Using Large Language Models to Automatically Identify Programming Concepts in Code Snippets

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ABSTRACT

Curating course material that aligns with students' learning goals is a challenging and time-consuming task that instructors undergo when preparing their curricula. For instance, it is a challenge to find multiple-choice questions or example codes that demonstrate recursion in an unlabeled question bank or repository. Recently, Large Language Models (LLMs) have demonstrated the capability to generate high-quality learning materials at scale. In this poster, we use LLMs to identify programming concepts found within code snippets, allowing instructors to quickly curate their course materials. We compare programming concepts generated by LLMs with concepts generated by experts to see the extent to which they agree. The agreement was calculated using Cohen's Kappa.

CCS CONCEPTS

• **Social and professional topics** → *Computing education*; • **Computing methodologies** → *Natural language generation.*

KEYWORDS

large language models, explanations, computer science education

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1 INTRODUCTION

Instructors face a sense-making challenge when trying to curate learning material for their courses [2]. To explore the potential for generating programming concepts found within code snippets, we expand on recent work using LLMs to generate learning material [1, 3, 6–9], such as programming assignments [1, 9] and explanations [3, 4, 6, 8].

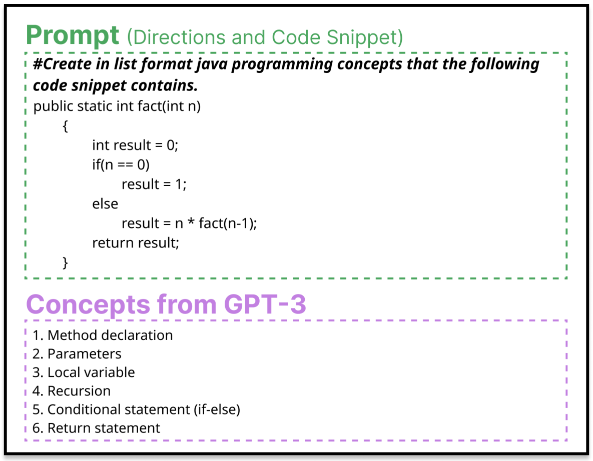
1.1 Methodology

We constructed a text corpus by randomly selecting 10 code examples from 10 Introduction to Java e-books, resulting in 100 code examples. We randomly sampled 50 of these examples from our text corpus for analysis. We then collect human-generated lists of programming concepts by having experts annotate the code examples. We report on the agreement between concepts identified by experts and the concepts generated by the LLM (GPT-3) using Cohen's Kappa Calculations (Figure 2).

2 DISCUSSION

2.1 Implications for the CS Classroom

Instructors may use LLMs to curate their course material and identify relevant course conceptsConcurrently, instructors would be able to identify missing material and close knowledge gaps.



#Create in list format java programming concepts that the following code snippet contains.

```
public static int fact(int n)
    {
        int result = 0;
        if(n == 0)
            result = 1;
        else
            result = n * fact(n-1);
        return result;
    }
```

1. Method declaration
2. Parameters
3. Local variable
4. Recursion
5. Conditional statement (if-else)
6. Return statement

Figure 1: Prompt, Code Snippet, and LLM-generated Concepts

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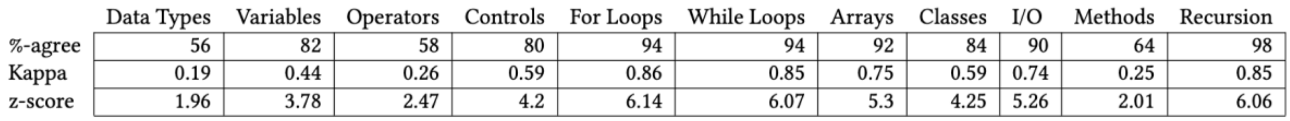

	Data Types	Variables	Operators	Controls	For Loops	While Loops	Arrays	Classes	I/O	Methods	Recursion
%-agree	56	82	58	80	94	94	92	84	90	64	98
Kappa	0.19	0.44	0.26	0.59	0.86	0.85	0.75	0.59	0.74	0.25	0.85
z-score	1.96	3.78	2.47	4.2	6.14	6.07	5.3	4.25	5.26	2.01	6.06

Figure 2: Results from Cohen's Kappa tests between LLM and Experts across 11 Introduction to Java concepts.

2.2 Implications for Students' Metacognition

Identifying programming concepts found in code may encourage students to think explicitly about the concepts they are learning and make connections between concepts and tangible examples. This explicit labeling may provide students with a *framework for monitoring* [5, 10] their learning.

3 CONCLUSION

Our poster presentation will include various examples of LLM-generated code snippets and concept lists. We will discuss cases where LLMs struggled to produce the correct concept. Future work will investigate the potential for automatically annotating code examples found in the wild. We hypothesize that repeated exposure to code examples labeled with relevant programming concepts may help students develop a familiarity with these concepts and a curiosity to learn more when encountering concepts they don't know. The potential value of these annotations, which may not have previously justified the effort, may become evident when implemented on a large scale.

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