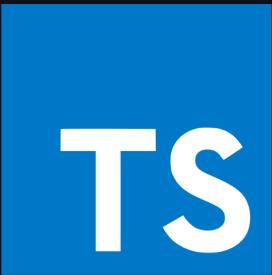


타입 레벨 프로그래밍

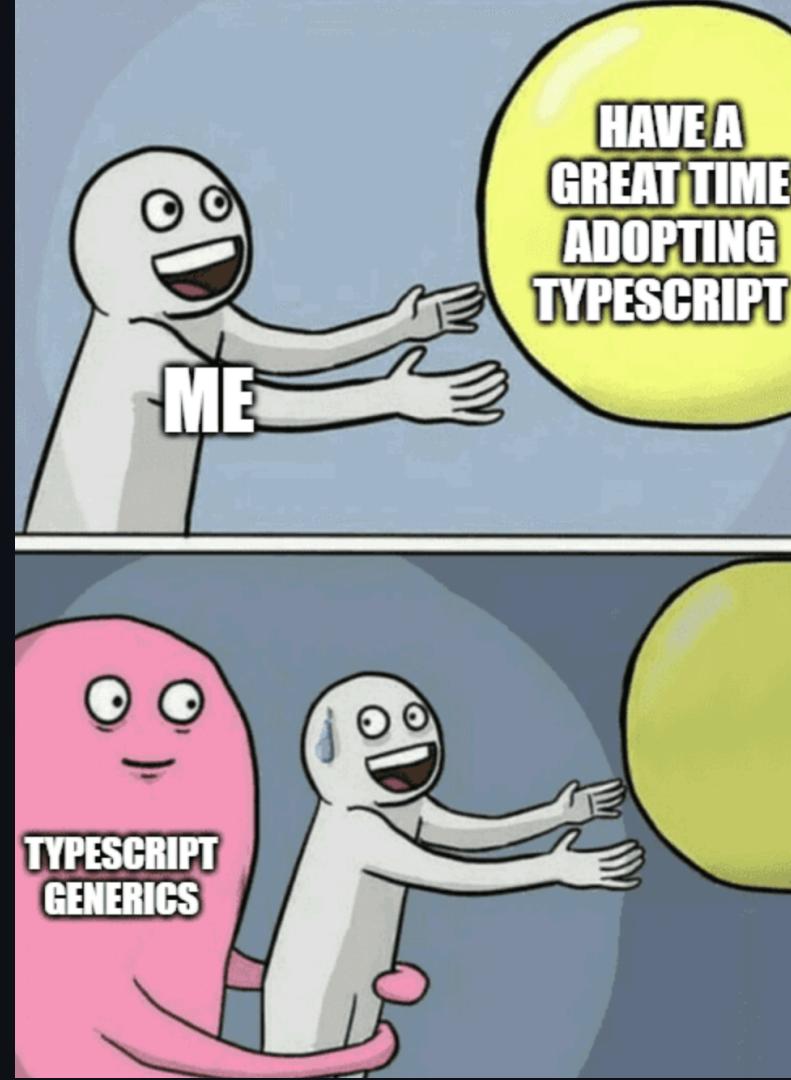


```
interface TS extends JS {  
    typeSafety: true;  
}
```



타입스크립트

- 2012년에 등장
- 자바스크립트의 슈퍼셋
- 정적 타입 언어



**TYPE SAFETY
WITH TYPESCRIPT**



타입시스템은 완전 튜링하다.

- 튜링 머신 이란?

수학자 앤런 튜링이 1936년에 제시한 개념으로 계산하는 기계의 일반적인 개념을 설명하기 위한 가상의 기계이며 오토마타의 일종이다

증명

microsoft / TypeScript

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TypeScript's Type System is Turing Complete #14833

Open hediet opened this issue on Mar 24, 2017 · 87 comments

hediet commented on Mar 24, 2017 · edited Member ...

This is not really a bug report and I certainly don't want TypeScript's type system being restricted due to this issue. However, I noticed that the type system in its current form (version 2.2) is turing complete.

Turing completeness is being achieved by combining mapped types, recursive type definitions, accessing member types through index types and the fact that one can create types of arbitrary size.

In particular, the following device enables turing completeness:

튜링 완전 언어 특징

- 계산 능력
- 조건문 과 반복문
- 기억과 상태 (변수 할당)
- ...

제네릭

- 제네릭은 선언 시점이 아니라 생성 시점에 타입을 명시하여 하나의 타입만이 아닌 다양한 타입을 사용할 수 있도록 하는 기법

```
type A<T> = T  
  
type B = A<number> // number  
  
type C = A<string> // string
```

제네릭

개인적으로 타입레벨의 함수라고 생각함.

```
type Foo<  
  A /* arg 1 */,  
  B /* arg 2 */,  
  C /* arg 3 */,  
> = A & B & C /* return Type */
```

조건문

`extends` 의 역할은 두가지가 있는데 그중하나가 `if`의 역할이다.

```
type User {  
    name: string;  
    email: string;  
}  
  
type IsHasField<T, FieldName extends string> = FieldName extends keyof T  
    ? true  
    : false;  
  
type HasEmailField<T> = IsHasField<T, 'email'>  
  
type UseHasEmailField = HasEmailField<User> // true
```

반복문

- 반복문은 존재하지않지만 타입 재귀는 가능하다!
- 여기서 중요한 키워드는 `infer`

```
type IsAllNumber<T extends unknown[]> = T extends [infer First, ...infer Rest]
  ? First extends number
    ? IsAllNumber<Rest>
      : false
    : true;

type A = IsAllNumber<[1, 2, 3]>; // true
type B = IsAllNumber<[1, 2, 'knowre']>; // false
```

유틸 타입

```
type AnyFn = (...args: any[]) => any;

// 타입스크립트에서 제공되는 유틸 타입
type Parameters<T extends AnyFn> = T extends (...args: infer P) => any
    ? P
    : never;
// Parameters<(a: string, b: number) => boolean> // [a: string, b: number]

type Head<T extends any[]> = T extends [infer First, ...any[]]
    ? First
    : never;
// Head<[1, 2, 3, 4, 5]> // 1

type Tail<T extends any[]> = T extends [any, ...infer Rest]
    ? Rest
    : never;
// Tail<[1, 2, 3, 4, 5]> // [2, 3, 4, 5]

type Length<T extends any[]> = T["length"];
// Length<[1, 2, 3, 4, 5]> // 5
```

Currying의 타입을 만들어볼려고함.

그전에... currying 이란?

커링 함수

```
const curry = (fn) => {
  return function curried (...args) {
    if (fn.length === args.length) {
      return fn(...args)
    }
    return curried.bind(this, ...args)
  }
}

const add = (a, b) => a + b

add(3, 11) // 14

const curried = _.curry(abc)

const addFive = curried(5)

addFive(3) // 8
```

단순화 하여 생각하기

전달 받는 함수의 `length`가 2일 경우

```
const add = (a: number, b: number) => a + b;

/**
 * ((a: number, b: number) => number) &
 * ((a: number) => (b: number) => number)
 */
const curried = _._.curry(add);
curried(5, 3); // 8

const addFive = curried(5); // (b: number) => number
addFive(3); // 8
```

```
type AnyFn = (...args: any[]) => any

type HasTail<T extends any[]> = T extends [] | [any] ? false : true;

type Curried<P extends any[], R> = P extends [infer Head, ...infer Rest]
? HasTail<P> extends true
? ((a: Head, ...b: Rest) => R) &
((a: Head) => Curried<Rest, R>)
: (a: Head) => R // head 하나만 넘어옴
: never;

type Curry<Fn extends AnyFn> = Curried<Parameters<Fn>, ReturnType<Fn>>;
```

```
declare function curry <T extends AnyFn>(fn: T): Curry<T>

/** ((a: number, b: number) => number) & ((a: number) => (last: number) => number) */
const curriedAdd = curry(add2);
const five = curriedAdd(2, 3); // number
const addTwo = curriedAdd(2); // (last: number) => number
```

전달받는 함수의 length가 3이상일 경우

```
const foo = (a: number, b: string, c: boolean) => true;

/**
 * (
 *   (a: number) => (
 *     (b: string) => (c: boolean) => boolean) &
 *   ((b: string, c: boolean) => boolean)
 * )
 * ) &
 * ((a: number, b: string) => (c: boolean) => boolean) &
 * ((a: number, b: string, c: boolean) => boolean)
 */
const curriedFoo = _.curry(foo);

const a = curriedFoo(3, 'knowre') // (c: boolean) => boolean
const b = curriedFoo(3, 'knowre', false) // true

/**
 * (b: string) => (c: boolean) => boolean) &
 * ((b: string, c: boolean) => boolean)
 */
const c = curriedFoo(3)
```

```
type Curried<P extends any[], R, PrevParams extends any[] = []> = P extends [
  infer Head,
  ...infer Tail
]
? HasTail<P> extends true
  ? (...args: [...PrevParams, Head]) => Curried<Tail, R> & // 커링된 함수를 리턴.
    Curried<Tail, R, [...PrevParams, Head]> // 커링 없이 실행한 함수 리턴
  : (...args: [...PrevParams, Head]) => R // Arg가 1개 남았을 경우 모든 Prams를 넣어서 실행하는 함수
: never;

type Curry<Fn extends AnyFn> = Curried<Parameters<Fn>, ReturnType<Fn>>;
// ((args_0: 1) => (args_0: 2) => true) & ((args_0: 1, args_1: 2) => true)
type TestA = Curried<[1, 2], true>
// (args_0: 1, args_1: 2) => true
type TestB = Curried<[2], true, [1]>
```

완성된 커링

```
namespace _ {
    type AnyFn = (...args: any) => any;
    type HasTail<T extends any[]> = T extends [] | [any] ? false : true;

    type Curried<P extends any[], R, PrevParams extends any[] = []> = P extends [
        infer Head,
        ...infer Tail
    ] ? HasTail<P> extends true
        ? ((...args: [...PrevParams, Head]) => Curried<Tail, R>)
            Curried<Tail, R, [...PrevParams, Head]>
        : (...args: [...PrevParams, Head]) => R
    : never;

    type Curry<Fn extends AnyFn> = Curried<Parameters<Fn>, ReturnType<Fn>>;
}

export function curry<T extends AnyFn>(fn: T): Curry<T>;
export function curry(fn: any) {
    return function curried(...args) {
        if (fn.length === args.length) {
            return fn(...args);
        }

        return curried.bind(null, ...args);
    };
}
```

타입스크립트 챌린지

<https://github.com/type-challenges/type-challenges>

Type<Challenge[]>

hard 53

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감사합니다