How Students Progress Through Functional Programming Assignments

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Introduction

Chuqin Geng, Wenwen Xu, Yingjie Xu, Brigitte Pientka, and Xujie Si. Identifying Different Student Clusters in Functional Programming Assignments: From Quick Learners to Struggling Students. (SIGCSE 2023)

- Grade is usually considered a key measure of how well a student is doing.
- Can be misleading - especially with access to autograders.
- By considering other features, like number of static errors, authors identify 4 clusters of students (quick-learning, hardworking, satisficing and struggling).
- Authors analyze how work habits, range of errors and ability to fix errors impact the different student clusters.
- Study provides a nuanced picture of student behaviours.

Introduction

Will Crichton and Shriram Krishnamurthi. Profiling Programming Language Learning. (OOPSLA 2024)

- Gather data to understand what makes language learning difficult.
- Use the data to improve language learning.
- Modify The Rust Programming Language book to include learner profiles and quizzes.
- Provide hints to poorly performed quesitons and check if it improves student performance.
- Most readers drop off after encountering difficult language concepts (Rust Ownership).
- Statistics on questions help instructors identify questions that are too difficult.

Introduction

Chris Kerslake. Stump-the-Teacher: Using Student-generated Examples during Explicit Debugging Instruction (SIGCSE 2024)

- Debugging instruction - often a just-in-time support for specific problems
- 2 classroom activities to introduce explicit debugging instruction:
  1. Students purposefully introduce bugs to working code and teacher shows how to fix (stump the teacher).
  2. Students compare how they would have approached the same scenario.
- Bugs are mostly syntax related.
- Students pick up debugging skills faster.

Objectives

Can we:

- split student submissions by question and analyse the questions separately?
- establish if students spend more time maximizing their grade or fixing type errors?
- establish what question a student is working on when they make a submission?
- establish when students switch between questions?
- establish when students get stuck and if they get stuck on similar type/logical errors?

Experiment Setup
Data

- Source - Introductory Functional Programming course at McGill University.
- OCaml code from student submission log data: LearnOCaml grade events, compile events and eval events.
- Chuqin et. al. groups students in dataset into 4 categories quick learning, hardworking, satisficing and struggling.
- Our work builds on this prior classification and does a **question-by-question** analysis on the different categories.

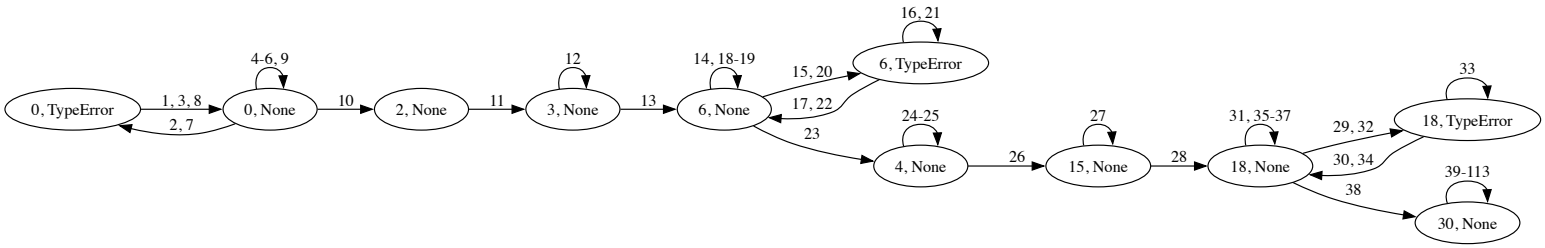
Experiment Setup
Data Preprocessing - Question Split

- Split student submissions by question using OCaml compiler libs.
- Leave out tests in the question split - studies show students tend not to use test driven development.
- Grade questions individually and record type errors, grade, submission time and code included in the submission.
- Using data from the grading we build state machines which we perform analysis on.

Experiment Setup
State Machines

- Combine eval, compile and grade events chronologically.
- Only take unique events into consideration: use unix diff to check if the code is the same between 2 submissions.
- Type error states take the same grade as the last well typed state before the error occurs.
- Each node has the grade and whether the code is well typed or ill-typed.

State Machine Example



Ratio	Entire State Machine	First 3/4	Last 1/4
WT/IT	2.66	4	2
LE/IT	2.3	3	1

Figure: Comparison of different ratios

WT - Well Typed (includes 100% grade) IT - Ill Typed

LE - Logical Error (doesn't include 100% grade)

Conclusion

Through further analysis we aim to test more hypotheses:

- Students struggle with similar type errors.
- Students struggle with type errors throughout the development of their solution to homework problems.

THANK YOU!