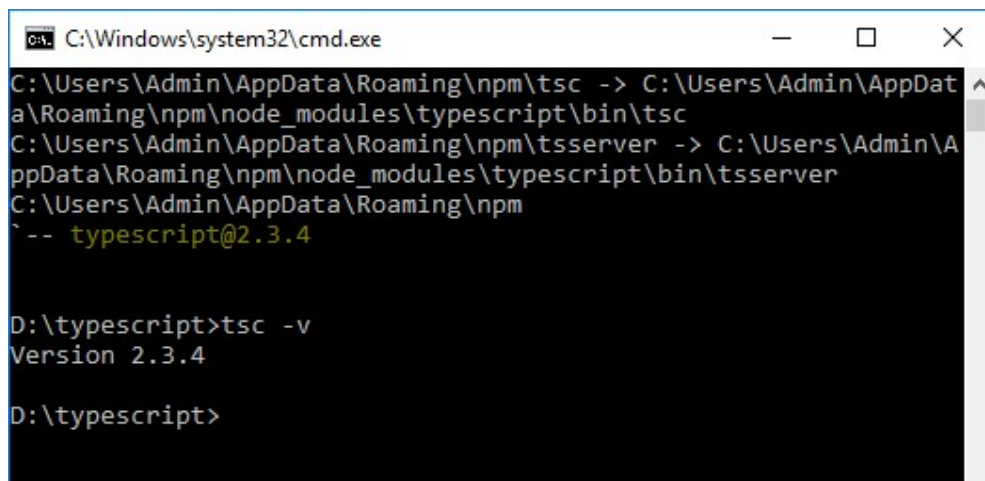
Installing TypeScript and running typescript compiler.

To install TypeScript Compiler

```
npm install -g typescript
```

To check with the typescript version

```
tsc -v
```



```
C:\Windows\system32\cmd.exe
C:\Users\Admin\AppData\Roaming\npm\tsc -> C:\Users\Admin\AppData\Roaming\npm\node_modules\typescript\bin\tsc
C:\Users\Admin\AppData\Roaming\npm\tsserver -> C:\Users\Admin\AppData\Roaming\npm\node_modules\typescript\bin\tsserver
C:\Users\Admin\AppData\Roaming\npm
-- typescript@2.3.4

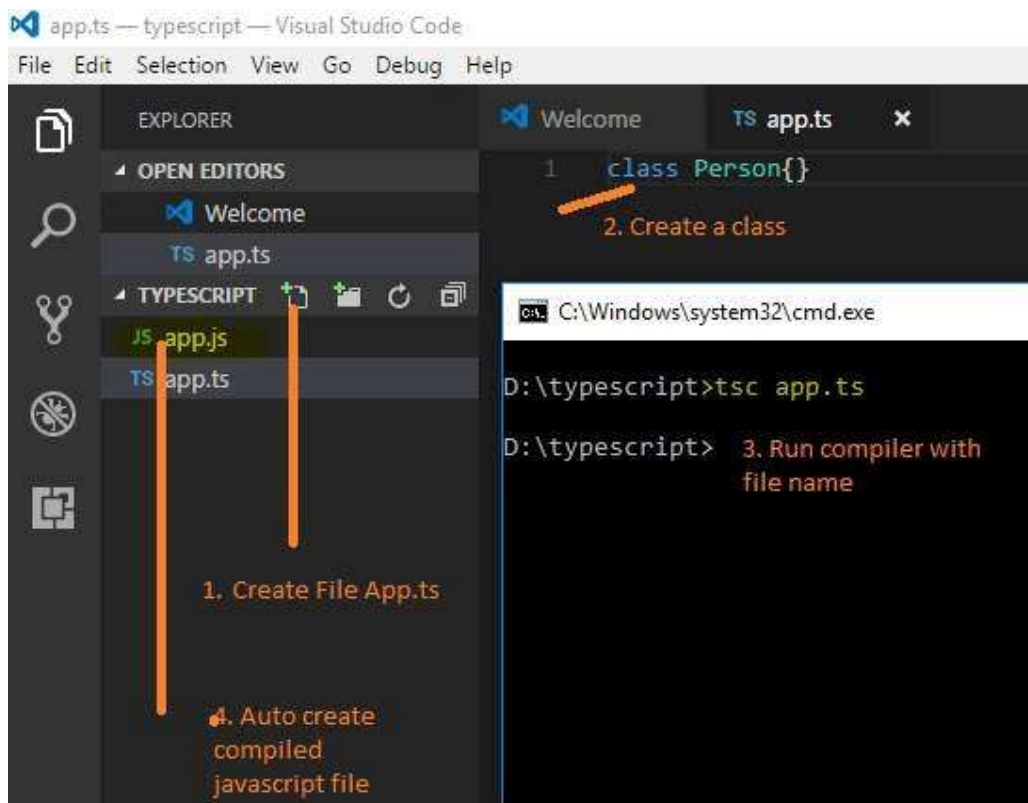
D:\typescript>tsc -v
Version 2.3.4

D:\typescript>
```

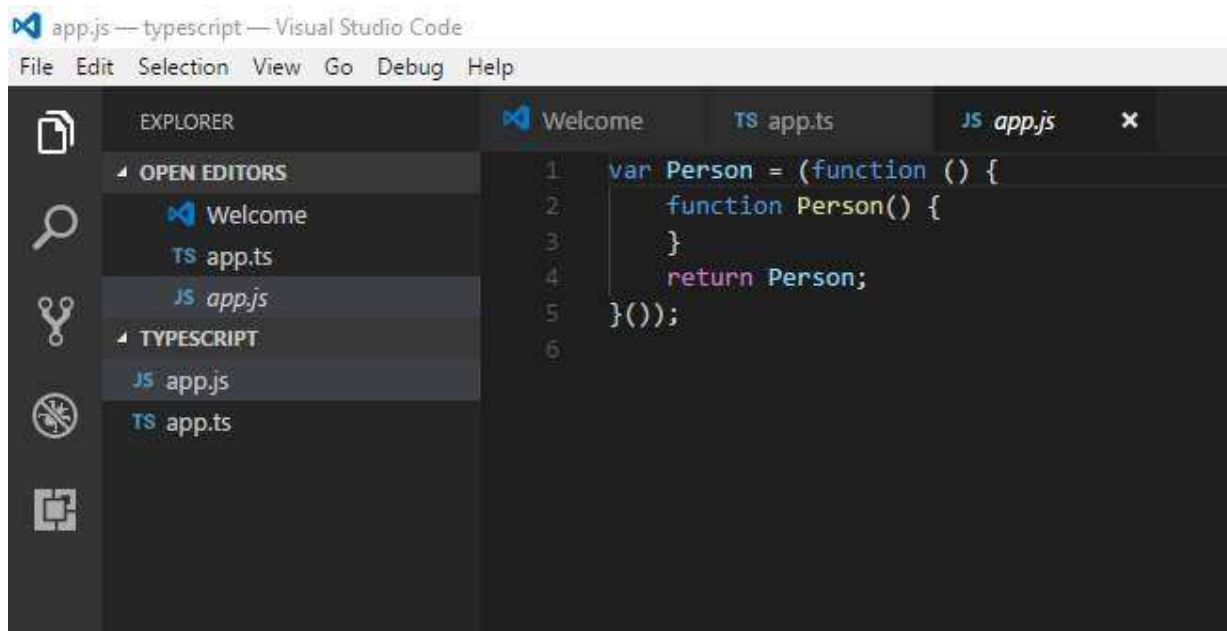
Download Visual Studio Code for Linux/Windows

[Visual Code Download Link](#)

1. Open Visual Studio Code
2. Open Same Folder where you have installed TypeScript compiler
3. Add File by clicking on plus icon on left pane
4. Create a basic class.
5. Compile your type script file and generate output.



See the result in compiled javascript of written typescript code.



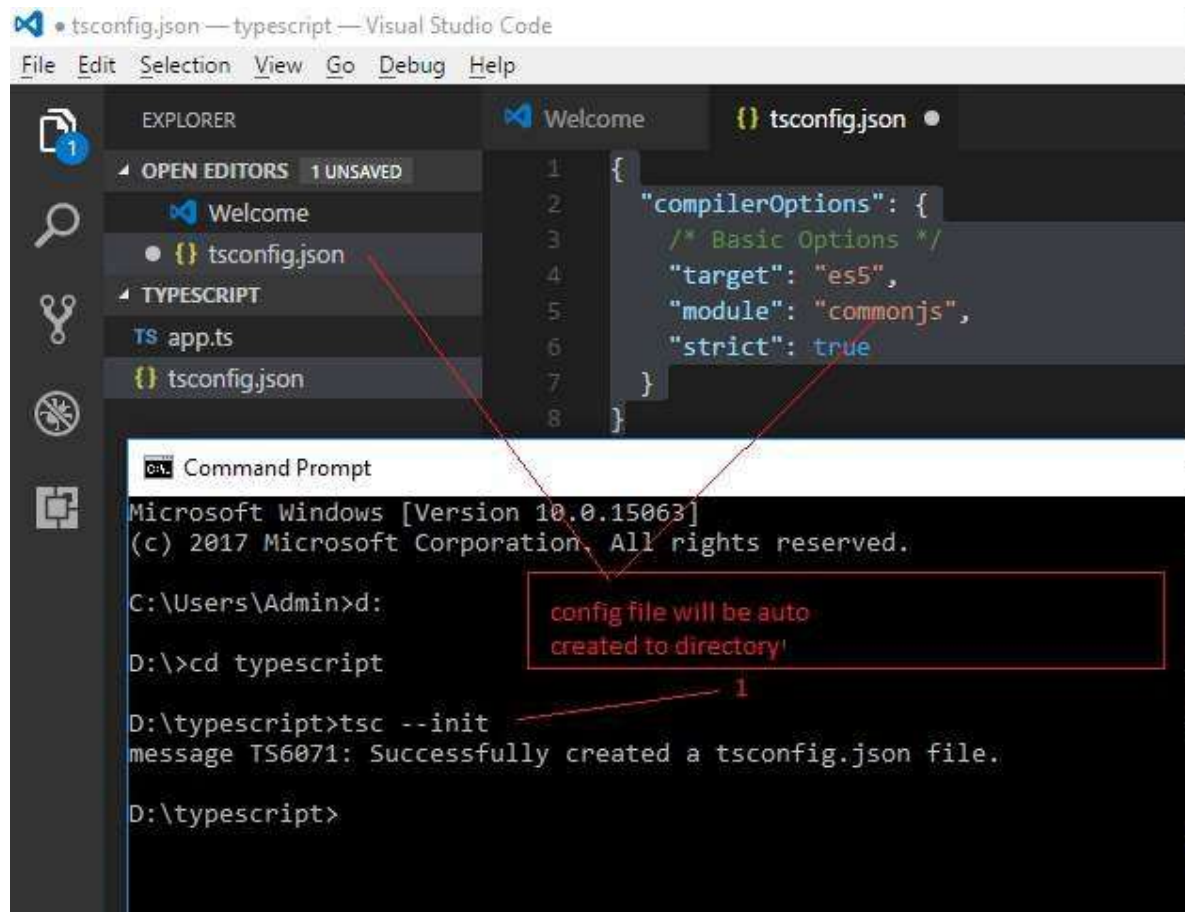
Thank you.

Chapter 21: Configure typescript project to compile all files in typescript.

creating your first .tsconfig configuration file which will tell the TypeScript compiler how to treat your .ts files

Section 21.1: TypeScript Configuration file setup

- Enter command "**tsc --init**" and hit enter.
- Before that we need to compile ts file with command "**tsc app.ts**" now it is all defined in below config file automatically.



The screenshot shows the Visual Studio Code interface. The Explorer pane on the left shows the project structure with files: Welcome, tsconfig.json, app.ts, and tsconfig.json. The main editor shows the content of tsconfig.json, which is a JSON object with compiler options. Below the editor, a Command Prompt window is open, showing the execution of the 'tsc --init' command. A red box highlights the message 'Successfully created a tsconfig.json file.' and a red arrow points from this message to the tsconfig.json file in the Explorer pane.

```
tsconfig.json — typescript — Visual Studio Code
File Edit Selection View Go Debug Help

EXPLORER
OPEN EDITORS 1 UNSAVED
Welcome
• {} tsconfig.json
TYPESCRIPT
TS app.ts
{} tsconfig.json

1 {
2   "compilerOptions": {
3     /* Basic Options */
4     "target": "es5",
5     "module": "commonjs",
6     "strict": true
7   }
8 }
```

```
Command Prompt
Microsoft Windows [Version 10.0.15063]
(c) 2017 Microsoft Corporation. All rights reserved.

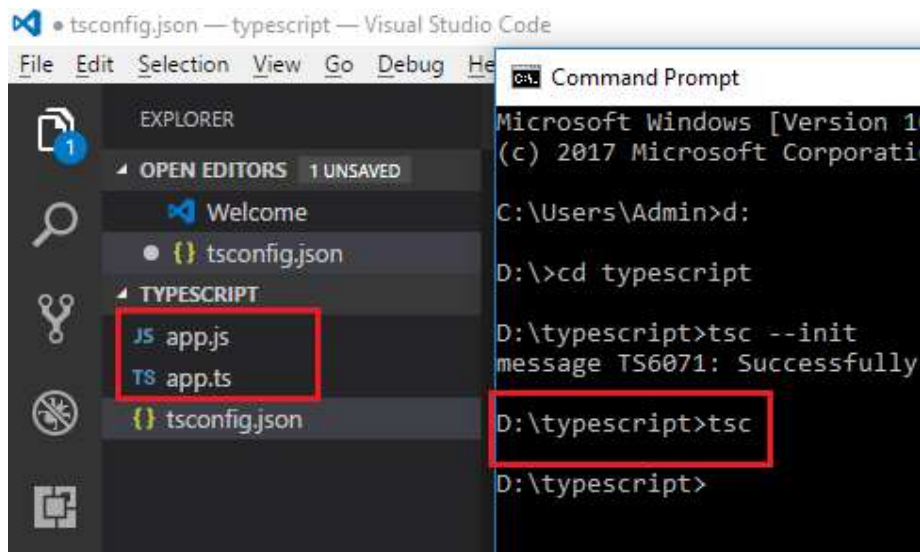
C:\Users\Admin>d:
D:\>cd typescript

D:\typescript>tsc --init
message TS6071: Successfully created a tsconfig.json file.

D:\typescript>
```

config file will be auto created to directory!

- Now, You can compile all typescripts by command "**tsc**". it will automatically create ".js" file of your typescript file.



- If you will create another typescript and hit "tsc" command in command prompt or terminal javascript file will be automatically created for typescript file.

Thank you,

Chapter 22: Integrating with Build Tools

Section 22.1: Browserify

Install

```
npm install tsify
```

Using Command Line Interface

```
browserify main.ts -p [ tsify --noImplicitAny ] > bundle.js
```

Using API

```
var browserify = require("browserify");  
var tsify = require("tsify");  
  
browserify()  
  .add("main.ts")  
  .plugin("tsify", { noImplicitAny: true })  
  .bundle()  
  .pipe(process.stdout);
```

More details: [smrg/TSify](https://github.com/smrg/TSify)

Section 22.2: Webpack

Install

```
npm install ts-loader --save-dev
```

Basic webpack.config.js

webpack 2.x, 3.x

```
module.exports = {  
  resolve: {  
    extensions: ['.ts', '.tsx', '.js']  
  },  
  module: {  
    rules: [  
      {  
        // Set up ts-loader for .ts/.tsx files and exclude any imports from node_modules.  
        test: /\.tsx?$/,  
        loaders: ['ts-loader'],  
        exclude: /node_modules/  
      }  
    ]  
  },  
  entry: [  
    // Set index.tsx as application entry point.  
    './index.tsx'  
  ],  
  output: {  
    filename: "bundle.js"  
  }  
};
```

webpack 1.x

```
module.exports = {  
  entry: "./src/index.tsx",  
  output: {  
    filename: "bundle.js"  
  }  
};
```

```

    },
    resolve: {
      // Add '.ts' and '.tsx' as a resolvable extension.
      extensions: ['', '.webpack.js', '.web.js', '.ts', '.tsx', '.js']
    },
    module: {
      loaders: [
        // all files with a '.ts' or '.tsx' extension will be handled by 'ts-loader'
        { test: /\.ts(x)?$/, loader: "ts-loader", exclude: /node_modules/ }
      ]
    }
  },
}

```

See more details on [ts-loader here](#).

Alternatives:

- [awesome-typescript-loader](#)

Section 22.3: Grunt

Install

```
npm install grunt-ts
```

Basic Gruntfile.js

```

module.exports = function(grunt) {
  grunt.initConfig({
    ts: {
      default: {
        src: ["**/*.ts", "!node_modules/**/*.ts"]
      }
    }
  });
  grunt.loadNpmTasks("grunt-ts");
  grunt.registerTask("default", ["ts"]);
};

```

More details: [TypeStrong/grunt-ts](#)

Section 22.4: Gulp

Install

```
npm install gulp-typescript
```

Basic gulpfile.js

```

var gulp = require("gulp");
var ts = require("gulp-typescript");

gulp.task("default", function () {
  var tsResult = gulp.src("src/*.ts")
    .pipe(ts({
      noImplicitAny: true,
      out: "output.js"
    }));
  return tsResult.js.pipe(gulp.dest("built/local"));
});

```

gulpfile.js using an existing tsconfig.json

```
var gulp = require("gulp");
```

```

var ts = require("gulp-typescript");

var tsProject = ts.createProject('tsconfig.json', {
  noImplicitAny: true // You can add and overwrite parameters here
});

gulp.task("default", function () {
  var tsResult = tsProject.src()
    .pipe(tsProject());
  return tsResult.js.pipe(gulp.dest('release'));
});

```

More details: ivogabe/gulp-typescript

Section 22.5: MSBuild

Update project file to include locally installed Microsoft.TypeScript.Default.props (at the top) and Microsoft.TypeScript.targets (at the bottom) files:

```

<?xml version="1.0" encoding="utf-8"?>
<Project ToolsVersion="4.0" DefaultTargets="Build"
  xmlns="http://schemas.microsoft.com/developer/msbuild/2003">
  <!-- Include default props at the bottom -->
  <Import

    Project="$(MSBuildExtensionsPath32)\Microsoft\VisualStudio\v$(VisualStudioVersion)\TypeScript\Microsoft.TypeScript.Default.props"

    Condition="Exists('$(MSBuildExtensionsPath32)\Microsoft\VisualStudio\v$(VisualStudioVersion)\TypeScript\Microsoft.TypeScript.Default.props')" />

  <!-- TypeScript configurations go here -->
  <PropertyGroup Condition="'$(Configuration)' == 'Debug'">
    <TypeScriptRemoveComments>>false</TypeScriptRemoveComments>
    <TypeScriptSourceMap>true</TypeScriptSourceMap>
  </PropertyGroup>
  <PropertyGroup Condition="'$(Configuration)' == 'Release'">
    <TypeScriptRemoveComments>true</TypeScriptRemoveComments>
    <TypeScriptSourceMap>>false</TypeScriptSourceMap>
  </PropertyGroup>

  <!-- Include default targets at the bottom -->
  <Import

    Project="$(MSBuildExtensionsPath32)\Microsoft\VisualStudio\v$(VisualStudioVersion)\TypeScript\Microsoft.TypeScript.targets"

    Condition="Exists('$(MSBuildExtensionsPath32)\Microsoft\VisualStudio\v$(VisualStudioVersion)\TypeScript\Microsoft.TypeScript.targets')" />
</Project>

```

More details about defining MSBuild compiler options: [Setting Compiler Options in MSBuild projects](#)

Section 22.6: NuGet

- Right-Click -> Manage NuGet Packages
- Search for Microsoft.TypeScript.MSBuildHit
- Install
- When install is complete, rebuild!

More details can be found at [Package Manager Dialog](#) and [using nightly builds with NuGet](#)

Section 22.7: Install and configure webpack + loaders

Installation

```
npm install -D webpack typescript ts-loader
```

webpack.config.js

```
module.exports = {
  entry: {
    app: ['./src/'],
  },
  output: {
    path: __dirname,
    filename: './dist/[name].js',
  },
  resolve: {
    extensions: ['', '.js', '.ts'],
  },
  module: {
    loaders: [{
      test: /\.ts(x)?$/, loaders: ['ts-loader'], exclude: /node_modules/
    }],
  }
};
```

Chapter 23: Using TypeScript with RequireJS

RequireJS is a JavaScript file and module loader. It is optimized for in-browser use, but it can be used in other JavaScript environments, like Rhino and Node. Using a modular script loader like RequireJS will improve the speed and quality of your code.

Using TypeScript with RequireJS requires configuration of `tsconfig.json`, and including an snippet in any HTML file. Compiler will traduce imports from the syntax of TypeScript to RequireJS' format.

Section 23.1: HTML example using RequireJS CDN to include an already compiled TypeScript file

```
<body onload="__init();">
  ...
  <script src="http://requirejs.org/docs/release/2.3.2/comments/require.js"></script>
  <script>
    function __init() {
      require(["view/index.js"]);
    }
  </script>
</body>
```

Section 23.2: `tsconfig.json` example to compile to view folder using RequireJS import style

```
{
  "module": "amd",      // Using AMD module code generator which works with
  "rootDir": "./src",  // Change this to your source
  "outDir": "./view",
  "outFile": "main.js",
}
```

Chapter 24: TypeScript with AngularJS

Name	Description
controllerAs	is an alias name, to which variables or functions can be assigned to. @see: https://docs.angularjs.org/guide/directive
\$inject	Dependency Injection list, it is resolved by angular and passing as an argument to constructor functions.

Section 24.1: Directive

```
interface IMyDirectiveController {
    // specify exposed controller methods and properties here
    getUrl(): string;
}

class MyDirectiveController implements IMyDirectiveController {

    // Inner injections, per each directive
    public static $inject = ["$location", "toaster"];

    constructor(private $location: ng.ILocationService, private toaster: any) {
        // $location and toaster are now properties of the controller
    }

    public getUrl(): string {
        return this.$location.url(); // utilize $location to retrieve the URL
    }
}

/*
 * Outer injections, for run once control.
 * For example we have all templates in one value, and we want to use it.
 */
export function myDirective(templatesUrl: ITemplates): ng.IDirective {
    return {
        controller: MyDirectiveController,
        controllerAs: "vm",

        link: (scope: ng.IScope,
            element: ng.IAugmentedJQuery,
            attributes: ng.IAttributes,
            controller: IMyDirectiveController): void => {

            let url = controller.getUrl();
            element.text("Current URL: " + url);

        },

        replace: true,
        require: "ngModel",
        restrict: "A",
        templateUrl: templatesUrl.myDirective,
    };
}

myDirective.$inject = [
    Templates.prototype.slug,
];
```

```
// Using slug naming across the projects simplifies change of the directive name
myDirective.prototype.slug = "myDirective";

// You can place this in some bootstrap file, or have them at the same file
angular.module("myApp").
  directive(myDirective.prototype.slug, myDirective);
```

Section 24.2: Simple example

```
export function myDirective($location: ng.ILocationService): ng.IDirective {
  return {
    link: (scope: ng.IScope,
          element: ng.IAugmentedJQuery,
          attributes: ng.IAttributes): void => {

      element.text("Current URL: " + $location.url());

    },

    replace: true,
    require: "ngModel",
    restrict: "A",
    templateUrl: templatesUrl.myDirective,
  };
}

// Using slug naming across the projects simplifies change of the directive name
myDirective.prototype.slug = "myDirective";

// You can place this in some bootstrap file, or have them at the same file
angular.module("myApp").
  directive(myDirective.prototype.slug, [
    Templates.prototype.slug,
    myDirective
  ]);
```

Section 24.3: Component

For an easier transition to Angular 2, it's recommended to use Component, available since Angular 1.5.8

myModule.ts

```
import { MyModuleComponent } from "../components/myModuleComponent";
import { MyModuleService } from "../services/MyModuleService";

angular
  .module("myModule", [])
  .component("myModuleComponent", new MyModuleComponent())
  .service("myModuleService", MyModuleService);
```

components/myModuleComponent.ts

```
import IComponentOptions = angular.IComponentOptions;
import IControllerConstructor = angular.IControllerConstructor;
import Injectable = angular.Injectable;
import { MyModuleController } from "../controller/MyModuleController";

export class MyModuleComponent implements IComponentOptions {
```

```
public templateUrl: string = "../app/myModule/templates/myComponentTemplate.html";
public controller: Injectable<IControllerConstructor> = MyModuleController;
public bindings: {[boundProperty: string]: string} = {};
}
```

templates/myModuleComponent.html

```
<div class="my-module-component">
  {{$ctrl.someContent}}
</div>
```

controller/MyModuleController.ts

```
import IController = angular.IController;
import { MyModuleService } from "../services/MyModuleService";

export class MyModuleController implements IController {
  public static readonly $inject: string[] = ["$element", "myModuleService"];
  public someContent: string = "Hello World";

  constructor($element: JQuery, private myModuleService: MyModuleService) {
    console.log("element", $element);
  }

  public doSomething(): void {
    // implementation..
  }
}
```

services/MyModuleService.ts

```
export class MyModuleService {
  public static readonly $inject: string[] = [];

  constructor() {
  }

  public doSomething(): void {
    // do something
  }
}
```

somewhere.html

```
<my-module-component></my-module-component>
```


Chapter 25: TypeScript with SystemJS

Section 25.1: Hello World in the browser with SystemJS

Install systemjs and plugin-typescript

```
npm install systemjs
npm install plugin-typescript
```

NOTE: this will install typescript 2.0.0 compiler which is not released yet.

For TypeScript 1.8 you have to use plugin-typescript 4.0.16

Create hello.ts file

```
export function greeter(person: String) {
  return 'Hello, ' + person;
}
```

Create hello.html file

```
<!doctype html>
<html>
<head>
  <title>Hello World in TypeScript</title>
  <script src="node_modules/systemjs/dist/system.src.js"></script>

  <script src="config.js"></script>

  <script>
    window.addEventListener('load', function() {
      System.import('./hello.ts').then(function(hello) {
        document.body.innerHTML = hello.greeter('World');
      });
    });
  </script>

</head>
<body>
</body>
</html>
```

Create config.js - SystemJS configuration file

```
System.config({
  packages: {
    "plugin-typescript": {
      "main": "plugin.js"
    },
    "typescript": {
      "main": "lib/typescript.js",
      "meta": {
        "lib/typescript.js": {
          "exports": "ts"
        }
      }
    }
  }
})
```

```

    },
    map: {
      "plugin-typescript": "node_modules/plugin-typescript/lib/",
      /* NOTE: this is for npm 3 (node 6) */
      /* for npm 2, typescript path will be */
      /* node_modules/plugin-typescript/node_modules/typescript */
      "typescript": "node_modules/typescript/"
    },
    transpiler: "plugin-typescript", meta:
    {
      "./hello.ts": {
        format: "esm",
        loader: "plugin-typescript"
      }
    },
    typescriptOptions: {
      typeCheck: 'strict'
    }
  }
});

```

NOTE: if you don't want type checking, remove loader: "plugin-typescript" and typescriptOptions from config.js. Also note that it will never check javascript code, in particular code in the `<script>` tag in html example.

Test it

```

npm install live-server
./node_modules/.bin/live-server --open=hello.html

```

Build it for production

```

npm install systemjs-builder

```

Create build.js file:

```

var Builder = require('systemjs-builder');
var builder = new Builder();
builder.loadConfig('./config.js').then(function() {
  builder.bundle('./hello.ts', './hello.js', {minify: true});
});

```

build hello.js from hello.ts

```

node build.js

```

Use it in production

Just load hello.js with a script tag before first use

hello-production.html file:

```

<!doctype html>
<html>
<head>
  <title>Hello World in TypeScript</title>
  <script src="node_modules/systemjs/dist/system.src.js"></script>

  <script src="config.js"></script>
  <script src="hello.js"></script>

```

<script>

```
    window.addEventListener('load', function() {  
      System.import('./hello.ts').then(function(hello) {  
        document.body.innerHTML = hello.greeter('World');  
      });  
    });
```

</script>

</head>

<body>

</body>

</html>

Chapter 26: Using TypeScript with React (JS & native)

Section 26.1: ReactJS component written in TypeScript

You can use ReactJS's components easily in TypeScript. Just rename the 'jsx' file extension to 'tsx':

```
//helloMessage.tsx:
var HelloMessage = React.createClass({
  render: function() {
    return <div>Hello {this.props.name}</div>;
  }
});

ReactDOM.render(<HelloMessage name="John" />, mountNode);
```

But in order to make full use of TypeScript's main feature (static type checking) you must do a couple things:

1) convert `React.createClass` to an ES6 Class:

```
//helloMessage.tsx:
class HelloMessage extends React.Component {
  render() {
    return <div>Hello {this.props.name}</div>;
  }
}

ReactDOM.render(<HelloMessage name="John" />, mountNode);
```

For more info on converting to ES6 look [here](#)

2) Add Props and State interfaces:

```
interface Props {
  name: string;
  optionalParam?: number;
}

interface State {
  //empty in our case
}

class HelloMessage extends React.Component<Props, State> {
  render() {
    return <div>Hello {this.props.name}</div>;
  }
}

// TypeScript will allow you to create without the optional parameter
ReactDOM.render(<HelloMessage name="Sebastian" />, mountNode);
// But it does check if you pass in an optional parameter of the wrong type
ReactDOM.render(<HelloMessage name="Sebastian" optionalParam='foo' />, mountNode);
```

Now TypeScript will display an error if the programmer forgets to pass props. Or if trying to pass in props that are not defined in the interface.

Section 26.2: TypeScript & react & webpack

Installing typescript, typings and webpack globally

```
npm install -g typescript typings webpack
```

Installing loaders and linking typescript

```
npm install --save-dev ts-loader source-map-loader npm link typescript
```

Linking TypeScript allows ts-loader to use your global installation of TypeScript instead of needing a separate local copy [typescript doc](#)

installing `.d.ts` files with typescript 2.x

```
npm i @types/react --save-dev
npm i @types/react-dom --save-dev
```

installing `.d.ts` files with typescript 1.x

```
typings install --global --save dt-react typings
install --global --save dt-react-dom
```

`tsconfig.json` configuration file

```
{
  "compilerOptions": {
    "sourceMap": true,
    "noImplicitAny": true,
    "module": "commonjs",
    "target": "es5",
    "jsx": "react"
  }
}
```

`webpack.config.js` configuration file

```
module.exports = {
  entry: "<path to entry point>", // for example ./src/helloMessage.tsx
  output: {
    filename: "<path to bundle file>", // for example ./dist/bundle.js
  },

  // Enable sourcemaps for debugging webpack's output.
  devtool: "source-map",

  resolve: {
    // Add '.ts' and '.tsx' as resolvable extensions.
    extensions: [ "", ".webpack.js", ".web.js", ".ts", ".tsx", ".js" ]
  },

  module: {
    loaders: [
      // All files with a '.ts' or '.tsx' extension will be handled by 'ts-loader'.
      { test: /\.tsx?$/, loader: "ts-loader" }
    ],
  },
}
```

```

    preLoaders: [
      // All output '.js' files will have any sourcemaps re-processed by 'source-map-loader'.
      {test: /\.js$/, loader: "source-map-loader"}
    ],

    // When importing a module whose path matches one of the following, just
    // assume a corresponding global variable exists and use that instead.
    // This is important because it allows us to avoid bundling all of our
    // dependencies, which allows browsers to cache those libraries between builds.
    externals: {
      "react": "React",
      "react-dom": "ReactDOM"
    }
  };

```

finally run webpack or webpack -w (for watch mode)

Note: React and ReactDOM are marked as external

Chapter 27: TSLint - assuring code quality and consistency

TSLint performs static analysis of code and detect errors and potential problems in code.

Section 27.1: Configuration for fewer programming errors

This tslint.json example contains a set of configuration to enforce more typings, catch common errors or otherwise confusing constructs that are prone to producing bugs and following more the [Coding Guidelines for TypeScript Contributors](#).

To enforce this rules, include tslint in your build process and check your code before compiling it with tsc.

```
{
  "rules": {
    // TypeScript Specific
    "member-access": true, // Requires explicit visibility declarations for class members.
    "no-any": true, // Disallows usages of any as a type declaration.
    // Functionality
    "label-position": true, // Only allows labels in sensible locations.
    "no-bitwise": true, // Disallows bitwise operators.
    "no-eval": true, // Disallows eval function invocations.
    "no-null-keyword": true, // Disallows use of the null keyword literal.
    "no-unsafe-finally": true, // Disallows control flow statements, such as return, continue,
    break and throws in finally blocks.
    "no-var-keyword": true, // Disallows usage of the var keyword.
    "radix": true, // Requires the radix parameter to be specified when calling parseInt.
    "triple-equals": true, // Requires === and !== in place of == and !=.
    "use-isnan": true, // Enforces use of the isNaN() function to check for NaN references
    insteadof a comparison to the NaN constant.
    // Style
    "class-name": true, // Enforces PascalCased class and interface names.
    "interface-name": [ true, "never-prefix" ], // Requires interface names to begin with a capital
    'I'
    "no-angle-bracket-type-assertion": true, // Requires the use of as Type for type assertions
    instead of <Type>.
    "one-variable-per-declaration": true, // Disallows multiple variable definitions in the same
    declaration statement.
    "quotemark": [ true, "double", "avoid-escape" ], // Requires double quotes for string literals.
    "semicolon": [ true, "always" ], // Enforces consistent semicolon usage at the end of every
    statement.
    "variable-name": [true, "ban-keywords", "check-format", "allow-leading-underscore"] // Checks
    variable names for various errors. Disallows the use of certain TypeScript keywords (any, Number,
    number, String, string, Boolean, boolean, undefined) as variable or parameter. Allows only
    camelCased
    or UPPER_CASED variable names. Allows underscores at the beginning (only has an effect if
    "check-format" specified).
  }
}
```

Section 27.2: Installation and setup

To install [tslint](#) run command

```
npm install -g tslint
```

Tslint is configured via file `tslint.json`. To initialize default configuration run command

```
tslint --init
```

To check file for possible errors in file run command

```
tslint filename.ts
```

Section 27.3: Sets of TSLint Rules

- [tslint-microsoft-contrib](#)
- [tslint-eslint-rules](#)
- [codelyzer](#)

Yeoman generator supports all these presets and can be extends also:

- [generator-tslint](#)

Section 27.4: Basic tslint.json setup

This is a basic tslint.json setup which

- prevents use of any
- requires curly braces for if/else/for/do/while statements
- requires double quotes (") to be used for strings

```
{
  "rules": {
    "no-any": true,
    "curly": true,
    "quotemark": [true, "double"]
  }
}
```

Section 27.5: Using a predefined ruleset as default

tslint can extend an existing rule set and is shipped with the defaults tslint:recommended and tslint:latest.

tslint:recommended is a stable, somewhat opinionated set of rules which we encourage for general TypeScript programming. This configuration follows semver, so it will not have breaking changes across minor or patch releases.

tslint:latest extends tslint:recommended and is continuously updated to include configuration for the latest rules in every TSLint release. Using this config may introduce breaking changes across minor releases as new rules are enabled which cause lint failures in your code. When TSLint reaches a major version bump, tslint:recommended will be updated to be identical to tslint:latest.

[Docs](#) and [source code of predefined ruleset](#)

So one can simply use:

```
{
  "extends": "tslint:recommended"
}
```


to have a sensible starting configuration.

One can then overwrite rules from that preset via rules, e.g. for node developers it made sense to set no-console to **false**:

```
{
  "extends": "tslint:recommended",
  "rules": {
    "no-console": false
  }
}
```

Chapter 28: tsconfig.json

Section 28.1: Create TypeScript project with tsconfig.json

The presence of a **tsconfig.json** file indicates that the current directory is the root of a TypeScript enabled project.

Initializing a TypeScript project, or better put tsconfig.json file, can be done through the following command:

```
tsc --init
```

As of TypeScript v2.3.0 and higher this will create the following tsconfig.json by default:

```
{
  "compilerOptions": {
    /* Basic Options */
    "target": "es5", /* Specify ECMAScript target version: 'ES3' (default),
    'ES5', 'ES2015', 'ES2016', 'ES2017', or 'ESNEXT'. */
    "module": "commonjs", /* Specify module code generation: 'commonjs',
    'amd', 'system', 'umd' or 'es2015'. */
    // "lib": [], /* Specify library files to be included in
    the compilation:
    // "allowJs": true, /* Allow javascript files to be compiled. */
    // "checkJs": true, /* Report errors in .js files. */
    // "jsx": "preserve", /* Specify JSX code generation: 'preserve',
    'react-native', or 'react'. */
    // "declaration": true, /* Generates corresponding '.d.ts' file. */
    // "sourceMap": true, /* Generates corresponding '.map' file. */
    // "outFile": "./", /* Concatenate and emit output to single file. */
    // "outDir": "./", /* Redirect output structure to the directory. */
    // "rootDir": "./", /* Specify the root directory of input files. Use
    to control the output directory structure with --outDir. */
    // "removeComments": true, /* Do not emit comments to output. */
    // "noEmit": true, /* Do not emit outputs. */
    // "importHelpers": true, /* Import emit helpers from 'tslib'. */
    // "downlevelIteration": true, /* Provide full support for iterables in 'for-
    of', spread, and destructuring when targeting 'ES5' or 'ES3'. */
    // "isolatedModules": true, /* Transpile each file as a separate module (similar
    to 'ts.transpileModule'). */

    /* Strict Type-Checking Options */
    "strict": true /* Enable all strict type-checking options. */
    // "noImplicitAny": true, /* Raise error on expressions and declarations with
    an implied 'any' type. */
    // "strictNullChecks": true, /* Enable strict null checks. */
    // "noImplicitThis": true, /* Raise error on 'this' expressions with an
    implied 'any' type. */
    // "alwaysStrict": true, /* Parse in strict mode and emit "use strict" for
    each source file. */

    /* Additional Checks */
    // "noUnusedLocals": true, /* Report errors on unused locals. */
    // "noUnusedParameters": true, /* Report errors on unused parameters. */
    // "noImplicitReturns": true, /* Report error when not all code paths in
    function return a value. */
    // "noFallthroughCasesInSwitch": true, /* Report errors for fallthrough cases in
    switch statement. */

    /* Module Resolution Options */
    // "moduleResolution": "node", /* Specify module resolution strategy: 'node' (Node.js)
```

```

or 'classic' (TypeScript pre-1.6). */
// "baseUrl": "./", /* Base directory to resolve non-absolute module names.
*/
// "paths": {}, /* A series of entries which re-map imports to lookup
locations relative to the 'baseUrl'. */
// "rootDirs": [], /* List of root folders whose combined
content represents the structure of the project at runtime. */
// "typeRoots": [], /* List of folders to include type definitions from. */
// "types": [], /* Type declaration files to be included
in compilation. */
// "allowSyntheticDefaultImports": true, /* Allow default imports from modules with no
default export. This does not affect code emit, just typechecking. */

/* Source Map Options */
// "sourceRoot": "./", /* Specify the location where debugger should
locate TypeScript files instead of source locations. */
// "mapRoot": "./", /* Specify the location where debugger should
locate map files instead of generated locations. */
// "inlineSourceMap": true, /* Emit a single file with source maps instead
of having a separate file. */
// "inlineSources": true, /* Emit the source alongside the sourcemaps
within a single file; requires '--inlineSourceMap' or '--sourceMap' to be set. */

/* Experimental Options */
// "experimentalDecorators": true, /* Enables experimental support for ES7 decorators. */
// "emitDecoratorMetadata": true, /* Enables experimental support for emitting
typemetadata for decorators. */
}
}

```

Most, if not all, options are generated automatically with only the bare necessities left uncommented.

Older versions of TypeScript, like for example v2.0.x and lower, would generate a tsconfig.json like this:

```

{
  "compilerOptions": {
    "module": "commonjs",
    "target": "es5",
    "noImplicitAny": false,
    "sourceMap": false
  }
}

```

Section 28.2: Configuration for fewer programming errors

There are very good configurations to force typings and get more helpful errors which are not activated by default.

```

{
  "compilerOptions": {

    "alwaysStrict": true, // Parse in strict mode and emit "use strict" for each source file.

    // If you have wrong casing in referenced files e.g. the filename is Global.ts and you have
    a ///
    <reference path="global.ts" /> to reference this file, then this can cause to unexpected
    errors.
    Visite: http://stackoverflow.com/questions/36628612/typescript-transpiler-casing-issue
    "forceConsistentCasingInFileNames": true, // Disallow inconsistently-cased references to the
    same file.

    // "allowUnreachableCode": false, // Do not report errors on unreachable code. (Default:
    false)
  }
}

```

```

"noFallthroughCasesInSwitch": true, // Report errors for fall through cases in switch
statement.
"noImplicitReturns": true, // Report error when not all code paths in function return a
value.

"noUnusedParameters": true, // Report errors on unused parameters.
"noUnusedLocals": true, // Report errors on unused locals.

"noImplicitAny": true, // Raise error on expressions and declarations with an implied "any"
type.
"noImplicitThis": true, // Raise error on this expressions with an implied "any" type.

"strictNullChecks": true, // The null and undefined values are not in the domain of every
typeand are only assignable to themselves and any.

// To enforce this rules, add this configuration.
"noEmitOnError": true // Do not emit outputs if any errors were reported.
}

```

Not enough? If you are a hard coder and want more, then you may be interested to check your TypeScript files with tslint before compiling it with tsc. Check how to configure tslint for even stricter code.

Section 28.3: compileOnSave

Setting a top-level property compileOnSave signals to the IDE to generate all files for a given **tsconfig.json** upon saving.

```

{
  "compileOnSave": true,
  "compilerOptions": {
    ...
  },
  "exclude": [
    ...
  ]
}

```

This feature is available since TypeScript 1.8.4 and onward, but needs to be directly supported by IDE's. Currently, examples of supported IDE's are:

- Visual Studio 2015 [with Update 3](#)
- [JetBrains WebStorm](#)
- Atom [with atom-typescript](#)

Section 28.4: Comments

A tsconfig.json file can contain both line and block comments, using the same rules as ECMAScript.

```

//Leading comment
{
  "compilerOptions": {
    //this is a line comment
    "module": "commonjs", //eol line comment
    "target" /*inline block*/ : "es5",
    /* This is a
    block
    comment */
  }
}

```

```
/* trailing comment */
```

Section 28.5: preserveConstEnums

TypeScript supports constant enumerables, declared through `const enum`.

This is usually just syntax sugar as the constant enums are inlined in compiled JavaScript.

For instance the following code

```
const enum Tristate {  
    True,  
    False,  
    Unknown  
}  
  
var something = Tristate.True;
```

compiles to

```
var something = 0;
```

Although the performance benefit from inlining, you may prefer to keep enums even if constant (ie: you may wish readability on development code), to do this you have to set in `tsconfig.json` the `preserveConstEnums` clause into the `compilerOptions` to `true`.

```
{  
  "compilerOptions": {  
    "preserveConstEnums" = true,  
    ...  
  },  
  "exclude": [  
    ...  
  ]  
}
```

By this way the previous example would be compiled as any other enums, as shown in following snippet.

```
var Tristate;  
(function (Tristate) {  
    Tristate[Tristate["True"] = 0] = "True";  
    Tristate[Tristate["False"] = 1] = "False";  
    Tristate[Tristate["Unknown"] = 2] = "Unknown";  
})(Tristate || (Tristate = {}));  
  
var something = Tristate.True
```

Chapter 29: Debugging

There are two ways of running and debugging TypeScript:

Transpile to JavaScript, run in node and use mappings to link back to the TypeScript source files

or

Run TypeScript directly using [ts-node](#)

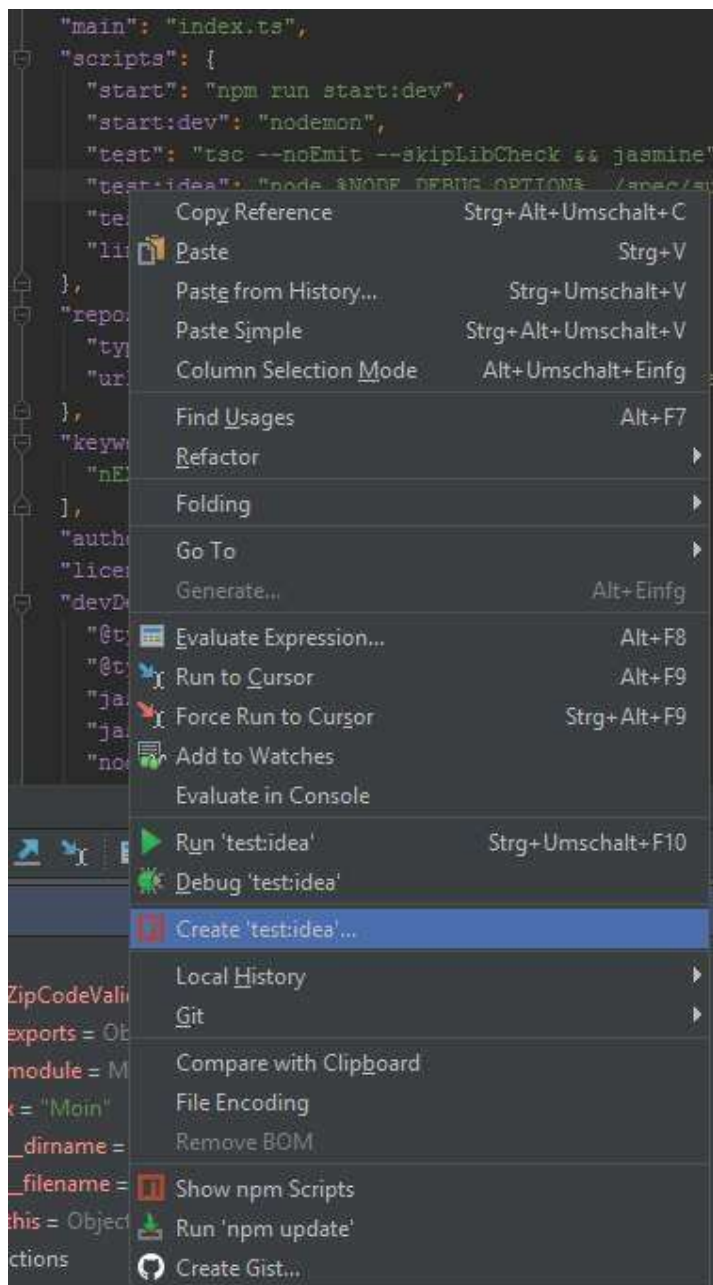
This article describes both ways using [Visual Studio Code](#) and [WebStorm](#). All examples presume that your main file is *index.ts*.

Section 29.1: TypeScript with ts-node in WebStorm

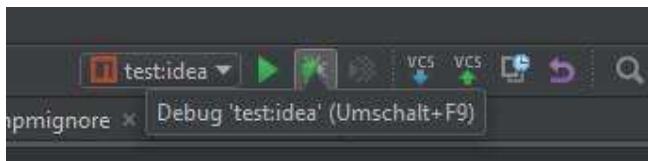
Add this script to your package.json:

```
"start:idea": "ts-node %NODE_DEBUG_OPTION% --ignore false index.ts",
```

Right click on the script and select *Create 'test:idea'...* and confirm with 'OK' to create the debug configuration:



Start the debugger using this configuration:



Section 29.2: TypeScript with ts-node in Visual Studio Code

Add ts-node to your TypeScript project:

```
npm i ts-node
```

Add a script to your package.json:

```
"start:debug": "ts-node --inspect=5858 --debug-brk --ignore false index.ts"
```

The `launch.json` needs to be configured to use the `node2` type and start npm running the `start:debug` script:

```
{
  "version": "0.2.0",
  "configurations": [
    {
      "type": "node2",
      "request": "launch",
      "name": "Launch Program",
      "runtimeExecutable": "npm",
      "windows": {
        "runtimeExecutable": "npm.cmd"
      },
      "runtimeArgs": [
        "run-script",
        "start:debug"
      ],
      "cwd": "${workspaceRoot}/server",
      "outFiles": [],
      "port": 5858,
      "sourceMaps": true
    }
  ]
}
```

Section 29.3: JavaScript with SourceMaps in Visual Studio Code

In the `tsconfig.json` set

```
"sourceMap": true,
```

to generate mappings alongside with js-files from the TypeScript sources using the `tsc` command.

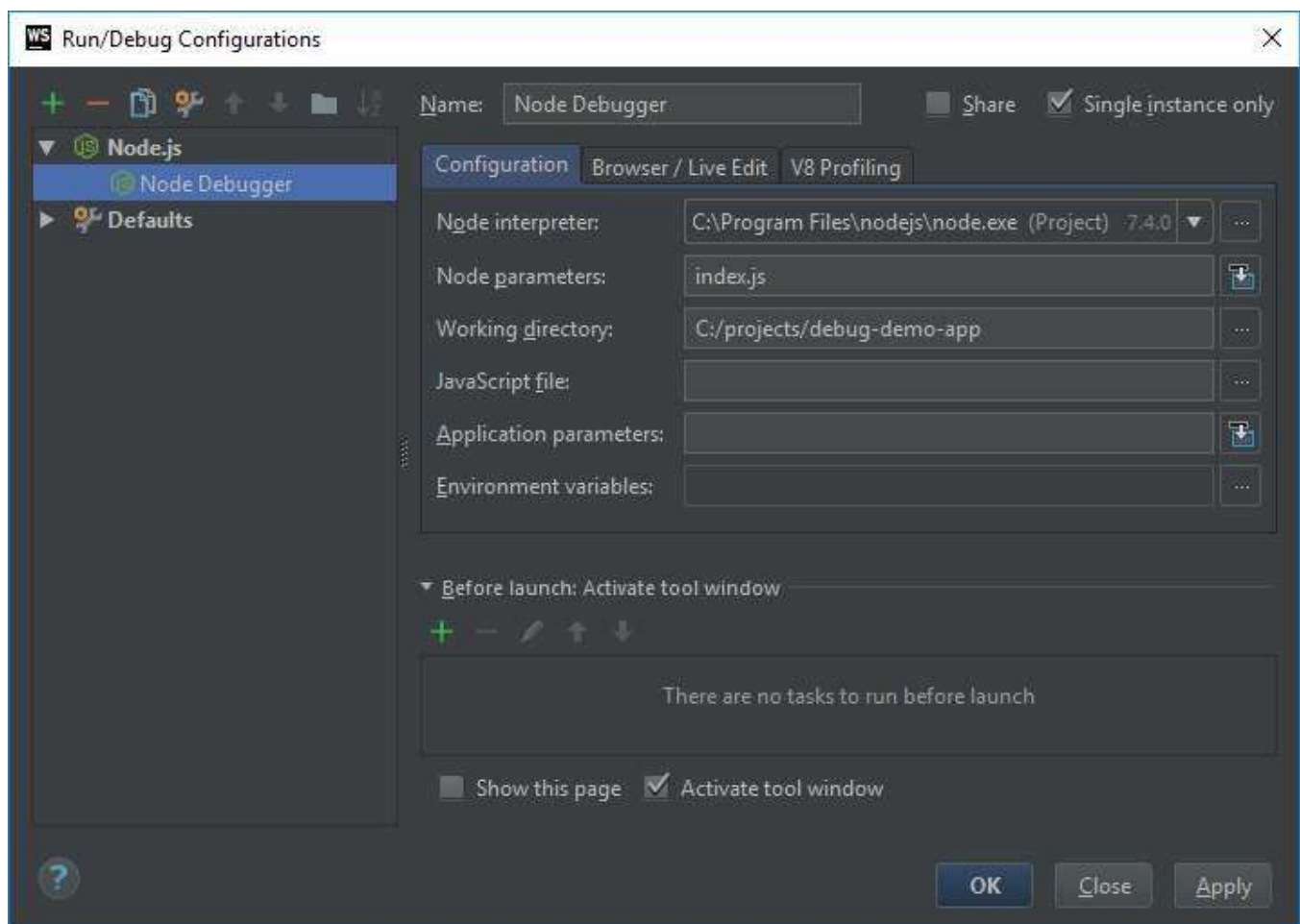
The `launch.json` file:

```
{
  "version": "0.2.0",
  "configurations": [
    {
      "type": "node",
      "request": "launch",
      "name": "Launch Program",
      "program": "${workspaceRoot}\\index.js",
      "cwd": "${workspaceRoot}",
      "outFiles": [],
      "sourceMaps": true
    }
  ]
}
```

This starts node with the generated `index.js` (if your main file is `index.ts`) file and the debugger in Visual Studio Code which halts on breakpoints and resolves variable values within your TypeScript code.

Section 29.4: JavaScript with SourceMaps in WebStorm

Create a `Node.js debug configuration` and use `index.js` as *Node parameters*.



Chapter 30: Unit Testing

Section 30.1: tape

[tape](#) is minimalistic JavaScript testing framework, it outputs [TAP-compliant](#) markup.

To install tape using npm run command

```
npm install --save-dev tape @types/tape
```

To use tape with TypeScript you need to install ts-node as global package, to do this run command

```
npm install -g ts-node
```

Now you are ready to write your first test

```
//math.test.ts
import * as test from "tape";

test("Math test", (t) => {
  t.equal(4, 2 + 2);
  t.true(5 > 2 + 2);

  t.end();
});
```

To execute test run command

```
ts-node node_modules/tape/bin/tape math.test.ts
```

In output you should see

```
TAP version 13
# Math test
ok 1 should be equal
ok 2 should be truthy

1..2
# tests 2
# pass 2

# ok
```

Good job, you just ran your TypeScript test.

Run multiple test files

You can run multiple test files at once using path wildcards. To execute all TypeScript tests in tests directory run command

```
ts-node node_modules/tape/bin/tape tests/**/*.ts
```

Section 30.2: jest (ts-jest)

[jest](#) is painless JavaScript testing framework by Facebook, with [ts-jest](#) can be used to test TypeScript code.

To install jest using npm run command

```
npm install --save-dev jest @types/jest ts-jest typescript
```

For ease of use install jest as global package

```
npm install -g jest
```

To make jest work with TypeScript you need to add configuration to package.json

```
//package.json
{
  ...
  "jest": {
    "transform": {
      "ts|tsx": "<rootDir>/node_modules/ts-jest/preprocessor.js"
    },
    "testRegex": "(/__tests__/.*|\\.(test|spec))\\.\\.(ts|tsx|js)$",
    "moduleFileExtensions": ["ts", "tsx", "js"]
  }
}
```

Now jest is ready. Assume we have sample fizz buz to test

```
//fizzBuzz.ts
export function fizzBuzz(n: number): string {
  let output = '';
  for (let i = 1; i <= n; i++) {
    if (i % 5 && i % 3) {
      output += i + ' ';
    }
    if (i % 3 === 0) {
      output += 'Fizz ';
    }
    if (i % 5 === 0) {
      output += 'Buzz ';
    }
  }
  return output;
}
```

Example test could look like

```
//FizzBuzz.test.ts
/// <reference types="jest" />

import {fizzBuzz} from './fizzBuzz';
test('FizzBuzz test', () =>{
  expect(fizzBuzz(2)).toBe("1 2 ");
  expect(fizzBuzz(3)).toBe("1 2 Fizz ");
});
```

To execute test run

jest

In output you should see

```
PASS  ./fizzBuzz.test.ts
✓ FizzBuzz test (3ms)

Test Suites: 1 passed, 1 total
Tests:      1 passed, 1 total
Snapshots:  0 total
Time:       1.46s, estimated 2s
Ran all test suites.
```

Code coverage

jest supports generation of code coverage reports.

To use code coverage with TypeScript you need to add another configuration line to `package.json`.

```
{
  ...
  "jest": {
    ...
    "testResultsProcessor": "<rootDir>/node_modules/ts-jest/coverageprocessor.js"
  }
}
```

To run tests with generation of coverage report run

```
jest --coverage
```

If used with our sample fizz buzz you should see

```
PASS  ./fizzBuzz.test.ts
✓ FizzBuzz test (3ms)

-----|-----|-----|-----|-----|-----|
File      | % Stmts | % Branch | % Funcs | % Lines |Uncovered Lines |
-----|-----|-----|-----|-----|-----|
All files |    92.31 |     87.5 |     100 |    91.67 |                  |
fizzBuzz.ts |    92.31 |     87.5 |     100 |    91.67 |             13 |
-----|-----|-----|-----|-----|-----|

Test Suites: 1 passed, 1 total
Tests:      1 passed, 1 total
Snapshots:  0 total
Time:       1.857s
Ran all test suites.
```

jest also created folder `coverage` which contains coverage report in various formats, including user friendly html report in `coverage/lcov-report/index.html`

All files

92.31% Statements 12/13 87.5% Branches 7/8 100% Functions 1/1 91.67% Lines 11/12

File		Statements		Branches		Functions		Lines	
fizzBuzz.ts	<div><div></div></div>	92.31%	12/13	87.5%	7/8	100%	1/1	91.67%	11/12

Section 30.3: Alsatian

[Alsatian](#) is a unit testing framework written in TypeScript. It allows for usage of Test Cases, and outputs [TAP-compliant](#) markup.

To use it, install it from npm:

```
npm install alsatian --save-dev
```

Then set up a test file:

```
import { Expect, Test, TestCase } from "alsatian";
import { SomeModule } from "../src/some-module";

export SomeModuleTests {

  @Test()
  public statusShouldBeTrueByDefault() {
    let instance = new SomeModule();

    Expect(instance.status).toBe(true);
  }

  @Test("Name should be null by default")
  public nameShouldBeNullByDefault() {
    let instance = new SomeModule();

    Expect(instance.name).toBe(null);
  }

  @TestCase("first name")
  @TestCase("apples")
  public shouldSetNameCorrectly(name: string) {
    let instance = new SomeModule();

    instance.setName(name);

    Expect(instance.name).toBe(name);
  }
}
```

For a full documentation, see [Alsatian's GitHub repo](#).

Section 30.4: chai-immutable plugin

1. Install from npm chai, chai-immutable, and ts-node

```
npm install --save-dev chai chai-immutable ts-node
```

2. Install types for mocha and chai

```
npm install --save-dev @types/mocha @types/chai
```

3. Write simple test file:

```
import {List, Set} from 'immutable';import
* as chai from 'chai';
import * as chaiImmutable from 'chai-immutable';chai.use(chaiImmutable);

describe('chai immutable example', () => {
  it('example', () => {
    expect(Set.of(1,2,3)).to.not.be.empty;

    expect(Set.of(1,2,3)).to.include(2);
    expect(Set.of(1,2,3)).to.include(5);
  })
})
```

4. Run it in the console:

```
mocha --compilers ts:ts-node/register,tsx:ts-node/register 'test/**/*.spec.@(ts|tsx)'
```