

# CS 4530: Fundamentals of Software Engineering

## Module 3.1: Trusting TypeScript (or not!)

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When Have I Written  
Enough Tests?

# When Have I Written Enough Tests?

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- When I've described the valid inputs
- When I've tested all the code
- When the tests will catch bugs

# Learning Goals for this Lesson

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At the end of this lesson, you should be able to

- Explain how TypeScript types and documented preconditions influence what tests you need to write
- Explain the difference between the **any** vs **unknown** types in TypeScript

# What Inputs Should We Test?

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What input values do I need to test this function on?

- Edge cases (definitely 0)
- Probably 1 and some larger number? But most numbers  $> 1$  are kind of interchangeable.
- What about -3? 1.4? NaN? `null`? `{ lol: 'owned' }` ?

```
/**
 * Prints "hello" repeatedly
 *
 * @param numHellos - number of times to print "hello",
 *   must be an integer  $\geq 0$ 
 */
function helloNTimes(numHellos: number) {
  for (let i = numHellos; i !== 0; i--) { console.log('hello'); }
}
```

# For Unit Testing, Tests Inputs Should Respect a Function's Contracts

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- **Unit Tests:** testing a single function in isolation
  - Unit testing only needs to give a function tests that respect the functions preconditions: no need to test -3 or 1.4
- **Integration Tests** test how parts of a program work together: that's where we ensure *other* functions of the respect our function's contracts.

```
/**
 * Prints "hello" repeatedly
 *
 * @param numHellos - number of times to print "hello",
 *   must be an integer >= 0
 */
function helloNTimes(numHellos: number) {
  for (let i = numHellos; i !== 0; i--) { console.log('hello'); }
}
```

# TypeScript Types Are Easily Circumvented (1)

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- In a language like Java, we'd need to worry that another function could call `helloNTimes` with -3, but not with a string or `null`.
- That's not true in TypeScript, and that can be surprising.

```
/**
 * Prints "hello" repeatedly
 *
 * @param numHellos - number of times to print "hello",
 *   must be an integer >= 0
 */
function helloNTimes(numHellos: number) {
  for (let i = numHellos; i !== 0; i--) { console.log('hello'); }
}
```

# TypeScript Types Are Easily Circumvented (2)

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- In a language like Java, we'd need to worry that another function could call `helloNTimes` with `-3`, but not with a string or `null`.
- That's not true in TypeScript, and that can be surprising.
- TypeScript types are, at the end of the day, no better than preconditions mentioned in comments.

```
helloNTimes({ lol: 'owned ' } as unknown as number)
```

- They do seem to make it less likely you'll screw up *accidentally...*, and ESLint + TypeScript work together to do even more



# What Trusting Contracts Looks Like

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```
/**
 * Adds a message to a chat, updating the chat
 *
 * @param chatId - Ostensible chat id
 * @param user - Authenticated user
 * @param messageId - Valid message id
 * @returns the updated chat info object
 * @throws if the chat id is not valid
 */
export function addMessageToChat(
  chatId: string,
  user: UserWithId,
  messageId: string
): ChatInfo {
```

# Untrusted Inputs Are Unpredictable

Any input given to a web app can also be given by other means...

## Log into GameNite

☒ Show Password

local server / strategy.town

POST https://strategy.town/api/user/signup

Send

Docs Params Auth Headers (8) Body Scripts Settings

raw JSON

Schema Beautify

```
1 {
2   "username": "trugamer",
3   "password": "Hunter2"
4 }
```

Body 200 OK • 279 ms • 723 B • Save Response

JSON Preview Visualize

```
1 {
2   "username": "trugamer",
3   "display": "trugamer",
4   "createdAt": "2025-12-30T21:57:39.500Z"
5 }
```

```
curl https://strategy.town/api/user/signup -H 'Content-Type: application/json' \
  --data '{ "username": "trugamer", "password": "Hunter2" }'
```

# Untrusted Inputs Should Be **unknown**

- The appropriate TypeScript type for an unknown value is unknown

```
function lookAtMe(input: unknown) {  
  console.log(input.toUpperCase());  
  if (typeof input === "string") {  
    console.log(input.toUpperCase());  
  }  
}
```



TypeScript error here!



it's ok here!

- If you use the **any** type instead, TypeScript will just say “ok, I guess you know what you’re doing”

# Untrusted Inputs Should be “unknown”

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This can get complicated fast...

```
type Auth = { username: string, password: string }
```

```
function useAuth(x: unknown) {  
  if (  
    (typeof x === 'object' && x !== null) &&  
    ('username' in x && typeof x.username === 'string') &&  
    ('password' in x && typeof x.password === 'string')  
  ) {  
    const auth: Auth = { username: x.username, password: x.password };  
    // write the code you care about here!  
  }  
}
```

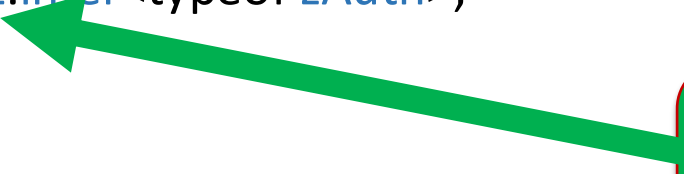
# Libraries Make Checking Types Easier

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*Zod* is a library that makes testing the structure of inputs less tedious and error-prone.

```
import { z } from 'zod';
```

```
const zAuth = z.object({ username: z.string(), password: z.string() });  
type Auth = z.infer<typeof zAuth>;
```



```
type Auth = {  
  username: string;  
  password: string;  
}
```

```
// { success: false }  
console.log(zAuth.safeParse({ username: 4, password: null }))  
// { success: true, data: { username: "", password: "" } }  
console.log(zAuth.safeParse({ username: "", password: "" }))
```

# Using “any”: Common, Not Great

```
import express from 'express';
const app = express();
app.use(express.json());
```

Only accept JSON

```
type Auth = { username: string; password: string };
app.post('/', (req, res) => {
  const auth: Auth = req.body;
```

This has type “any” 🤦

```
  if (auth.password !== 'secret') {
    res.status(403).send({ error: 'Wrong password' });
  } else {
    res.send({ message: `WELCOME, ${auth.username.toUpperCase()} ` });
  }
});
```

```
app.listen(8000, () => console.log(`Listening on port 8000`));
```

# Improving This Web Server With Zod

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```
import { z } from 'zod';
import express from 'express';
const app = express();
app.use(express.json());

const zAuth = z.object({ username: z.string(); password: z.string() });
app.post('/', (req, res) => {
  const auth = zAuth.safeParse(req.body);
  if (auth.error) {
    res.status(400).send({ error: 'Unexpected message' });
  } else if (auth.data.password !== 'secret') {
    res.status(403).send({ error: 'Wrong password' });
  } else {
    res.send({ message: `WELCOME, ${auth.data.username.toUpperCase()}` });
  }
});

app.listen(8000, () => console.log(`Listening on port 8000`));
```

# Zod Can Check Even More than TypeScript

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```
const zHelloInput = z.int().gte(0);

/**
 * Prints "hello" repeatedly
 *
 * @param numHellos - number of times to print "hello"
 * @throws if the input is not an integer >= 0
 */
function helloNTimes(numHellos: unknown) {
  const hellos = zHelloInput.parse(numHellos);
  for (let i = hellos; i !== 0; i--) { console.log('hello'); }
}
```



# Review

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- One view of TypeScript is that it's a handy way of documenting, and *imperfectly* checking, the contracts (preconditions and postconditions) of your code
- Do you need to test inputs that violate your contracts? It depends!
- You can never trust that the input to a web server will obey any sort of contract — important to test!