# Better TypeScript Types


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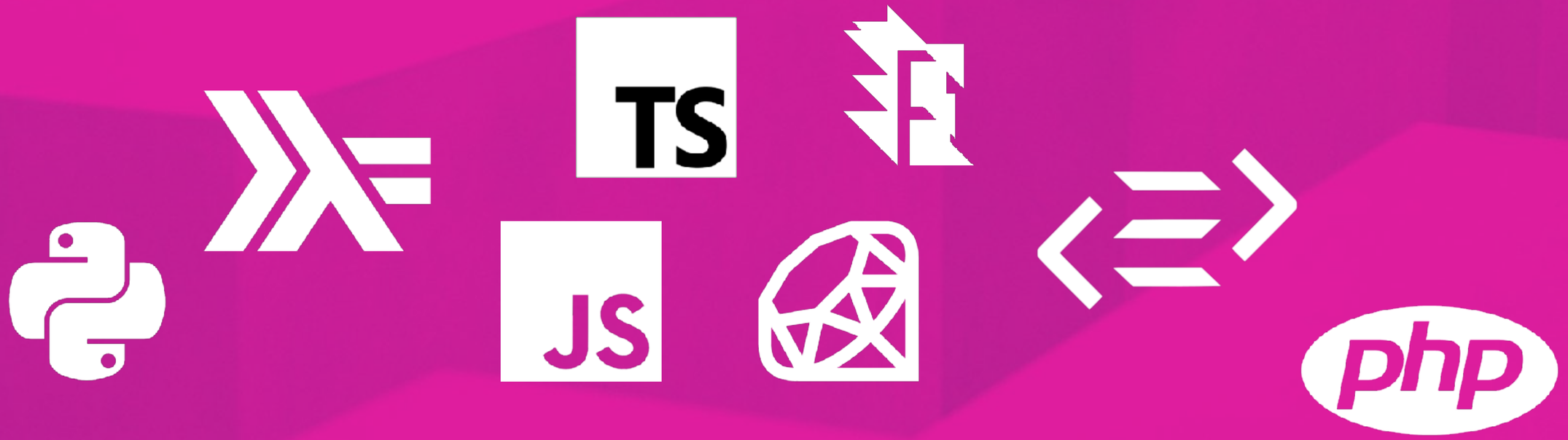

# Audience Interaction Time

# 0) Why

**Write down my assumptions in a way the computer understands, then have it tell me when I'm wrong.**


Dear Kate,
Here's to the crazy ones. The misfits.
The troublemakers. The round pegs in the
holes. The ones who see things differently.
not fond of rules. And they have no respect for the
status quo. You can quote them, disagree with them,
glorify or vilify them. About the only thing you can't
do is ignore them. Because they change things.
They push the human race forward. And while some
may see them as the crazy ones, we see genius.
Because the people who are crazy enough to think
they can change the world, are the ones who do.
Take care.
John Appleseed


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# 1) Possibilities

# 1.1) Keep only what's needed

```
function icon(type: string): string {
  ...
}
```

```
// CSS class name for icon
function icon(type: string): string {
  return `icon icon-${type}`;
}
```

```
// CSS class name for icon
function icon(type: string): string {
  return `icon icon-${type}`;
}
```

```
type Icon = 'spinner' | 'save';

function icon(type: Icon): string {
  ...
}
```

```
type Icon = 'spinner' | 'save';

function icon(type: Icon): string {
   ...
}
```

# string

# string

" "

# string

""

"spinner"

# string

```
""
        "spinner"

"Hello, world!"
```

# string

""

"spinner"

"Hello, world!"

"不忍人之心"

# string

""

"spinner"

"Hello, world!"

"ACT I
SCENE I. Athens. The palace of
THESEUS.

Enter THESEUS, HIPPOLYTA,
PHILOSTRATE, and Attendants

..."

"不忍人之心"

```
"spinner" | "save"
```

```
"spinner" | "save"
```

```
"spinner"
```

```
"spinner" | "save"
```

```
"spinner"
```

```
"save"
```

# Possibilities:
# lim n -> ∞...?

# Possibilities:
# 2

# 1.2) Don't spread a choice across multiple values.

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};

function Notification(props: Props): {
  ...
}
```

```
<Notification
  error={true}
>
  This is bad.
</Notification>
```

```
Notification({
   error: true,
   children: [
      "This is bad.",
   ]
})
```

```
<Notification
  error={true}
>
  This is bad.
</Notification>
```

```
<Notification
  error={true}
>
  This is bad.
</Notification>
```

```
<Notification
   success={true}
>
   This is good.
</Notification>
```

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};

function Notification(props: Props): {
  ...
}
```

```
<Notification
   success={true}
   error={true}
>
   This is ... ???
</Notification>
```

```
<Notification
   success={true}
   error={true}
>
   This is ... ???
</Notification>
```

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};

function Notification(props: Props): {
  ...
}
```

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};

function Notification(props: Props): {
  ...
}
```

```
type Props = {
  type: 'success' | 'warning' | 'error',
  ...
};



function Notification(props: Props): {
  ...
}
```

```
<Notification
  type="success"
>
  This is good.
</Notification>
```

```
<Notification
  type="success"
>
  This is good.
</Notification>
```

**Possibilities:**
**(true,true,true + true,true,false + true,false,false + ...)**
**8**

# Possibilities:
# 3

# 1.3) Things that change separately

```
type Props = {
  type: 'success' | 'warning' | 'error',
  dismissable: boolean,
};



function Notification(props: Props): {
  ...
}
```

```
type Props = {
  type: 'success' | 'warning' | 'error',
  dismissable: boolean,
};



function Notification(props: Props): {
  ...
}
```

# 1.4) Convenient types are tempting but can leave gaps.

```
type Props = {
  items: Array<Item>,
};



function Carousel(props: Props): {
  ...
}
```

```
<Carousel
  items=[...]
/>
```

```
<Carousel
  items=[]
/>
```

```
type Props = {
  items: Array<Item>,
};



function Carousel(props: Props): {
  ...
}
```

```
type Props = {
  itemsBefore: Array<Item>
  currentItem: Item,
  itemsAfter: Array<Item>,
};

function Carousel(props: Props): {
  ...
}
```

```
type Props = {
   itemsBefore: Array<Item>
   currentItem: Item,
   itemsAfter: Array<Item>,
};

function Carousel(props: Props): {
   ...
}
```

```
<Carousel
   itemsBefore=[]
   item=...
   itemsAfter=[]
/>
```

```
<Carousel
   itemsBefore=[]
   item=...
   itemsAfter=[]
/>
```

# 1.5) Combining Unions and values that change separately

```
function Example(props: Props): {
  const [isLoading, setLoading] =
    useState(false);
  const [isError, setError] =
    useState(false);
  const [data, setData] =
    useState<string | null>(null);


  ...
}
```

```
type State = {
  isLoading: boolean,
  isError: boolean,
  data: null | string,
}
```

```
type State =
  | { type: 'loading' }
  | { type: 'error' }
  | { type: 'success',
      data: null | string
    }
```

# Possibilities:
# (1 + 1 + (1 x 2))

# Possibilities:
# 4

# Sums
# and
# Products

# Possibilities

# A single possibility is a '1'

(eg. `true`, `5`, `"hi"`, `undefined`)

# Unions are Sums (addition)

Union types represent a group of 'either-or' possibilities.

Total states: add all the possibilities together.

```
type Icon =
    | "spinner"
    | "save"
```

```
type Icon =
    | "spinner"
    | "save"
```

← 1

```
type Icon =
    | "spinner"    ← 1
    | "save"       ← 1
```

```
type Icon =
    | "spinner"    ← 1
    | "save"       ← 1
```

**Possible states for `Icon`**

```
type Icon =
    | "spinner"
    | "save"
```

← 1

← 1

**Possible states for** `Icon`

**= 1 + 1**

```
type Icon =
    | "spinner"
    | "save"
```

← 1

← 1

**Possible states for** `Icon`

**= 1 + 1**

**= 2**

```
type boolean =
   | true          ← 1
   | false         ← 1
```

**Possible states for** `boolean`

**= 1 + 1**

**= 2**

```
type undefined =
  | undefined   ← 1
```

**Possible states for** `undefined`

**= 1**

```
type Icon = 'spinner' | 'save';

function icon(type: Icon): string {
  ...
}
```

# Values that change independently are Products (multiplication)

Total states: multiply the groups of possibilities together.

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};

function Notification(props: Props): {
  ...
}
```

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};
```

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};
```

```
success: true,
warning: false,
error:   false,
```

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};
```

```
success: false,
warning: true,
error:   true,
```

```
type Props = {
  success?: boolean,    success: false,
  warning?: boolean,    warning: false,
  error?:   boolean,    error:   false,
  ...
};
```

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};
```

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};
```

← true + false

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};
```

← 1 + 1

```
type Props = {
  success?: boolean,    ← 1 + 1
  warning?: boolean,    ← 1 + 1
  error?:   boolean,
  ...
};
```

```
type Props = {
  success?: boolean,    ← 1 + 1
  warning?: boolean,    ← 1 + 1
  error?:   boolean,    ← 1 + 1
  ...
};
```

```
type Props = {
  success?: boolean,    ← 1 + 1
  warning?: boolean,    ← 1 + 1
  error?:   boolean,    ← 1 + 1
  ...
};
```

# Possible states for Icon

```
type Props = {
  success?: boolean,    ← 1 + 1
  warning?: boolean,    ← 1 + 1
  error?:   boolean,    ← 1 + 1
  ...
};
```

**Possible states for Icon**

**= (1 + 1) x (1 + 1) x (1 + 1)**

```
type Props = {
  success?: boolean,
  warning?: boolean,
  error?:   boolean,
  ...
};
```

← 1 + 1
← 1 + 1
← 1 + 1

# Possible states for Icon

= (1 + 1) x (1 + 1) x (1 + 1)

= 8

# 2) Exhaustivity

```
type Icon = 'spinner' | 'save';

function icon(type: Icon): string {
  ...
}
```

```
type Icon = 'spinner' | 'save';

function icon(type: Icon): string {
  switch (type) {
    case 'spinner': ...
    case 'save': ...
  }
}
```

```
type Icon = 'spinner' | 'save' | 'ok';

function icon(type: Icon): string {
  switch (type) {
    case 'spinner': ...
    case 'save': ...
  }
}
```

```
type Icon = 'spinner' | 'save' | 'ok';

function icon(type: Icon): string {
  switch (type) {
    case 'spinner': ...
    case 'save': ...
  }
}
```

```
type Icon = 'spinner' | 'save' | 'ok';

function icon(type: Icon): string {
  switch (type) {
    case 'spinner': ...
    case 'save': ...
  }
}
```

```
Function lacks ending
return statement and
return type does not
include 'undefined'.
```

```
type Icon = 'spinner' | 'save' | 'ok';

function icon(type: Icon): string {
  switch (type) {
    case 'spinner': ...
    case 'save': ...
    case 'ok': ...
  }
}
```

```
type Icon = 'spinner' | 'save' | 'ok';

function icon(type: Icon): string {
  switch (type) {
    case 'spinner': ...
    case 'save': ...
    case 'ok': ...
  }
}
```


Dear Kate,
Here's to the crazy ones. The misfits.
The troublemakers. The round pegs in the
holes. The ones who see things differently.
not fond of rules. And they have no respect for the
status quo. You can quote them, disagree with them,
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They push the human race forward. And while some
may see them as the crazy ones, we see genius.
Because the people who are crazy enough to think
they can change the world, are the ones who do.
Take care.
John Appleseed

```
type Icon = 'spinner' | 'save' | 'ok';


function icon(type: Icon): string {
  switch (type) {
    case 'spinner': ...
    case 'save': ...
    case 'ok': ...
  }
}
```

```
type Example = string | boolean;


function example(x: Example): number {
  switch (typeof x) {
    case 'string': ...
    case 'boolean': ...
  }
}
```

```
type Example = string | boolean;


function example(x: Example): number {
  switch (typeof x) {
    case 'string': ...
    case 'boolean': ...
  }
}
```

```
type Example = string | boolean;


function example(x: Example): number {
  switch (typeof x) {
    case 'string': ...
    case 'boolean': ...
  }
}
```

```
type Example = string | Array<string>;


function example(x: Example): number {
  if (typeof x === 'string') {
    ...
  } else if (Array.isArray(x)) {
    ...
  }

}
```

```
type Example = string | Array<string>;


function example(x: Example): number {
  if (typeof x === 'string') {
    ...
  } else if (Array.isArray(x)) {
    ...
  }

}
```

```
type Example = string | Array<string>;


function example(x: Example): number {
  if (typeof x === 'string') {
    ...
  } else if (Array.isArray(x)) {
    ...
  }

}
```

```
Function lacks ending
return statement and
return type does not
include 'undefined'.
```

```ts
type Example = string | Array<string>;


function example(x: Example): number {
  if (typeof x === 'string') {
    ...
  } else if (Array.isArray(x)) {
    ...
  }
  return notExhaustive();
}
```

```
type Example = string | Array<string>;


function example(x: Example): number {
  if (typeof x === 'string') {
    ...
  } else if (Array.isArray(x)) {
    ...
  }
  return notExhaustive();
}
```

```
function notExhaustive(): never {
  throw new Error('Not exhaustive');
}
function example(x: Example): number {
  if (typeof x === 'string') {
    ...
  } else if (Array.isArray(x)) {
    ...
  }
  return notExhaustive();
}
```

# 3) Intentionally-Different Types

# If you mean something different, use a different type.

number

Row ID

Kilogram

Count

number

Length (cm)

Currency (AUD)

Currency (JP Yen)

```
async function saveUser(
  id:    string,
  email: string
): Promise<User> {
  ...
}
// ...
await saveUser(id, "a@b.c");
```

```
async function saveUser(
  id:    string,
  email: string
): Promise<User> {
  ...
}
// ...
await saveUser(id, "a@b.c");
```

```
async function saveUser(
  id:    string,
  email: string
): Promise<User> {
  ...
}
// ...
await saveUser(id, "a@b.c");
```

```
async function saveUser(
  id:    string,
  email: string
): Promise<User> {
  ...
}
// ...
await saveUser("a@b.c", id);
```

```
async function saveUser(
  id:    string,
  email: string
): Promise<User> {
  ...
}
// ...
await saveUser(id, "a@b.c");
```

# Method #1: Context

```
async function saveUser(
  id:    string,
  email: string
): Promise<User> {
  ...
}
// ...
await saveUser(id, "a@b.c");
```

```
async function saveUser({ id, email }:{
   id:    string,
   email: string
}): Promise<User> {
   ...
}
// ...
await saveUser({ id, email: "a@b.c"});
```

```
async function saveUser({ id, email }:{
   id:    string,
   email: string
}): Promise<User> {
   ...
}
// ...
await saveUser({ id, email: "a@b.c"});
```

```ts
type User = {
  id:    string,
  email: string,
};

async function saveUser(
  { id, email }: User
): Promise<User> {
  ...
}
```

```
type User = {
  id:    string,
  email: string,
};

async function saveUser(
  { id, email }: User
): Promise<User> {
  ...
}
```

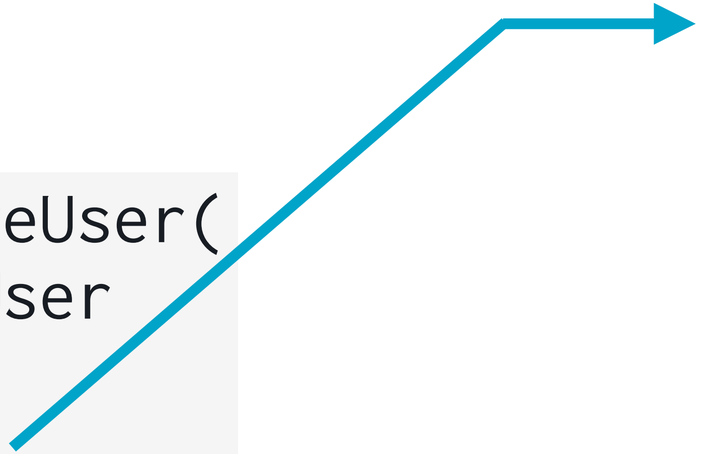
```
async function saveUser(
  { id, email }: User
): Promise<User> {
  ...
}
```

```
async function saveUser(
  { id, email }: User
): Promise<User> {
  ...
}
```

```
function checkId(string) {
  ...
}
```

```
function validEmail(string) {
  ...
}
```

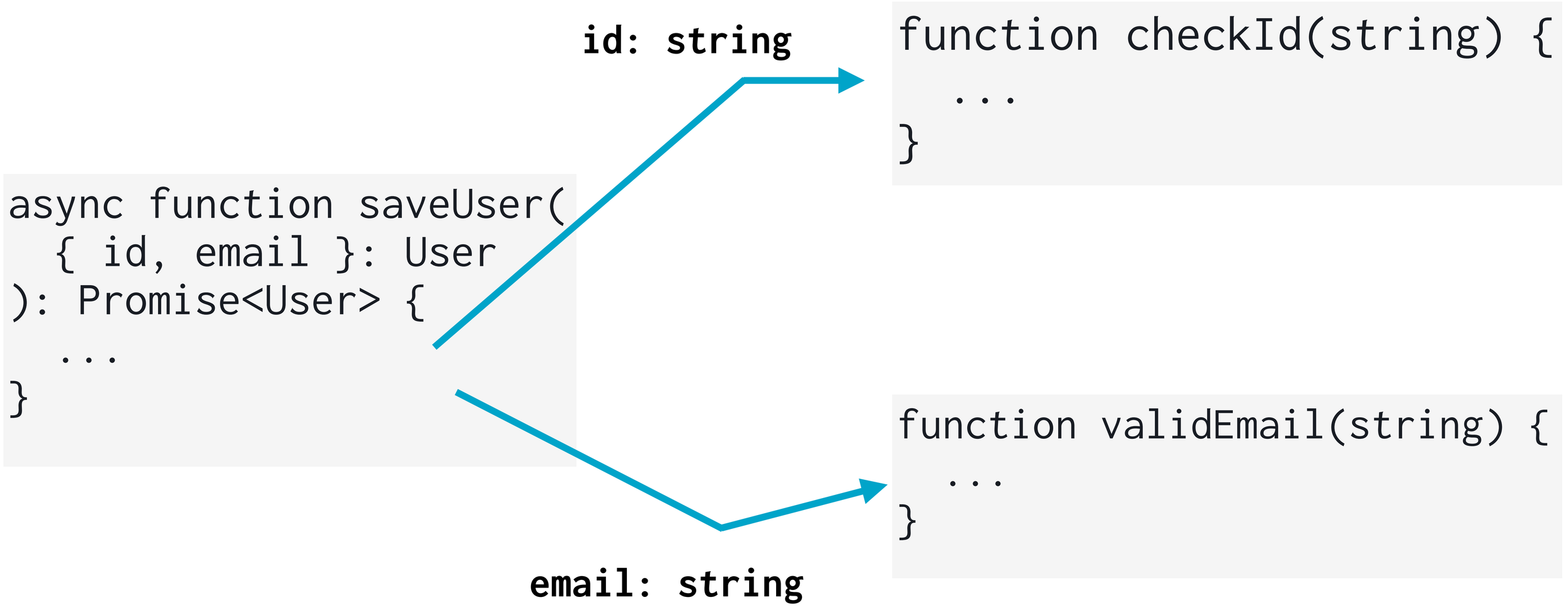
**id: string**



```
async function saveUser(
  { id, email }: User
): Promise<User> {
  ...
}
```

```
function checkId(string) {
  ...
}
```

```
function validEmail(string) {
  ...
}
```


id: string
function checkId(string) {
...
}
async function saveUser(
{ id, email }: User
): Promise<User> {
...
}
function validEmail(string) {
...
}
email: string

# Method #2: Brands

(Opaque/nominal types)

```
type Brand<WrappedType, TypeName> =
  WrappedType & { __brand: TypeName };
```

```
type Brand<WrappedType, TypeName> =
  WrappedType & { __brand: TypeName };

type UserId = Brand<string, 'UserId'>;
```

```
type Brand<WrappedType, TypeName> =
  WrappedType & { __brand: TypeName };

type UserId = Brand<string, 'UserId'>;

const id = '1234-abcd' as UserId;
```

```
type Brand<WrappedType, TypeName> =
  WrappedType & { __brand: TypeName };

type UserId = Brand<string, 'UserId'>;

const id = '1234-abcd' as UserId;
const email = 'a@b.c';
```

```
type Brand<WrappedType, TypeName> =
  WrappedType & { __brand: TypeName };

type UserId = Brand<string, 'UserId'>;

const id = '1234-abcd' as UserId;
const email = 'a@b.c';

expectsUserId(id);
```

```
type Brand<WrappedType, TypeName> =
  WrappedType & { __brand: TypeName };

type UserId = Brand<string, 'UserId'>;

const id = '1234-abcd' as UserId;
const email = 'a@b.c';

expectsUserId(id);
expectsUserId(email);
```

```ts
type Brand<WrappedType, TypeName> =
  WrappedType & { __brand: TypeName };

type UserId = Brand<string, 'UserId'>;

const id = '1234-abcd' as UserId;
const email = 'a@b.c';

expectsUserId(id);    // ✅
expectsUserId(email);
```

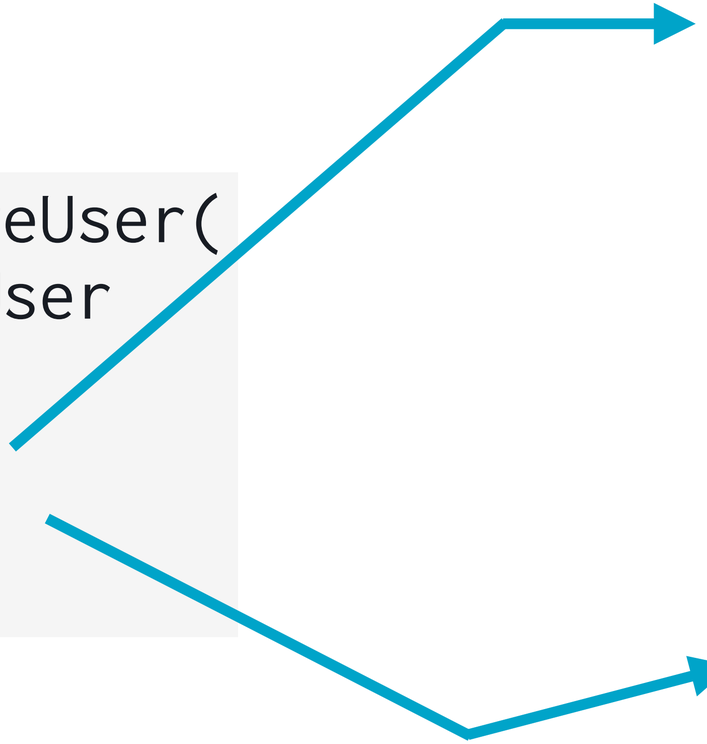
```ts
type Brand<WrappedType, TypeName> =
  WrappedType & { __brand: TypeName };

type UserId = Brand<string, 'UserId'>;

const id = '1234-abcd' as UserId;
const email = 'a@b.c';

expectsUserId(id);    // ✅
expectsUserId(email); // ❌
```

```
stringToUserId(id: string): UserId

userIdToString(id: UserId): string
```

```
type User = {
  id:    UserId,
  email: string,
};

async function saveUser(
  { id, email }: User
): Promise<User> {
  ...
}
```

**id: UserId**

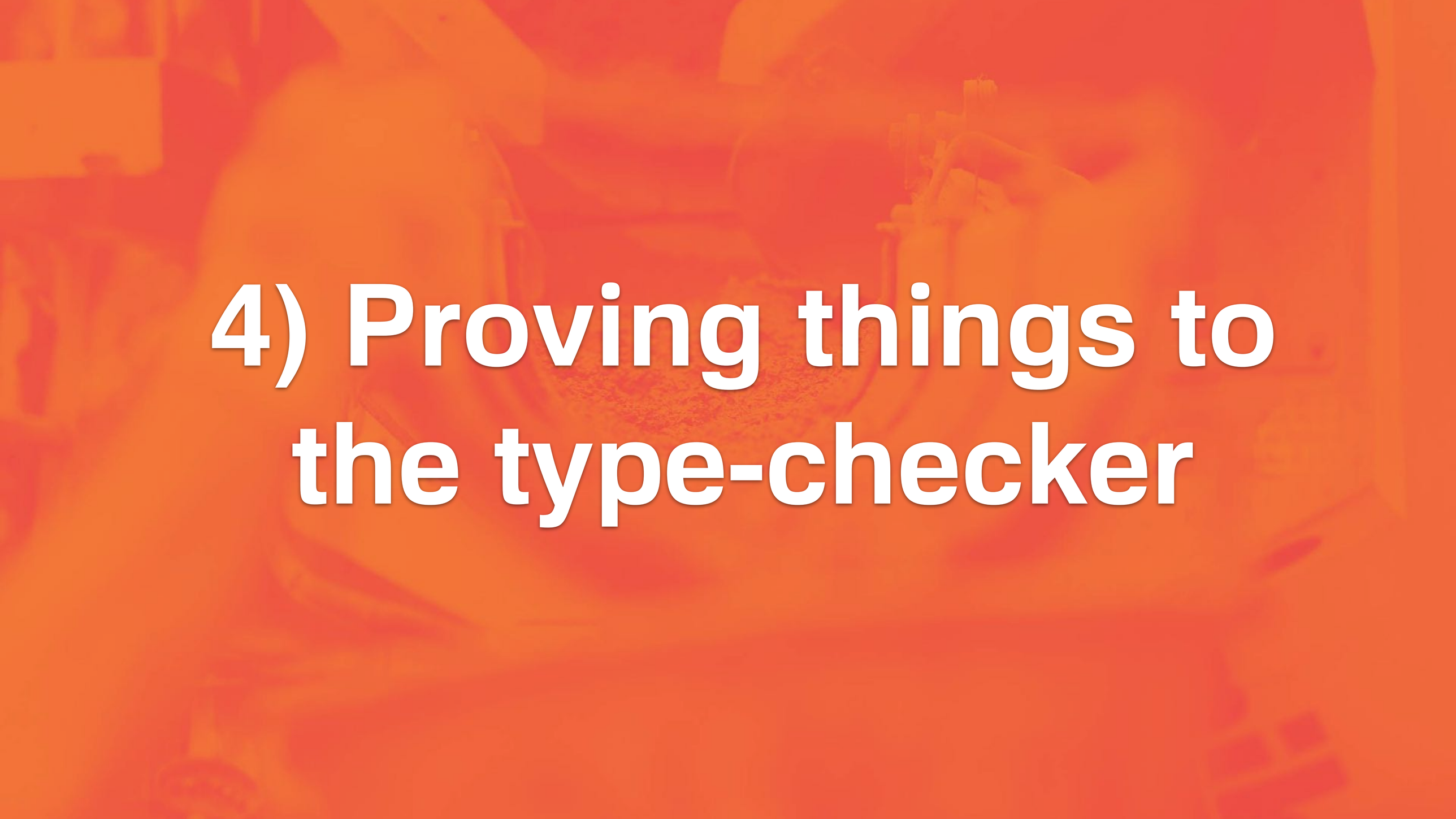
```
async function saveUser(
  { id, email }: User
): Promise<User> {
  ...
}
```



```
function checkId(UserId) {
  ...
}
```

```
function validEmail(string) {
  ...
}
```

**email: string**


4) Proving things to
the type-checker

```
(Array<Thing>) => NonEmptyArray<Thing>
```

unknown => known

(implicitly: … or throw an error)

```
function messageFromApi(
  raw: unknown
): { message: string } {
  if (typeof raw == 'object' && raw != ...) {
    return ...;
  }
}
```

```
import * as t from 'io-ts';

const User = t.type({
  id: t.string,
  email: t.string,
});

// Validation succeeded
User.decode(JSON.parse('{"id":1,"email":"g@z.com"}'));
  // => Right({ id: 1, name: "g@z.com" })

// Validation failed
User.decode(JSON.parse('{"email":"g@z.com"}'));
  // => Left([...])
```

# 5) Lightning Round of Odd Tips

# --strict

# **Avoid** enum

```
enum MyEnum {
   a = 1,
   b = 2,
}
function fun(en: MyEnum) {
   // ...
}

fun(666); // no error
```

https://twitter.com/GiulioCanti/status/1105873882882412545

# readonly & ReadOnly<...>

```
type User = {...};

type NewUser =
  Exclude<Post, 'id'>;
```

https://www.typescriptlang.org/docs/handbook/utility-types.html

# `type` **vs** `interface`

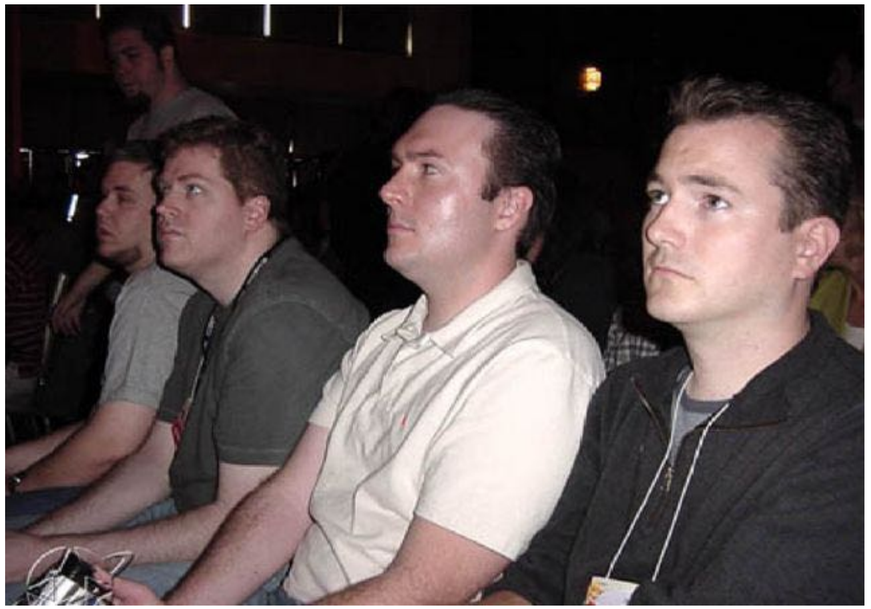
https://medium.com/@martin_hotell/interface-vs-type-alias-in-typescript-2-7-2a8f1777af4c

`interface`

`type`

interface

type



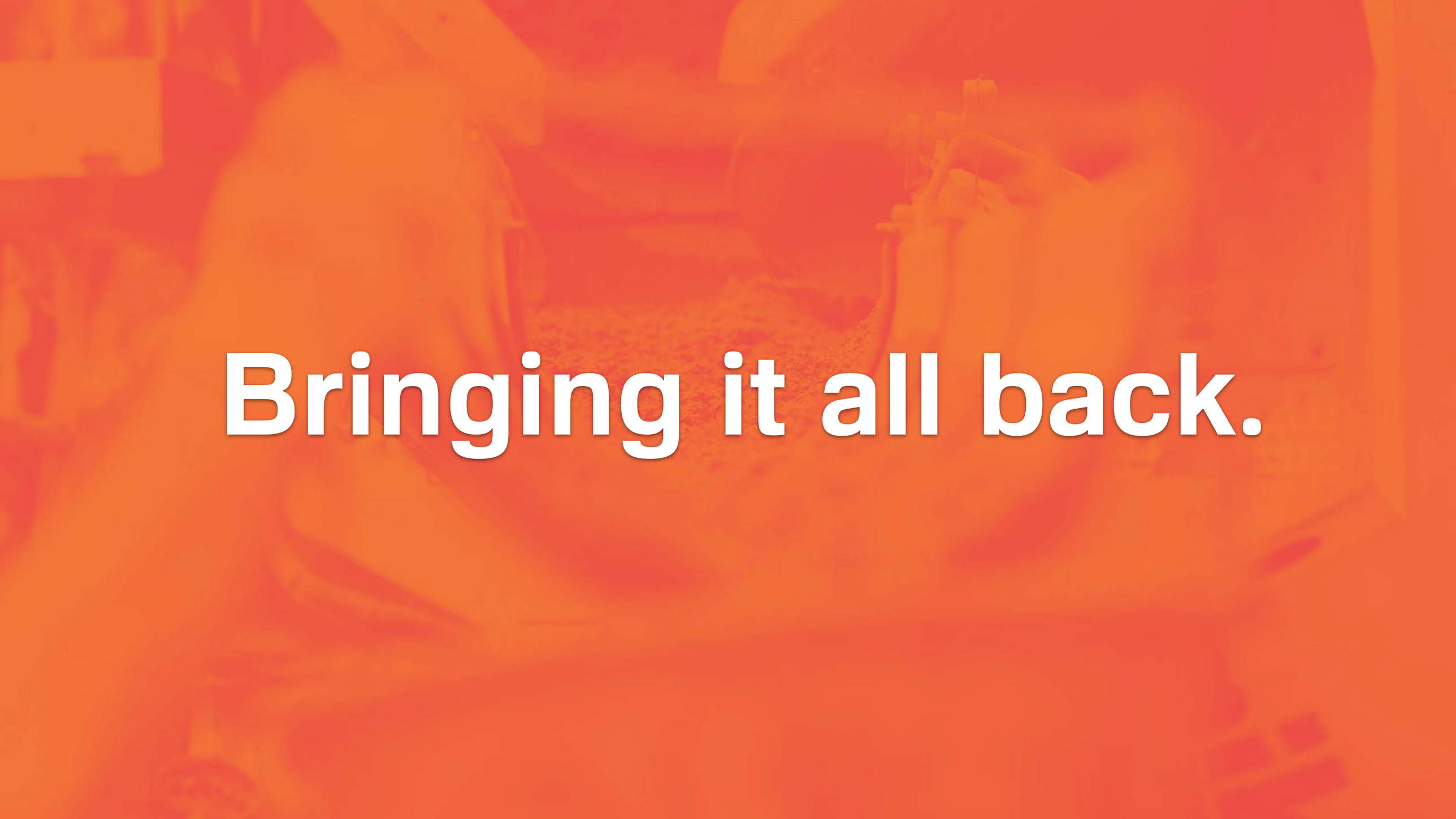
`any`

**vs**

`mixed / unknown`

**vs**

**type variables (generics)**


Bringing it all back.

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- 'Prove' things to the type checker so that it can do work for you.
- don't use `enum`s, please

# Better TypeScript Types

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- https://michalzalecki.com/nominal-typing-in-typescript/
- https://www.typescriptlang.org/docs/handbook/utility-types.html
- https://dev.to/busypeoples/notes-on-typescript-pick-exclude-and-higher-order-components-40cp
- https://medium.com/@martin_hotell/interface-vs-type-alias-in-typescript-2-7-2a8f1777af4c
- https://mariusschulz.com/blog/typescript-3-0-the-unknown-type
- https://gcanti.github.io/io-ts/
- https://basarat.gitbooks.io/typescript/