Typescript Fundamentals

Agenda

TypeScript Overview

Types & Arrays

ECMA Script 6+ Essentials

Classes, Interfaces, Functions

Generics, Modules, Decorators

Promises, Async Operations & Consuming Services

Using TS in SharePoint

TypeScript Overview

What is TypeScript

TypeScript is a typed superset of JavaScript that compiles to plain JavaScript

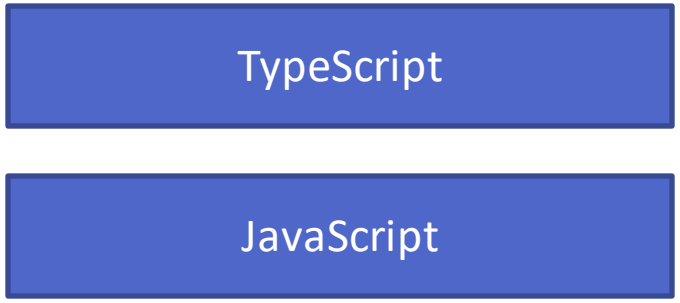
Allows use of classes and other features in browsers that do not support ECMA Script 6

Compiled by the TypeScript compiler from *.ts to *.js by „tsc.exe“

Language spec on http://www.typescriptlang.org/

Co-authored by Anders Hejlsberg – father of C#

Current version 3.1



TypeScript vs JavaScript

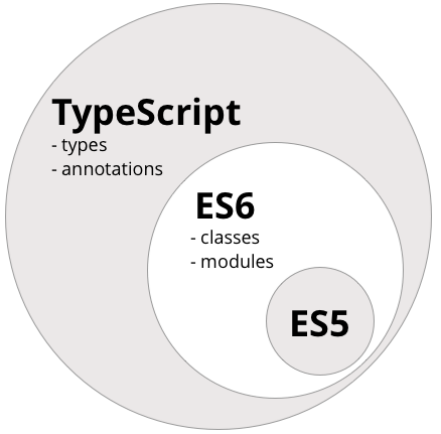
JavaScript Standard is defined as ECMA Script

ES 6 introduced modern JavaScript

- Classes, Decorators
- Array Helpers
- Arrow Functions
- Fetch API

Typescript adds on Top

- Types, Enums, Interfaces ....



Features

100% ECMA Script 3 or 5 support

Static Typing

Encapsulation using Revealing Module Pattern

Support for constructors, properties, interfaces, enums

Arrow Function support

Can be combined with other JS Libs:

- Angular
- React
- SharePoint Framework

Playground

Online editor at http://typescriptlang.org that helps understanding TS and see JS output

Keywords & Operators

Keyword	Description
class	Container for members such as properties and functions
constructor	Provides initialization functionality in a class
exports	Export a member from a module
extends	Extend a class or interface
implements	Implement an interface
imports	Import a module
interface	Defines a code contract that can be implemented by types
module	Container for classes and other code
public/private	Member visibility modifiers
...	Rest parameter syntax
=>	Arrow syntax used with definitions and functions
<typeName>	< > characters use to cast/convert between types
:	Separator between variable/parameter names and types

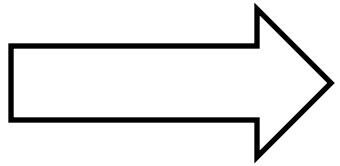
Transpiling

Transpiling is the process of converting TypeScript code to the requires ECMA Script version

Can be automated to happen "on Save„ using SPFastDeploy

```
class Voucher {
    ID: number;
    Text: string;
    Amount: number;
    Date: Date;
}

let v: Voucher = new Voucher();
v.ID = 0;
v.Text = "Demo Voucher";
```



```
var Voucher = (function () {
    function Voucher() {
    }
    return Voucher;
}());

var v = new Voucher();
v.ID = 0;
v.Text = "Demo Voucher";
```

Compilation

Typescript compilation (transpilation) is done using tsc.exe

Converts TypeScript file to JavaScript file: tsc app.ts -> app.js

Options documented @ https://www.typescriptlang.org/docs/handbook/compiler-options.html

Configuration of tsc can be automated using tsconfig.json

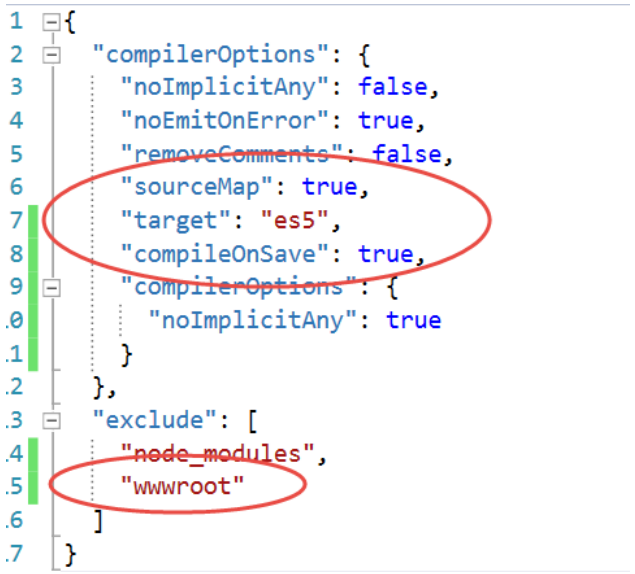
tsconfig.json

Documented at https://www.typescriptlang.org/docs/handbook/tsconfig-json.html

tsconfig.json file indicates and configures a TypeScript project.

Files to be compiled can be configured using:

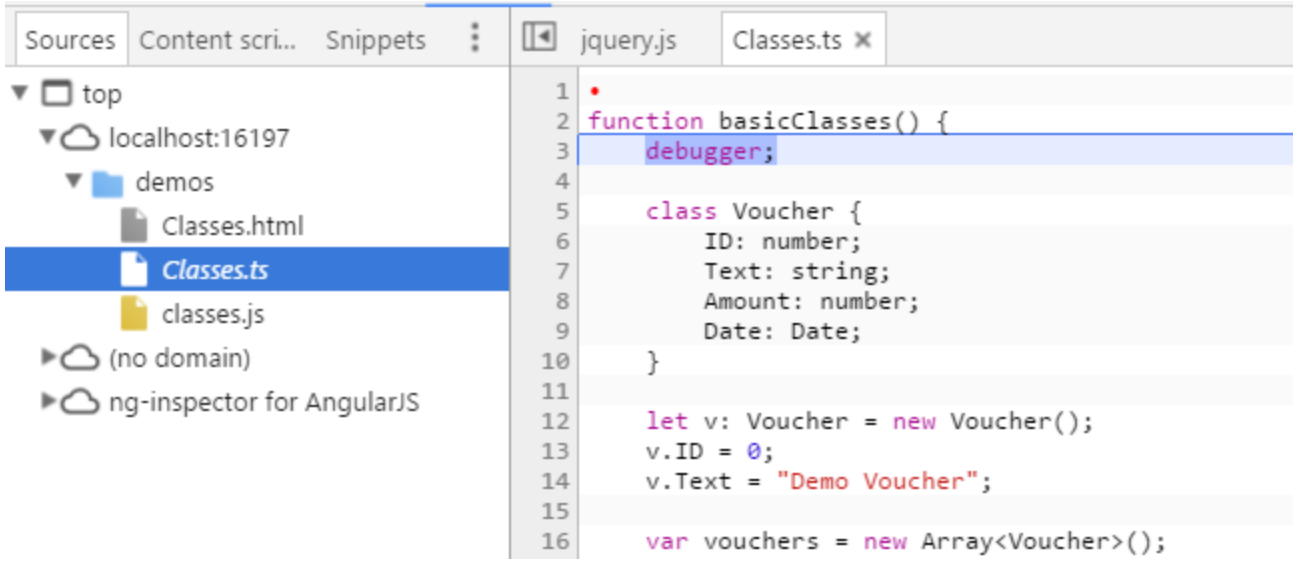
- "files"
- "include"
- "exclude"



Source Maps

Map files are source map files that let tools map between the emitted JavaScript code and the TypeScript source files that created it

Allows debugging *.ts files instead of the *.js files

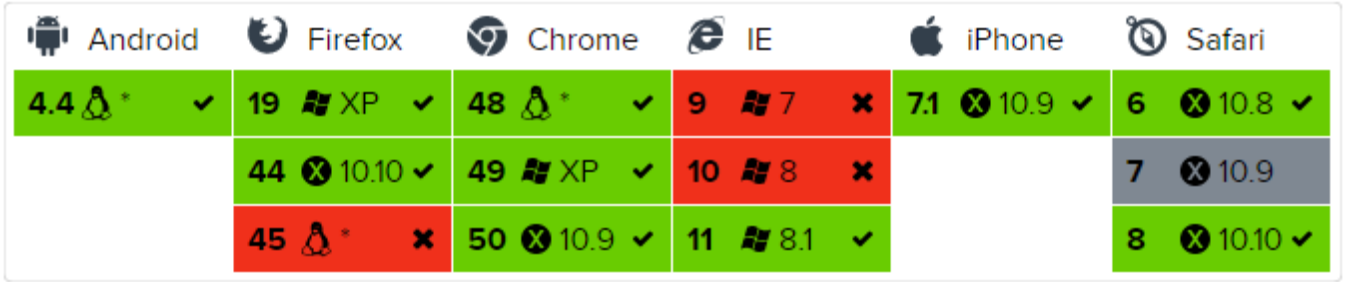


ES 6 Shims

Provides compatibility shims so that legacy JavaScript engines behave as closely as possible to ECMAScript 6

A *shim* is a library that brings a new API to an older environment, using only the means of that environment

Published @ https://www.npmjs.com/package/es6-shim



Polyfill

A polyfill is a piece of code (or plugin) that provides the technology that you, the developer, expect the browser to provide natively.

Thus, a polyfill is a shim for a browser API

You typically check if a browser supports an API and load a polyfill if it doesn’t

Types

Types and Variables

string

number

Boolean

any

Date

object, complex type

void

Null, undefinded

```
var age: number;
var weight: number = 83.12;
var dogWeight = 25.4;

var isCustomer: boolean = false;
var finished = false;

var dogName: string = "Giro";
var otherDogName = "Soi";
var x = 10;
```

Number, Strings & Booleans

Boolean - The most basic datatype is the simple true/false value

Number – Allows storage of all numeric types (descimal, hex, int, binary)

String - Uses double quotes (") or single quotes (') to surround string data

```
var numbers: number[] = [];
numbers[0] = 1;
//numbers.push("two"); // compile-time error
```

var | let | const

Variables can be declared using "var" or "let" – the difference is scoping

"let" is scoped to the nearest enclosing block or global if outside any block

const decrates constants – value cannot be changed

```
var index: number = 0;
var array = ["a", "b", "c"];
for (let index: number = 0; index < array.length; index++) {
    console.log("Inside for ..." + index);
    console.log("Inside for ..." + array[index]);
}
console.log(index); // 0
const pi = 3.14;
//pi = 2;
```

String Functions

Template Literals using Backticks `...` and ${*VARIABLE*}

String.prototype.repeat / String.prototype.contains

String.prototype.startsWith / String.prototype.endsWith

```
//Template Literals
var productID = 100;
var category = "music";
var url = "http://server/" + category + "/" + productID;
var templateLiteral = `http://server/${category}/${productID}`;

//startsWith
var str = 'To be, or not to be, that is the question.';
console.log(str.startsWith('To be'));        // true
console.log(str.endsWith('question.'));      // true
```

Enums

Enums allow us to define a set of named numeric constants.

An enum can be defined using the enum keyword.

```
enum VoucherStatus {draft, complete, pending};

var n: VoucherStatus;
n = VoucherStatus.draft;
n = VoucherStatus.complete;
//n = VoucherStatus.unfinished; // compile-time error
//n = "on the way"; // compile-time error
```

Any

Any allows you to gradually opt-in and opt-out of type-checking during compilation

-> Avoid using Any

Remember if you need to convert C# types to types in TypeScript use Typescript Syntax Past or one of the many online services

```
let notSure: any = 4;
notSure = "maybe a string instead";
notSure = false; // okay, definitely a boolean
```

Void

Void is a little like the opposite of any – the absence of any type at all

Usefull when used together with function

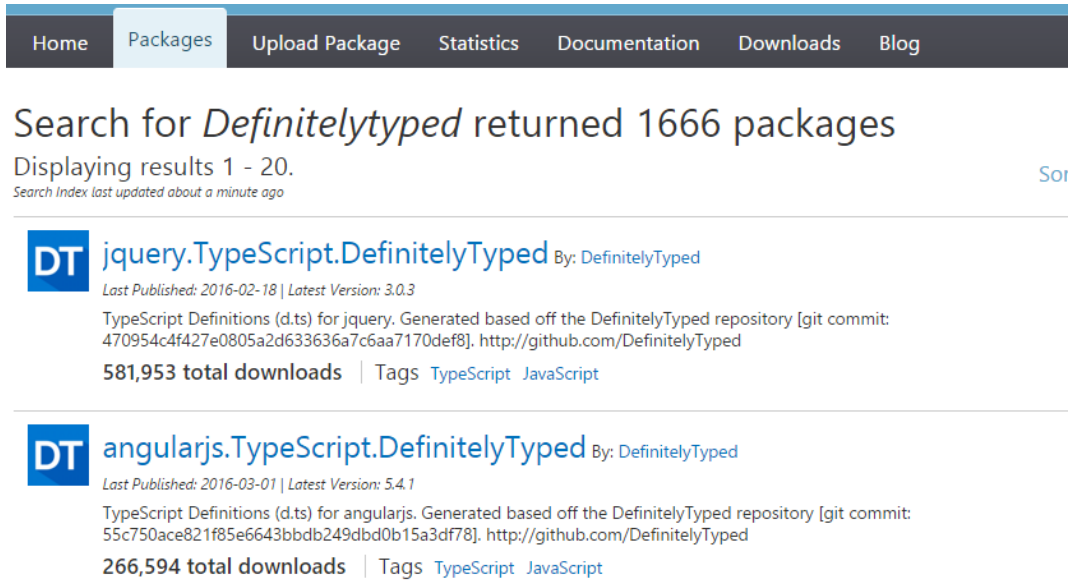
No so usefull for variables -> can hold only null or undefined

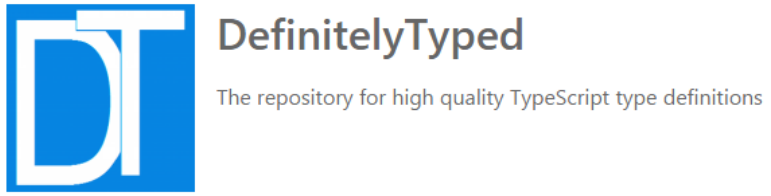
```
function handleClick(): void {
    var g = "I don't return anything.";
    console.log(g);
}
```

Type Definitions - *.d.ts

Additional IntelliSense for 3rd Party Libs using Type Definition Files like Definitely Typed published on

http://definitelytyped.org/






```
PM> Install-Package jquery.TypeScript.DefinitelyTyped
```

Using Typings

Add import statements as needed

```
import * as moment from 'moment';
import * as $ from 'jquery';
```

Use your lib accordingly

```
//using moment
let dt = new Date();
console.log("Using time format: ", moment(dt).format('LTS'));

//using jQuery
let myArray = ["Angular", "React", "SPFx"];
console.log("myArray is an Array: ", $.isArray(myArray));
```

Arrays

Arrays

Arrays can be typed

```
//declaration using type followed by []
var customers: string[] = ["Alex", "Giro", "Sonja", "Soi", "David"];
//declaration using generic array type
let nbrs: Array<number> = [3, 4, 5];
```

ECMA Script 6 arry functionality is supported

- for … of
- destructuring
- map
- ….

```
let input = [1, 2];
let [first, second] = input;
```

For-of-loop

The for-of loop iterates over the values

- Of an array
- Of an iteratable object

```
var someArray = ["a", "b", "c"];
for (var item in someArray) {
    console.log(item); // 0,1,2 ... Returns the key ... the index
}

for (var item of someArray) {
    console.log(item); // a, b, c
}
```

Destructuring

Makes it possible to unpack values from arrays, or properties from objects, into distinct variables.

```
var rect = { x: 0, y: 10, width: 15, height: 20 };

// Destructuring assignment
var { x, y, width, height } = rect;
console.log(x, y, width, height); // 0,10,15,20
```

REST Parameter

Represented using ...items

Allows calling a function with a variable numer of arguments without using the arguments object

```
store.add('fruit', 'apple');
store.add('dairy', 'milk', 'cheese', 'yoghurt');
store.add('pastries', 'donuts', 'croissants');

store.add = function(category, ...items) {
    items.forEach(function (item) {
        store.aisle[category].push(item);
    });
};
```

Spread Operator

The spread operator allows an expression to be expanded in places where multiple arguments (for function calls) or multiple elements (for array literals) are expected

```
var a, b, c, d, e;
a = [1, 2, 3];
b = "dog";
c = [42, "cat"];

// Using the concat method.
d = a.concat(b, c);
// Using the spread operator.
e = [...a, b, ...c];
console.log(d);
console.log(e);

// Output:
// 1, 2, 3, "dog", 42, "cat"
// 1, 2, 3, "dog", 42, "cat"
```

Functions

Functions

Typescript knows named and anonymous functions

Parameteres can be typed

Optional, default parameters supported

Lambda Expressions, Rest Parameters supported

```
function multiply(a, b = 1) {
    return a*b;
}

multiply(5); // 5
```

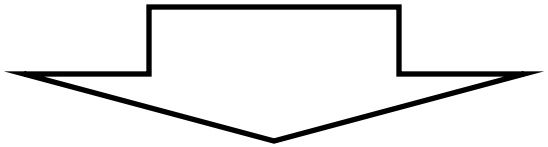
```
var rectangleFunction = function (width: number, height: number) {
    return width * height;
}

//Implemented as Lambda or "Arrow" Function
var rectangleFunctionArrow = (width: number, height: number) => height * width;
var result: number = rectangleFunctionArrow(10, 22);
```

Arrow Functions

Known als Lambda Functions in C#

```
numbers.sort(function(a, b){
    return b - a;
});
```



```
numbers.sort((a, b) => b - a);
```

```
var fullnames = people.filter(p => p.age >= 18).map(p => p.fullname);
```

Function Overloading

TypeScript allows you to define overloaded functions

Only one impelmentation

Requires type checking during the implementation because of underlying JS

```
                    number
                     string
                   any
    if (value && typeof value == "number") {
        alert("First overload - " + value);
    }
    if (value && typeof value == "string") {
        alert("Second overload - " + value);
    }
}
```

Objects

Object Literals

An object literal is a list of zero or more pairs of property names and associated values of an object, enclosed in curly braces {}

Possible to add funtions to Object Literals

```
let person: any = {Id: 1, Name: 'Alexander'}
person.walk = () => console.log(`I am ${person.Name} and I'm walking`);
```

Property / Method Shorthand

```
//Property value shorthand
function getCarES5(make, model, value) {
 return {
  make: make,
  model: model,
  value: value
 };
}

// with property value shorthand
// syntax, you can omit the property
// value if key matches variable
// name
function getCar(make, model, value) {
 return {
  make,
  model,
  value
 };
}
```

```
//Method definition shorthand
function getBusES5(make, model, value) {
 return {
  depreciate: function() {
   this.value -= 2500;
  }
 };
}

// Method definition shorthand syntax
// omits `function` keyword & colon
function getBus(make, model, value) {
 return {
  depreciate() {
   this.value -= 2500;
  }
 };
}
```

Value / Reference Types

Javascript is always pass by value, but when a variable refers to an object (including arrays), the "value" is a reference to the object.

Changing the value of a variable never changes the underlying primitive or object, it just points the variable to a new primitive or object.

However, changing a property of an object referenced by a variable does change the underlying object.

Immutability

In object-oriented programming, an immutable object is an object whose state cannot be modified after it is created.

In JS string and numbers are immutable by design for other objects use Immutable.js

The concept of Immutability is often used in larger applications when State Management is centralized using libraries like Redux (... which can be used to manage State in Angular Apps)

Immutability eliminates the risk of having unwanted side effects by always creating „new“ copies of objects when changing the state

object.assign()

Is used to copy the values of all enumerable own properties from one or more source objects to a target object.

Will return the target object

Used when working with architectural patterns like Redux & immutablity

```
var obj = { name: 'alex' };
var copy = Object.assign({}, obj, {birth: moment("19700402", "YYYYMMDD").format("MMM Do YY")});
console.log(copy);
```

Cloning Objects using Spread Operator

Spread Operator can be used to

- create „new“ copies of objects or
- combine a set of objects

Needs no polyfill for older browsers (... compared to object.assign())

```
var simplePerson = { name: 'alex' };
var dataPerson = {birth: moment("19700402", "YYYYMMDD").format("MMM Do YY"), job: 'dev dude'}

var person = {...simplePerson, ...dataPerson};
console.log(person);
```

Classes, Interfaces

Classes

Implemented as modules to avoid poluting global namespace with the following members

Support:

- Fields – referenced using "this." – e. g. this.greeting
- Properties
- Constructor
- Functions
- ....

```
class Greeter {
    greeting: string;
    constructor(message: string) {
        this.greeting = message;
    }
    greet() {
        return "Hello, " + this.greeting;
    }
}

var greeter = new Greeter("world");
```

Constructor

Called when creating an instance of a class

Canbe overloaded – but only with one implementation

Can define public and private properties

Can define default values and nullable paremeters

```
class Person {
    name: string;
    alive: boolean;
    constructor(Name: string, Alive: boolean) {
        this.name = Name;
        this.alive = Alive;
    }
}
```

get / set

```
let passcode = "secret passcode";

class Citzien {
    private _fullName: string;

    get fullName(): string {
        return this._fullName;
    }

    set fullName(newName: string) {
        if (passcode == "secret passcode") {
            this._fullName = newName;
            console.log("name changed to " + newName);
        }
        else {
            console.log("Error: Unauthorized update of employee!");
        }
    }
}
```

Class Inheritance

Class inheritance is archieved using the "extends" keyword

Protected / Private / ReadOnly Properties are supported - Abstract classes are supported

Properties of the base calls are accessed using "super"

```
class Sighthound extends Dog {
    constructor(name: string) { super(name); }
    public speed: string = "with up to 110 km/h";
    move(meters = 500) {
        console.log("Running ..." + meters + "m. " + this.speed);
        super.move(meters);
    }
}
```

Static Members (Properties)

Classes in TypeScript can either contain

- static members or
- instance members.

```
class Grid {
    static origin = { x: 0, y: 0 };
    calculateDistanceFromOrigin(point: { x: number; y: number; }) {
        var xDist = (point.x - Grid.origin.x);
        var yDist = (point.y - Grid.origin.y);
        return Math.sqrt(xDist * xDist + yDist * yDist) / this.scale;
    }
    constructor(public scale: number) { }
}
```

Interfaces

In TypeScript, interfaces fill the role of defining contracts within your code as well as contracts with code outside of your project

Support optional properties

Can also be used to describe functions

```
interface SearchFunc {
    (source: string, subString: string): boolean;
}

var mySearch: SearchFunc;
mySearch = function (source: string, subString: string) {...}
```

Nullablility

Interfaces support nullable properties

```
interface IManager {
    name: string;
    salary?: number;
}

class DeliveryManager implements IManager {
    name: string;
}
```

Interfaces and Objects

Interfaces are many times used to hold value objects

- Data received from an WebApi or Angular service
- Client should only know structure of data

```
interface ILongLat { Long: number, Lat: number };
var position: ILongLat = { Long: 17.123123, Lat: 12.123123 };
console.log("We are at position Long: " + position.Long + " Lat: " + position.Lat);
```

Generics, Modules, Decorators

Generic Functions

Generics allow creating reusable components that can return any given type

The type in the generic is passed using <T>

```
function concat<T>(arg: Array<T>): string {
    let result = "";
    for (var m of arg) {
        result += m.toString() + ", ";
    }
    return result;
}

let stringArr: Array<string> = ["Alex", "Giro", "Soi the Whippet"];
console.log(concat<string>(stringArr));

let nbrArr: Array<number> = [100, 201, 322];
console.log(concat<number>(nbrArr));
```

Generic Interfaces

Generic Interfaces define Interfaces for a give type specified using T

```
interface IInventory<T> {

    getNewestItem: () => T;
    addItem: (newItem: T) => void;
    getAllItems: () => Array<T>;
}

let voucherInventory: IInventory<Vouchers.IVoucher>;
```

Generic Classes

Used to implement utility classes for a given type

Can implement generic interfaces

```
class Catalog<T> implements IInventory<T> {

    private items = new Array<T>();

    addItem(newItem: T) { this.items.push(newItem);}

    getNewestItem(): T { return this.items[this.items.length-1]; }

    getAllItems(): T[] { return this.items; }
}
```

Generic Constraints

Describe types that may be passed as a generic parameter

The "extends"-keyword applies the constraint

```
interface ICatalogItem {
    catalogNumber: number;
}

interface IInventory<T> {
    getAllItems: () => Array<T>;
}

class Catalog<T extends ICatalogItem> implements IInventory<T> {
    private items = new Array<T>();
    getAllItems(): T[] { return this.items; }
}
```

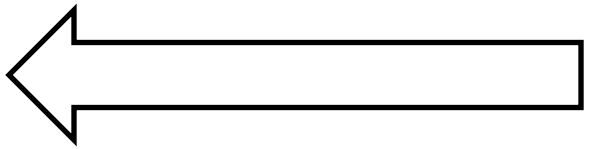
Modules

Organize other elements like classes and interfaces for better maintainability

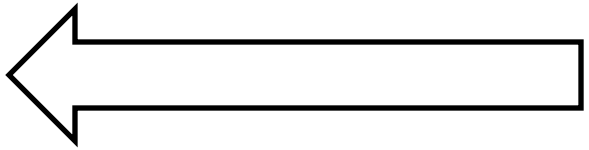
Are executed in their own scope – not the global scope

Elements that should be visible outside must explicitly be exported / imported

```
export namespace MathFunctions {
    export function square(nbr: number): number {
        return Math.pow(nbr, 2);
    }
}
```



```
import mathFunctions = require("./mathFunctions");
let sq = mathFunctions.MathFunctions.square(10);
```



Namespaces

Namespaces are declared using "namespace" keyword

TypeScript allows multi-file namespaces

Aliases simplify working with namespaces

```
export namespace MathFunctions {
    export function square(nbr: number) : number {
        return Math.pow(nbr, 2);
    }
}

import  mf = MathFunctions;
let sq = mf.square(10);
```

Decorators

Decorators add descriptive information to classes

- Annotations
- Metadata
- Used by frameworks like
  - Angular
  - React

```
1  import {Component} from '@angular/core';
2
3  @Component({
4    selector: 'app',
5    templateUrl: './app.component.html',
6  })
7  export class AppComponent {
8  }
```

tsconfig.json

```
1  {
2    "compileOnSave": false,
3    "compilerOptions": {
4      "outDir": "./dist/out-tsc",
5      "baseUrl": "src",
6      "sourceMap": true,
7      "declaration": false,
8      "moduleResolution": "node",
9      "emitDecoratorMetadata": true,
10     "experimentalDecorators": true,
11     "target": "es5",
12     "typeRoots": [
13       "node_modules/@types"
14     ],
15     "lib": [
16       "es2016",
17       "dom"
18     ]
19   }
20 }
```

Consuming Services

Consuming Services Overview

Service calls are typically async

Possible implementation paths

- XMLHttpRequest
- $.ajax
- Fetch Api – often used together with await
- Native Clients:
  - Angular: httpclient, http
  - SPFx: SPHttpClient

Using jQuery ajax()

Widely used in JS programming

Documentation @ https://api.jquery.com/jquery.ajax/

Historically uses callback pattern

```
import * as $ from "jquery";

$.ajax({
  type: "GET",
  url: this.url,
  contentType: "application/json; charset=utf-8",
  dataType: "json",
  success: function success(data: any) {
    console.log("Data received from jQuery: ", data);
  },
  //shortcut of callback pattern - function removed
  error(err: any) {
    console.log("Error received from jQuery: ", err);
  }
});
```

ES 6 Promise

Pattern to deal with async

Alternative to Callbacks

Benefit: Can be chained!

3 States: pending (in progress), fulfilled (success), rejected (error)

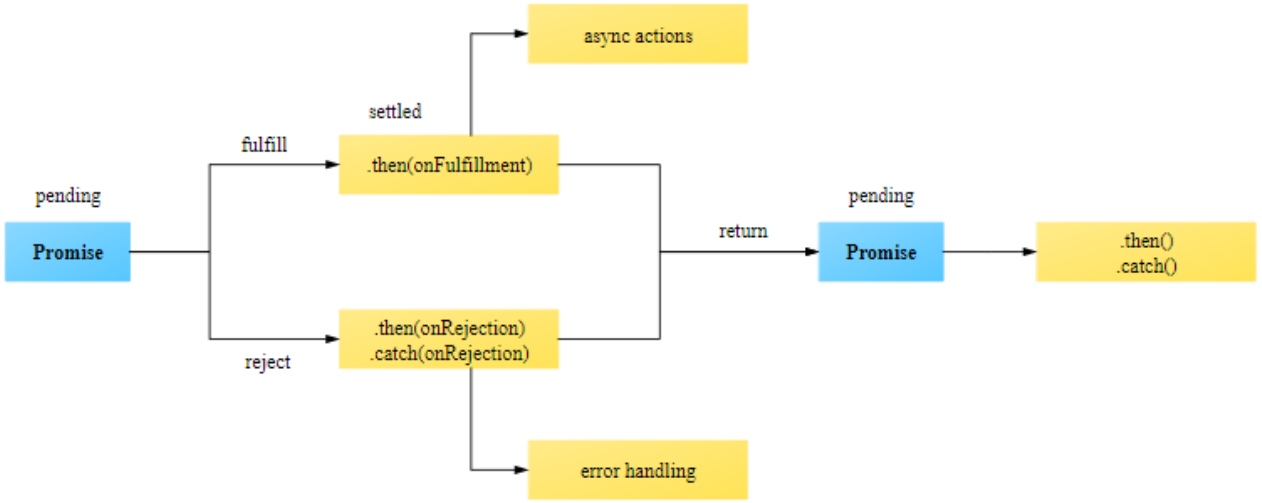
Use .then() & .catch() for further processing and error handling

If transpiling to ES5 reference ES6-shim (https://github.com/paulmillr/es6-shim)

Using ES6 Promises

```
getWebTitleREST() {
  console.log("executing rest");
  let qry = this.baseUrl + "/_api/web/title";

  $.ajax({
    type: "GET",
    url: qry,
    dataType: "json",
    headers: {
      accept: "application/json;odata=verbose"
    }
  })
    .then(data => {
      console.log(`Web Title is: ${data.d.Title}`);
    })
    .fail(err => {
      console.log(err);
    });
}
```



Manally creation of Promise

Use: newPromise<T>((resolve,reject))

Return Result / Err using resolve(Result) | reject(Result)

```
function doAsyncTask(succeed: boolean): Promise<string> {
    return new Promise<string>((resolve, reject) => {
        setTimeout(() => {
            console.log("Async Task Complete");
            if (succeed) {resolve("Outcome: Promise resolved");}
        else {reject("Outcome: Promise rejected");}
        }, 1000);
    });
}

doAsyncTask(true).then((msg) => {
    console.log(msg);
});
```