

# **Engaging, Large-Scale Functional Programming Education in Physical and Virtual Space**

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Technical University of Munich

## Challenges

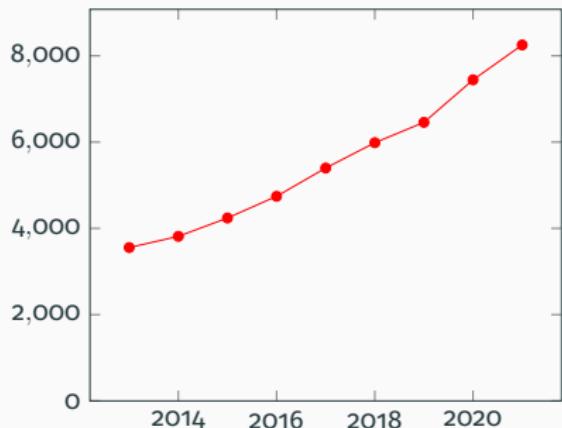
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# Soaring Enrolments

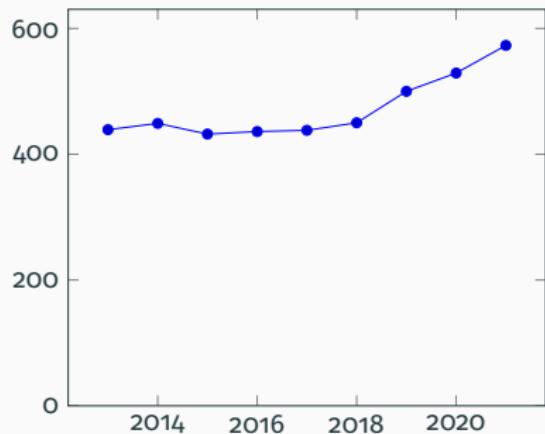
1. Number of Computer Science students exploded

# Soaring Enrolments

Example: Computer Science at TU Munich



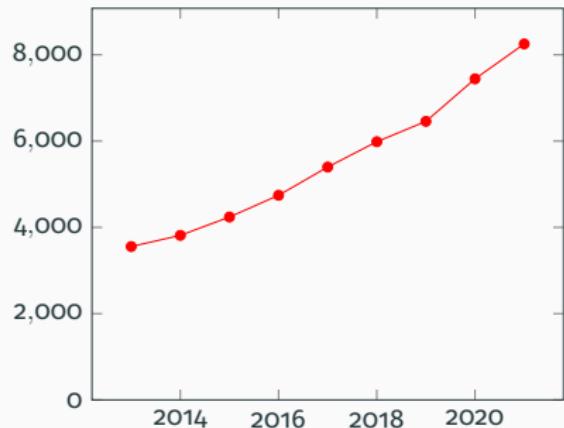
Number of CS students  
(132% increase)



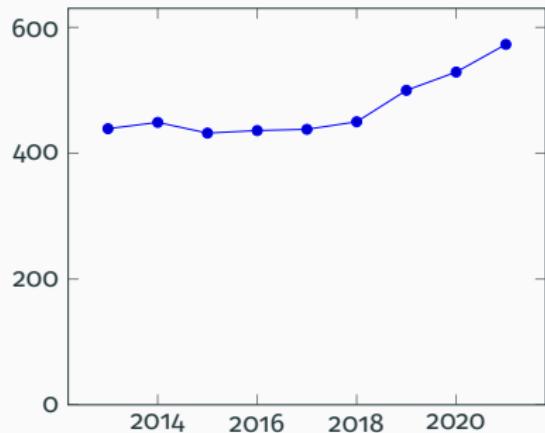
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1000+ students per course are the new normal

# The Pandemic

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2. Radical transition to online classes

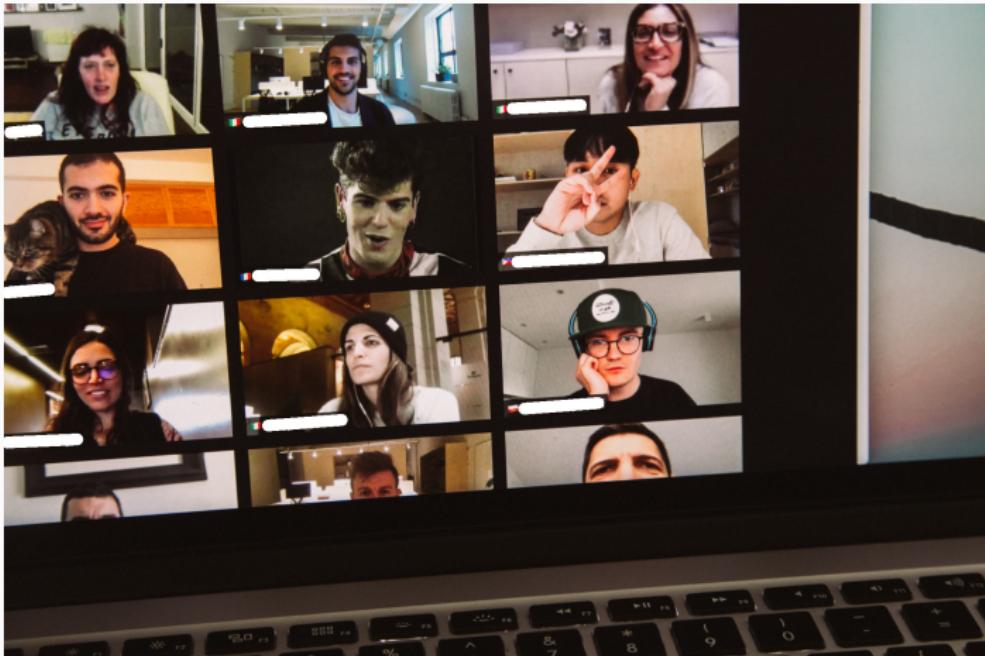
# The Pandemic

How can we go from here...



# The Pandemic

to here...



# The Pandemic

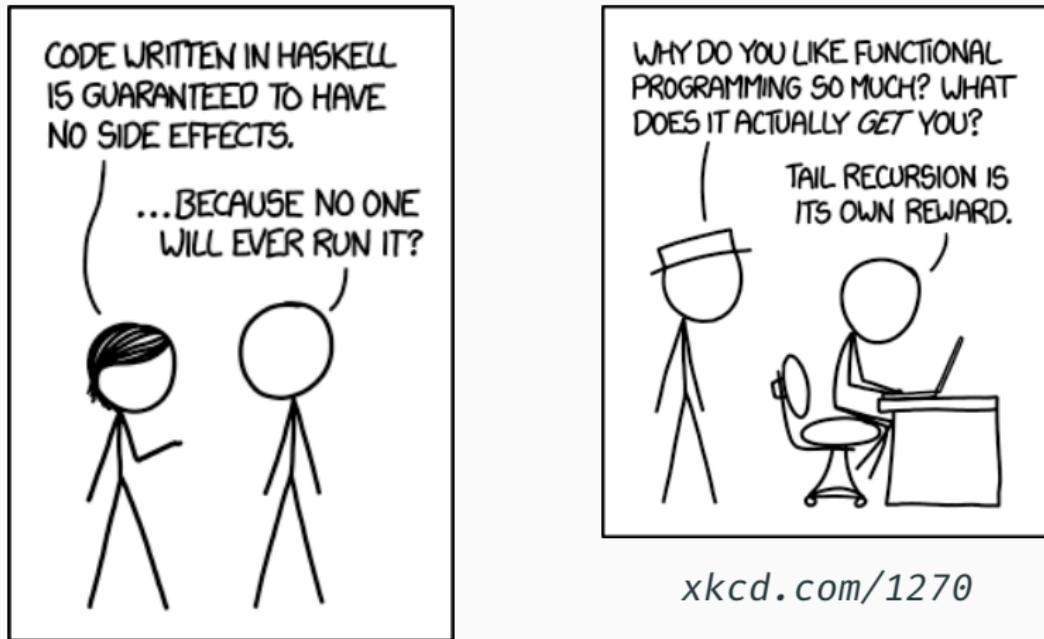
without ending up here?



# Usefulness of Functional Programming

3. Students question the usefulness of functional languages beyond academia

# Usefulness of Functional Programming



xkcd.com/1312

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<https://hub.com/kappelmann/engaging-large-scale-functional-programming>

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Note: We used Haskell, but most ideas apply to any functional programming course

## **Practical Part**

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### **Engagement Mechanisms**

## Grade Bonus

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Result: number of homework submissions severely decreased

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  - Student assistants create engaging exercises instead

## Workshops With Industry Partners

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- Little organisational work

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- Online courses are isolating...  
so let us foster social interaction:
  - Pair-programming in tutorials
  - ACM-ICPC-like programming contest
  - Get-together hangout sessions
  - Award ceremonies

## Competitions

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Code Golf

# Competitions

## Optimization

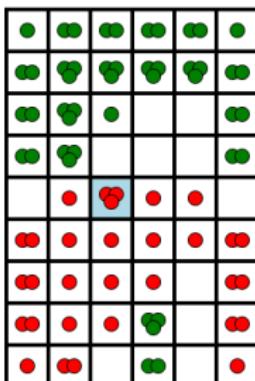
Rank	Name	Time [seconds]
1.	MC Jr	0.02
2.	Florian Hübler	0.13
2.	Luis Bahners	0.19
4.	Tobias Markus	0.35
4.	Robert Imschweiler	0.37
6.	Julian Pritzi	0.76

# Competitions

## Strategy

### 🕹 Tobias Markus vs. Severin Schmidmeier

🏆 Winner: 🟢 Severin Schmidmeier

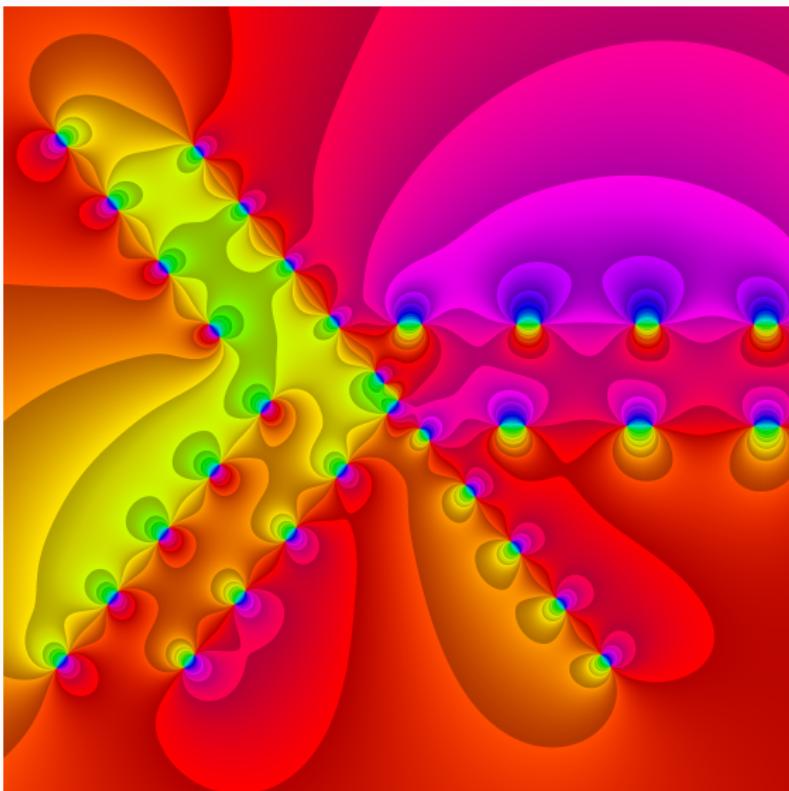


#### 📊 Stats

🔴 Statistic	🔴 Tobias Markus	🟢 Severin Schmidmeier
Moves made	49	49
Orbs captured	40	89
Capture/loss ratio	0.4494	2.2250

# Competitions

Creativity



# Competitions

## Creativity

```
module Exercise_13 where

import Data.Bool (bool)
import Data.Maybe (fromMaybe)
import Data.List (stripPrefix, isPrefixOf, findIndex, genericIndex)
import Data.Char (ord)
import Data.Word (Word8)
import qualified Data.ByteString as B
import Transform

animate :: [(String, Transform -> Transform)] -> String -> [String]
animate a s = map svg $ scanl (flip applyAnim) (parseInput s) $ map (:) a

paint :: String -> String
paint = svg . parseInput
```

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- Diverse, weekly competition exercises
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*but it is very time-consuming.*

## **Check Your Proof**

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## CYP In A Nutshell

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- Provides instant feedback
- Integrates with Tasty

## Background Theory

```
data List a = [] | a : List a
```

```
[] ++ ys = ys
```

```
(x : xs) ++ ys = x : (xs ++ ys)
```

```
goal xs ++ (ys ++ zs) .=. (xs ++ ys) ++ zs
```

## The [ ] Case

Lemma:  $xs \text{ ++ } (ys \text{ ++ } zs) \text{ .=} (xs \text{ ++ } ys) \text{ ++ } zs$

Proof by induction on **List** xs

Case []

To show:  $[] \text{ ++ } (ys \text{ ++ } zs) \text{ .=} ([] \text{ ++ } ys) \text{ ++ } zs$

Proof

$$[] \text{ ++ } (ys \text{ ++ } zs)$$

(by def ++)  $\text{.}=.$   $ys \text{ ++ } zs$

(by def ++)  $\text{.}=.$   $([] \text{ ++ } ys) \text{ ++ } zs$

QED

# The Cons Case

Case  $x : xs$

To show:  $(x : xs) ++ (ys ++ zs)$

$\therefore=.$   $((x : xs) ++ ys) ++ zs$

IH:  $xs ++ (ys ++ zs) \therefore=.$   $(xs ++ ys) ++ zs$

Proof

$(x : xs) ++ (ys ++ zs)$

(by def  $++$ )  $\therefore=.$   $x : (xs ++ (ys ++ zs))$

(by IH)  $\therefore=.$   $x : ((xs ++ ys) ++ zs)$

$((x : xs) ++ ys) ++ zs$

(by def  $++$ )  $\therefore=.$   $(x : (xs ++ ys)) ++ zs$

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QED

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## Our Experience With CYP

- Student feedback 18 positive, 3 negative

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- Student feedback 18 positive, 3 negative
- Main criticism: lack of documentation
- Mostly well-structured inductive proofs in the exam

# Find more in our repository!

- IO mocking framework
- ACM-ICPC-like programming contest framework
- A music synthesiser
- More engagement mechanisms and insights, our technical setup,...

*[thub.com/kappelmann/engaging-large-scale-functional-programmi](#)*

## **Future Work**

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# Future Work

Preventing collaboration/cheating



**Any questions?**