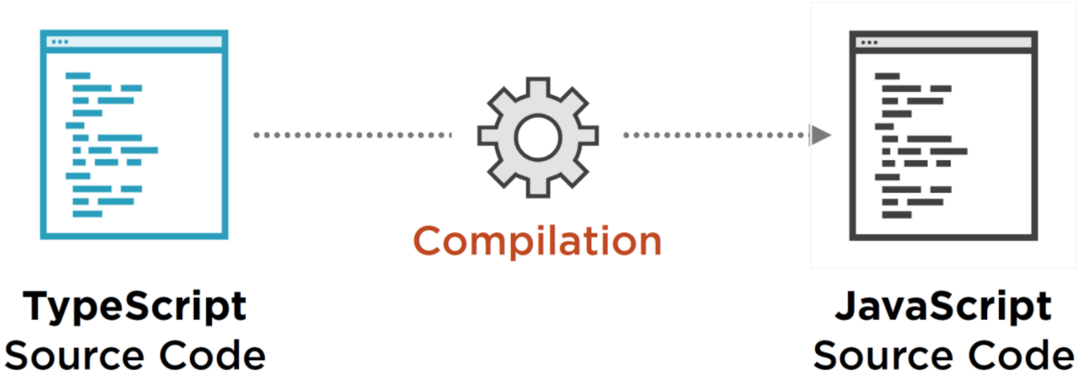
Practical Typescript



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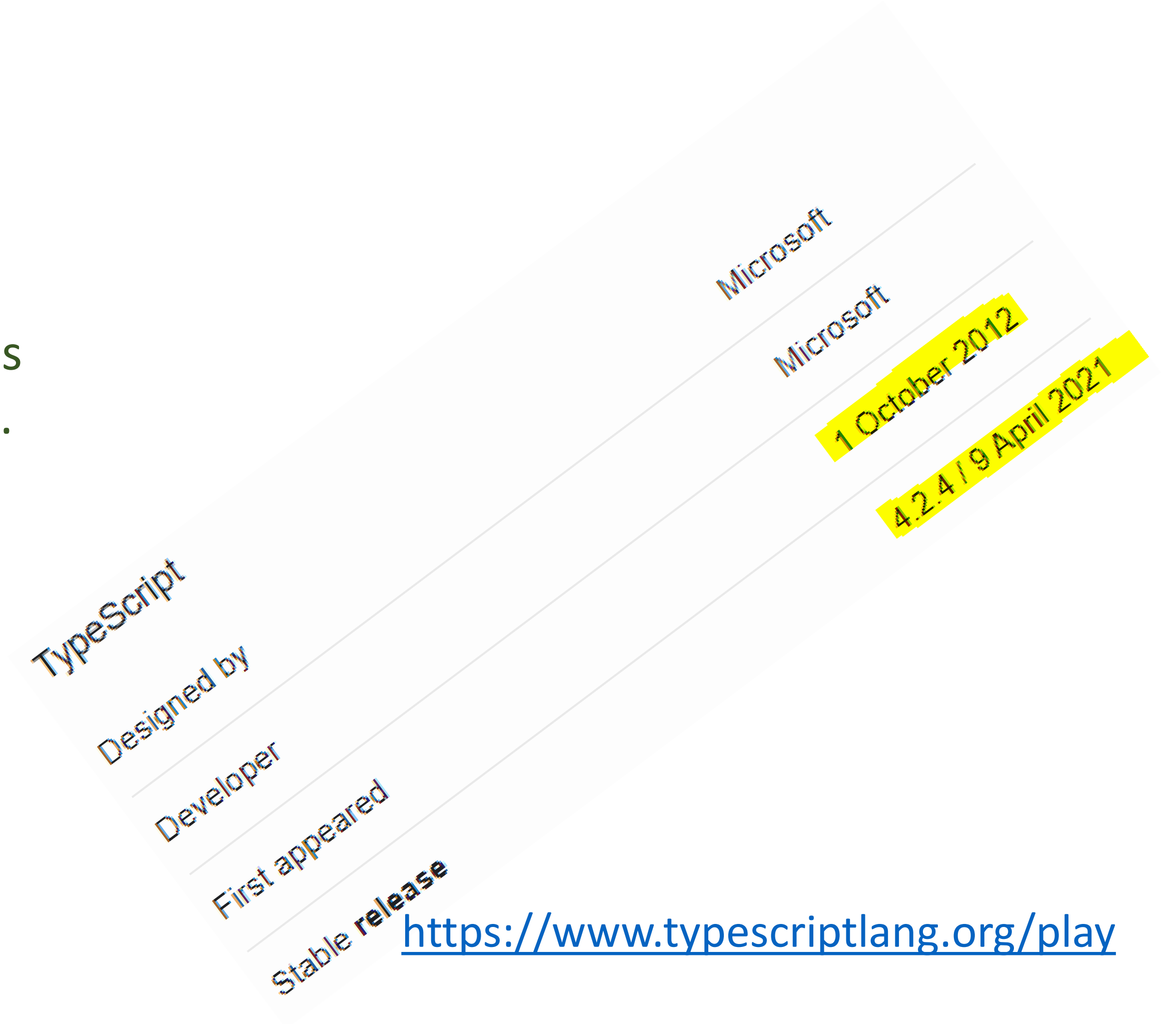
https://github.com/azatsatklichov/nodejs-app

Agenda

- ❑ Why Typescript
- ❑ Type Annotations/Inferences, Data Types
- ❑ Access modifiers, Properties
- ❑ Type Definition Files, Ambient Declaration. Typings
- ❑ Functions (Arrow), Params options, Overloading, …

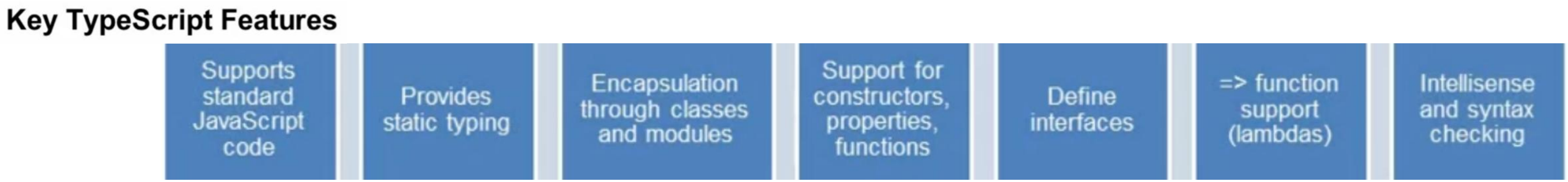
- ❑ Powerful Features (**Minimizing TS**)
  - ✓ Class Expression
  - ✓ Destruction
  - ✓ Spread operator
  - ✓ Combined Types (Union, Intersection)
  - ✓ String literal types, Type aliases
  - ✓ Declaration Merging
  - ✓ Type Guard



TypeScript

Designed by	Microsoft
Developer	Microsoft
First appeared	1 October 2012
Stable **release**	4.2.4 / 9 April 2021

https://www.typescriptlang.org/play



Key TypeScript Features

Supports standard JavaScript code
Provides static typing
Encapsulation through classes and modules
Support for constructors, properties, functions
Define interfaces
=> function support (lambdas)
Intellisense and syntax checking

Why Typescript

- ❖ Javascript don't dos (null, undefined, ===, this, ..) still may exist, so follow Do's and Don't in TS

- ❖ To get rid off Function Spaghetti Code → Ravioli Code (JavaScript Patterns) (Each JS module has specific concern)

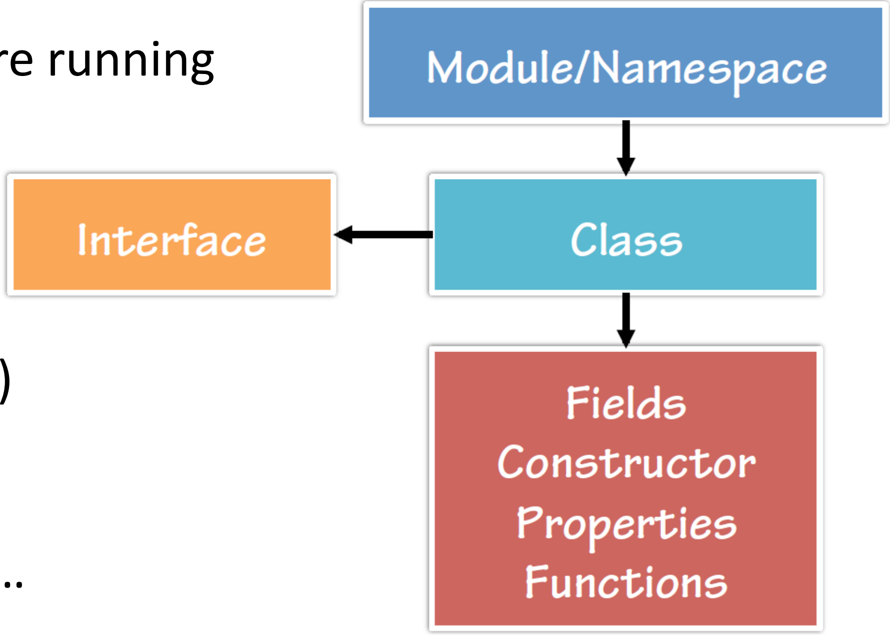
- ❖ TS is Super Set of JavaScript. Transpiled to JS code (ES3, ES5, Ecma2015[ES6], ..) , IIFE, ..

- ❖ Static Typing - Compile Time Type Checking eliminates errors before running

- ❖ Types declarations (*d.ts) - once using DOM, jQuery, lodash, ..

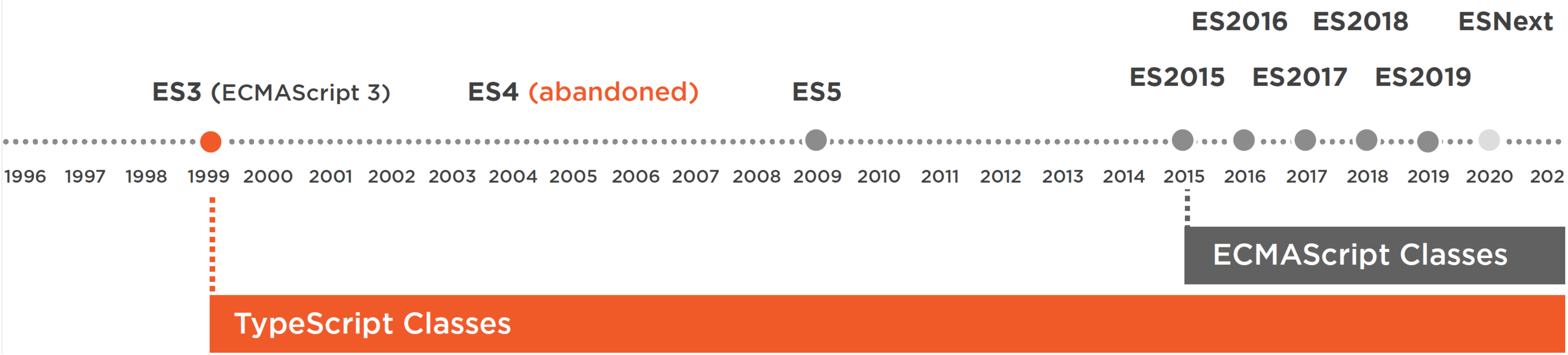
- ❖ Features

– EcmasScript 2015 – let/const (block scope, not hoisted, unique def.)
– Classes, Abstract classes, Enums, Tuples, Interfaces assistances
– Type Inference, Types Erasure, Destructions, Spread ..
– Async Programming (callbacks, Promise, async/awat), Decorators, …



- ❖ TS alternatives – Dart, CoffeeScript, Applying JavaScript Patterns, ..
- ❖ Cross Platform, Open Source

TypeScript vs ECMAScript Class Compatibility



Benefits of TypeScript:

Static Types

variables, parameters,
return types, etc.

Organization

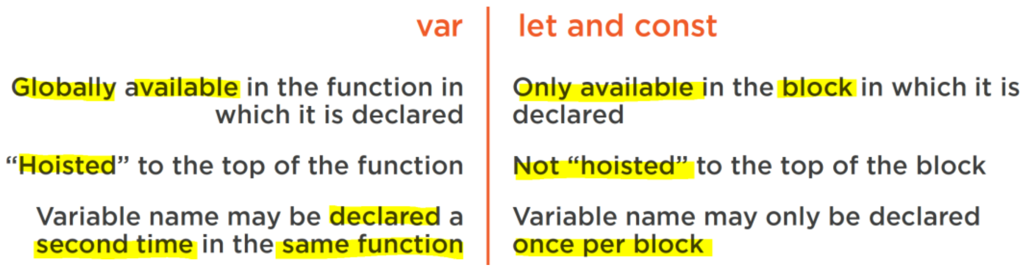
classes, modules,
namespaces, interfaces

Tooling

static type analysis
many "instant" errors
detect unused data / unreachable code
source maps — debug directly in TypeScript

Declaring variables and constants

var, let, const



var	let and const
Globally available in the function in which it is declared	Only available in the block in which it is declared
“Hoisted” to the top of the function	Not “hoisted” to the top of the block
Variable name may be declared a second time in the same function	Variable name may only be declared once per block

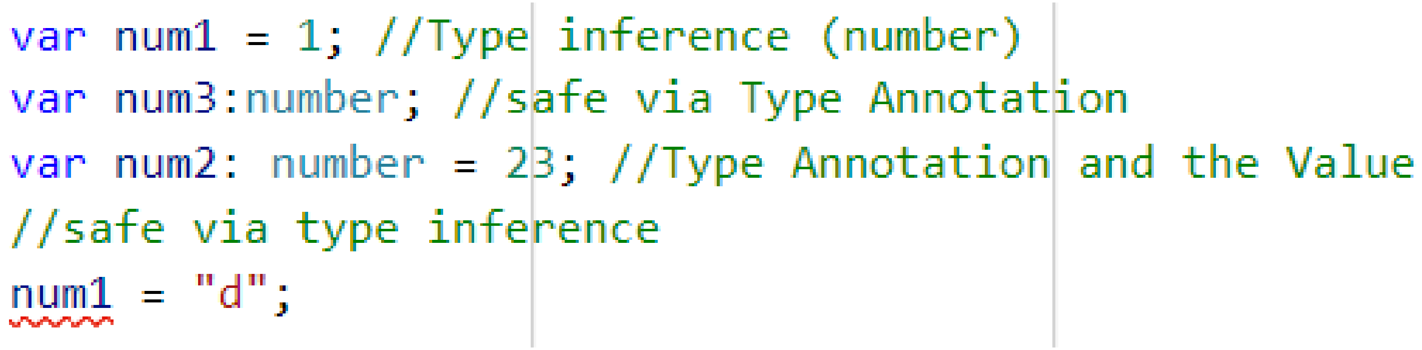
Data Types (primitive, Object)

Built-in: boolean, number, string, any (try to avoid no typing benefit), and Ecmascript 2015 new primitive type ‘**symbol**’

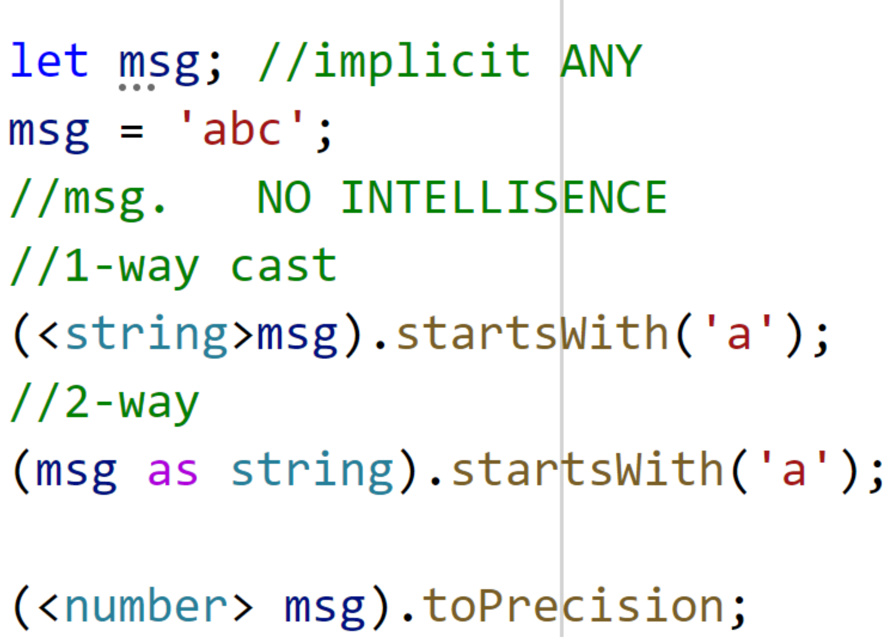
Custom: enum, classes, interfaces, array, ..

What about intellisense support with **ANY? Casting**

Type annotation and inference



```
var num1 = 1; //Type inference (number)
var num3:number; //safe via Type Annotation
var num2: number = 23; //Type Annotation and the Value
//safe via type inference
num1 = "d";
```



```
let msg; //implicit ANY
msg = 'abc';
//msg.   NO INTELLISENSE
//1-way cast
(<string>msg).startsWith('a');
//2-way
(msg as string).startsWith('a');

(<number> msg).toPrecision;
```

Data Types

Basic Types:

Boolean,Number,String,Arrays,Enum,Any,Void

```
//Cobol Punch Card has 5 fields on positions 0-6, 7, 8-11, 12-72, 72-80
enum PunchCard { Sequence = 0, Indicator = 7, AreaA = 8, AreaB = 12, IdentificationArea = 73 };

let startPosition: PunchCard = PunchCard.AreaA;
console.log(startPosition); //8
console.log(PunchCard.IdentificationArea); //73
let fieldName: string = PunchCard[startPosition];
console.log(fieldName); //AreaA
console.log(PunchCard[12]); //AreaB

//Also enums can be used with string values, mix, …
enum PrintMedia { Newspaper = "NEWSPAPER", Magazine = "MAGAZINE"}
PrintMedia.Newspaper; //returns NEWSPAPER
PrintMedia['Magazine'];//returns MAGAZINE

//Arrays
let arr1: string[] = ['a', 'b', 'c'];
let arr2: Array<string> = ['a', 'b', 'c'];
let arr3: any[] = ['a', true, 23];

//Tuple
let tuple: [number, string] = [123, "Broadcom"];
```

Access modifiers, Properties

Access modifiers (on fields methods), Encapsulation.
Public, [Also public if not defined], Private, Protected

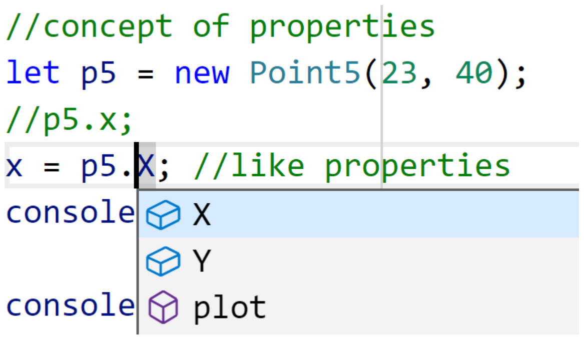
```
class Point {
   x: number;
   y: number;
   constructor(x?: number, y?: number) {
   this.x = x;
   this.y = y;
}
```

Constructor pattern (shorthand way). No multiple **constructor** (use optional params, or static factory methods)
TS compiler will generate fields implicitly with same name & initialize.

```
class Point {
    constructor(private x?: number, private y?: number) { //can be also public, then mutable,..
    }
}
```

How to access private fields?

1) Getters & Setters.
2) Concept of Properties: camelCase fields (get X **clashes** with x, so use _x)



```
//concept of properties
let p5 = new Point5(23, 40);
//p5.x;
x = p5.X; //like properties
console
console
```

Other Usage of '_' : E.g. app.get('/forms',   (_req, res) => {..} to defer warning "req" is declared but its never read.

Type Definition Files, Ambient Declaration

- Once you work with Javascript & DOM (Table, Input .. elements)
- lib.d.ts is referenced by default for the **DOM** and JavaScript in TS.
- Ambient Declarations (**declare**) do not appear **anywhere in the JavaScript**
- *.d.ts files not to run but to give context for **code-hints, err-detection**
- Primarily used as a TS wrapper for JS libraries

TS

```
declare var document;

document.title = "Hello";
```

Javascript

```
document.title = "Hello";
```

E.g. `var table: HTMLTableElement  = document.createElement('table');`

- Once working with third-party libs (jQuery, lodash etc.) you need *.d.ts file. E.g.

```
///</// <reference path="lodash.d.ts" />
import * as _ from "lodash";
console.log(_.snakeCase('UEFA Champions League')); //uefa_champions_league
```

Type Definition Files. Typings

- Get *.d.ts sources from GitHub (even you can contribute via PR ;))

https://github.com/borisyankov/DefinitelyTyped, http://definitelytyped.org/

- Tools to manage: direct download from GitHub, Nuget, tsd, typings
- 1-way: npm i --save lodash --save-dev @types/lodash

- 2-way: using tsd.json [deprecated] – Find&download *.d.ts files, keeps all /// in single file
  npm install tsd –g, then tsd install lodash –save, or tsd install jquery –save // typings folder

- 3-way: typings.json is new and like tsd but gets files from multiple sources GitHub, SVN, … add typings folder. Configure tsconfig.json files:["typings/main.d.ts“] to remove ///<…

➢ npm install typings –global

➢ typings install jquery --save

```
> typings -v
2.1.1
```

Functions in TypeScript Versus JavaScript

TypeScript	JavaScript
Types (of course!)	No types
Arrow functions	Arrow functions (ES2015)
Function types	No function types
Required and optional parameters	All parameters are optional
Default parameters	Default parameters (ES2015)
Rest parameters	Rest parameters (ES2015)
Overloaded functions	No overloaded functions

Arrow Functions.

- Compact form of expressions.
- Omit function keyword
- Have scope this

```
var myFun = function (x: number, y: number) {
          return x * y;
}
var myArrFun = (x: number, y: number) => x * y;

//or
myArr.forEach((val, idx, arr) => console.log(++idx + ' - ' + val));
```

```
//Capturing “this” in JavaScript
function Book() {
  let self = this;
  self.publishDate = 2016;
  setInterval(function () {
    console.log(self.publishDate);
  }, 1000);
}
```

```
//Capturing “this” in Arrow
function Book2() {
  this.publishDate = 2016;
  setInterval(() => {
    console.log(this.publishDate);
  }, 1000);
}
```

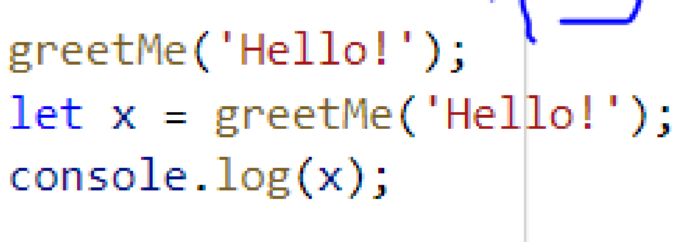
Function Types

```
let IdGenFunc: (chars: string, nums: number) => string;
IdGenFunc = (name: string, id: number) => { return id + name; }
let myID: string = IdGenFunc('gulsirin', 63);// 63gulsirin

//or
function PubMsg(year: number): string {
  return "Pub: " + year;
}
let pubFunc: (someYear: number) => string;
pubFunc = PubMsg;
let msg: string = pubFunc(2022);
```

Void return type

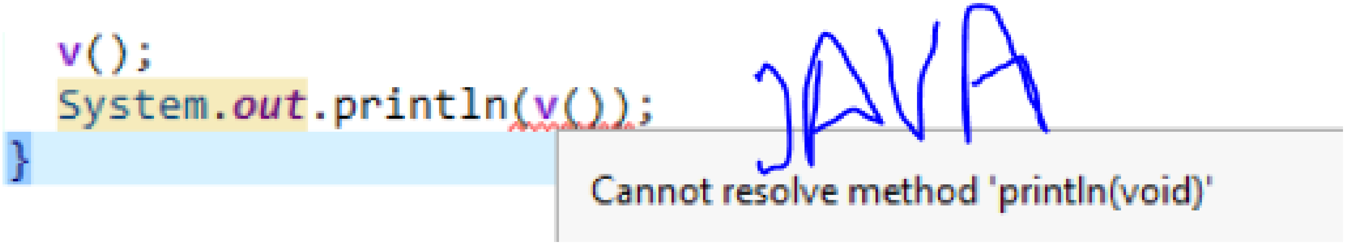
TS function with return type **void**. Still returns undefined, no compile error

TS



```
greetMe('Hello!');
let x = greetMe('Hello!');
console.log(x);
```

JAVA



```
v();
System.out.println(v());
}
```

Cannot resolve method 'println(void)'

Declaring Parameters (default, optional, rest, no-warning).

In **JS** by default all parameters are OPTIONAL. But in Typescript all parameters are **required** by default.

```
var myFun1 = function (y: string = "I am") {
  return  y;
};

 console.log(myFun1("23"));//23
 console.log(myFun1());//I am
```

```
 var myFun11 = function (y?: string) {
   return  y;
 };
console.log(myFun11("23")); //23
console.log(myFun11());//undefined
```

```
 //rest parameters
 var myFun3 = function (x: number, ... ids: number[])  {
    //tbd
 }
 myFun3(2);
 myFun3(2, 3);
 myFun3(2, 55, 453);
```

```
//No warning for un-used variables
function vars(_variable: string) {
     console.log('Just see, no warning even variable not used' );
}
```

Overloaded Functions

In TS once types are removed during transpilation to JS, this adds ambiguity .. .

```
//define overloaded functions
function getIds(user: string): string[];
function getIds(active: boolean): string[];

//implementation function
function getIds(factor: any): string[] {
    if (typeof factor == 'string') {
          //tbd
     } else if (typeof factor == 'boolean') {
         //tbd
     }
     return []; //TBD result
};
```

Class Expressions

In JS function expressions were used a lot.

```
abstract class Animal {
    abstract swim(txt: string): void;
}
//giving a class name is optional
let Dolphin = class extends Animal {
   swim(txt: string): void {
      console.log('swim like ' + txt);
   }
}
let myDolphin = new Dolphin();
myDolphin.swim('Dolphin');


//how to use class expression in extension
class Sharq extends class {name : string} { //not confuse with object, this is decl.
   elasmobranchii : string;
}
let mySharq = new Sharq();
mySharq.elasmobranchii = 'elasmobranchii Sharq';
mySharq.name = 'Alpha';
```

Destructing assignments

The process of assigning the elements of an array or the properties of an object to individual variables.

```
let apples: string[] = ['Granny Smith', '
Opal', 'Goldspur', 'Ligol', 'Melba'];

let apple1 = apples[0];
let apple2 = apples[1];
let apple3 = apples[3];
console.log(apple1);//Granny Smith

//destructing arrays
let [jablko1, jablko2, jablko3] = apples;
console.log(jablko1);//Granny Smith
```

```
let car  = {
    model: 'Skoda Fabia Kombi',
    karoserie: 'Kombi',
    assembly: 'Mlada Boleslav'
};

// let model = car.model;
// let karoserie = car.karoserie
// let assembly = car.assembly;

//property names exact match.
let {model, karoserie, assembly} = car;
console.log(model);//new variable
//if object props not match or different naming
let {model: znacka, karoserie:style, assembly:factory} = car;
console.log(znacka);//new variable
```

Spread operator

```
let greenApples: string[] = ['Granny Smith', 'Lodi', 'Smeralda'];

//using spread operator
let allApples: string[] = ['Opal', 'Goldspur', 'Ligol', 'Melba', ...greenApples];
```

Combining Types (union, intersection)

```
//union types used for parameters and return types
function getReport1(id: number | string) {
        //TBD
}
```

```
//intersection types - all properties must match
function getReport2(id: Mobile & Tablet) {
  //TBD
}
```

String Literal Types

```
//string literals - acts like distinct types
let mr : 'Mister'; //type of variable
let mr1: 'Mister' = 'Mister';
let mr2: 'Mister' = 'Madam'; // err – type is not assignable
//gives enum like behavior, e.g. to finite values
let mr3: 'Mister' | 'Madam' = 'Madam';
let mr4: 'Mister' | 'Madam' = 'Miss';//err
```

Type aliases

```
//type aliases
let mr5: 'Mister' | 'Madam' | 'Miss' = 'Miss';
type mrCategory= 'Mister' | 'Madam' | 'Miss';
let mr6: mrCategory= 'Madam';
let mr7: mrCategory= 'Madam';
let mr8: mrCategory= 'Mrs'; // err - is not assignable to type
```

Declaration Merging

Declaration merging – compiler merges two separate declarations declared with same name into one

```
interface Mashyn {
  name: string;
  go(): () => void;
}

//somewhere in app another Mashyn interface
interface Mashyn {
    color: string;
    stop(): () => void;
}

//TS compliler merges it and sees as single interface. Code completion support, ..
class Volga implements Mashyn {
    name: string;
     go(): () => void {
                    throw new Error("Method not implemented.");
      }
      color: string;
      stop(): () => void {
          throw new Error("Method not implemented.");
      }
}
```

Can be merged: Interfaces, Enums, Namespaces, Namespaces with classes | functions | enums

Can not be merged: Classes with classes. Workaround is Mixin concept

Type Guards, User defined Types

Compiler can do check more errors on narrowed block based on type guards [typeof, instanceof] .
Typesof is also used in Overloaded method implementation, …

```
let x: string | number = 144;
 if(typeof x === 'number') {
   //TYPE is NARROWED to NUMBER
   //(not exist in Java until Java 15)
} else {
   //narrowed to STRING. Compiler does this
 }
```

Instanceof - works on other types, which has a constructor, ..

```
class Football {}
class Hockey {}
let sport: Football | Hockey = new Football();
if(sport instanceof Football){
  //narrowed to Football, so safe to use
}
```

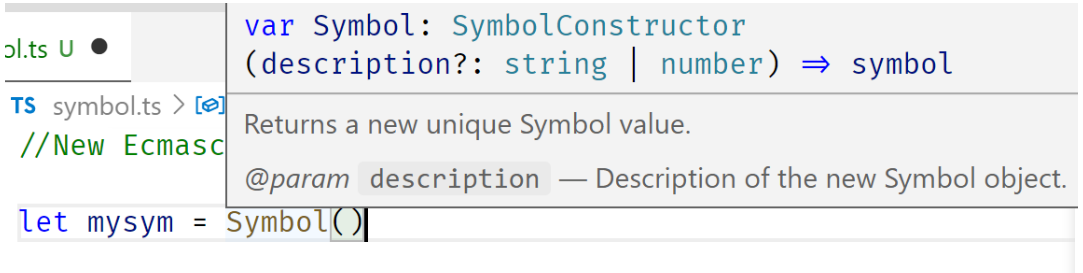
typeof drawback - only used for specific types (string, number, booleand and symbol)

User defined Type Guards

```
interface Drink { taste: string}
//Java has sealed Classes concept, can be used for similar usecase
function isDrink(d : any) : d is Drink {
    return (<Drink> d).taste !==undefined;
}
let f = new Football();
if(isDrink(f)){
 console.log('Yes it is a drink type');
} else {
   console.log('It is not a drink');
}
```

Symbols

New Ecmascript 2015 feature, in tsconfig.json change compiler option: "target": "ES2015“ (no ES5).
No **new** used to create symbol. No constructor function. Symbols are new primitive data type. Its type is SYMBOL. It is unique



```
var Symbol: SymbolConstructor
(description?: string | number) ⇒ symbol
```

Returns a new unique Symbol value.

@param `description` — Description of the new Symbol object.

```
//New Ecmasc

let mysym = Symbol()
```

```
let mySym1 = Symbol(23);
let mySym2 = Symbol(23);
console.log(mySym1 === mySym2);//false
console.log(typeof mySym2);//symbol
```

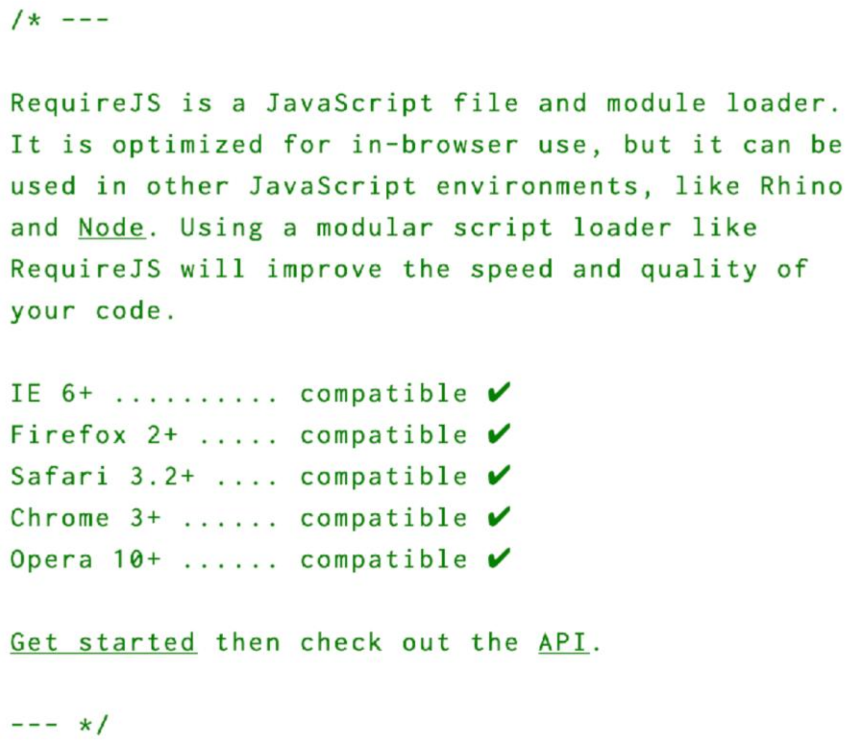
Functional programming, Currying in TS

```
const test = (a: string, b: string) => b + " " + a;
test("I am arg1", " I am arg2"); // I am arg1 I am arg2

//currying  –  nesting returning functions and be able to partially consume a function
const curr = (a: string) => (b: string) => b + " " + a;
curr("I am arg1")(" I am arg2"); // I am arg1 I am arg2

//const compute = (a: number, f: (x:number) => number) : number => f(a);
const compute : (a: number) => (f: (x : number) => number) => number = a => f => f(a)
```

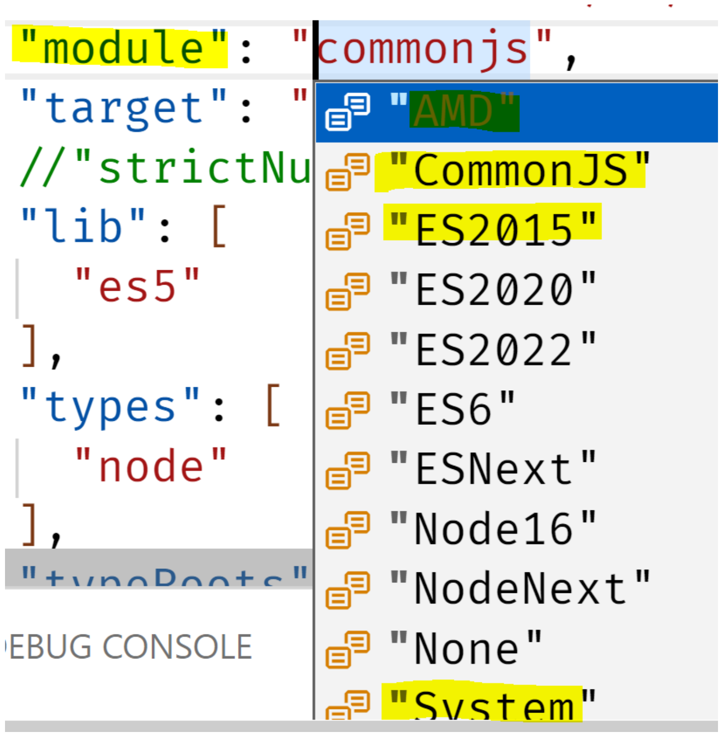
Modules vs. Namesapecs

Modules	Namespaces
Tool for organizing code	Tool for organizing code
Native support in Node.js	No special loader required
Browsers supported with module loader	Prevents global namespace pollution
Supports ES2015 module syntax	Best for smaller client applications
Facilitates code reuse	
Modules are the future!	

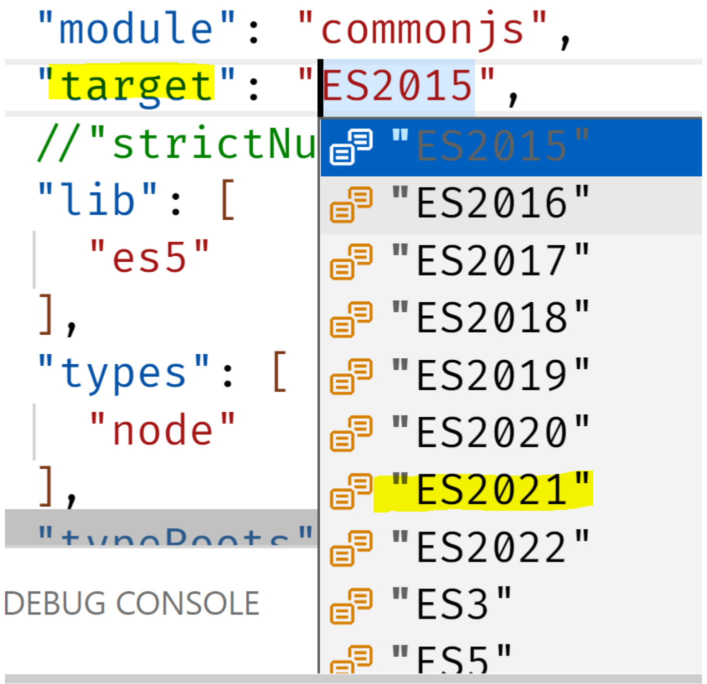
Modules/Namespaces



```
/* ---

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.

IE 6+ .......... compatible ✔
Firefox 2+ ..... compatible ✔
Safari 3.2+ .... compatible ✔
Chrome 3+ ...... compatible ✔
Opera 10+ ...... compatible ✔

Get started then check out the API.

--- */
```



```
"module": "commonjs",
"target": "
//"strictNu
"lib": [
  "es5"
],
"types": [
  "node"
],
"typeRoots"
```



```
"module": "commonjs",
"target": "ES2015",
//"strictNu
"lib": [
  "es5"
],
"types": [
  "node"
],
"typeRoots"
```

THANK YOU

References

https://www.typescriptlang.org/docs/
https://www.typescriptlang.org/docs/handbook/declaration-files/do-s-and-don-ts.html
https://github.com/danielstern/compiling-typescript
https://medium.com/@cb.yannick/functional-programming-with-typescript-part-1-3f7167a2c0ad