



**CITY UNIVERSITY OF SÃO PAULO
BACHELOR'S DEGREE IN COMPUTER SCIENCE**

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**The Use of Symbolic Artificial Intelligence for Teaching Logic
PROGRAMMING**

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This work was submitted to the University of São Paulo as a requirement for completion of the Computer Science course.

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SUMMARY

This project proposes the development of a symbolic Artificial Intelligence (AI)-based system focused on teaching programming logic to Information Technology (IT) students. The central motivation stems from the observation that many students face difficulties in understanding the fundamental logical concepts that structure programming. The proposed AI will be able to interact with students through natural language, answering questions, explaining concepts, and generating personalized exercises, with the goal of teaching and reinforcing learning. The methodology adopted is based on the principles of symbolic AI, which uses representations through symbols and logical rules to simulate human reasoning. The system will be implemented in Python, although it is inspired by the CLIPS project (*C Language Integrated Product System*) developed in the C programming language, aims to facilitate the understanding of the logical processes involved in programming due to its transparent and explainable approach. Currently, the project is in the planning and theoretical research phase. Expected results include the creation of a functional system with practical applications in educational settings. This work falls under the category of system development and has the potential to make a significant contribution to the teaching of programming logic.

Keywords: symbolic artificial intelligence; programming logic; expert systems; programming education; educational technology.

SUMMARY

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1 INTRODUCTION

Classical artificial intelligence, also known as symbolic AI or rule-based AI, is an approach to artificial intelligence that focuses on representing human knowledge through symbols and logical rules. In this model, knowledge is represented by symbols and the relationships between them, allowing the system to reason and make decisions based on predefined rules. It uses formal logic to infer new information from existing knowledge, being particularly useful for developing systems that can plan sequences of actions to achieve a goal. Therefore, symbolic AI is suitable for tasks that require reasoning about abstract concepts and symbolic knowledge.

So, the problem of knowledge representation is finding an effective way to represent knowledge in a computer in the form of data, to make it automatically usable. One way to classify computational knowledge is through network representations, which is based on the fact that knowledge is part of an interconnected network in our heads. We can reproduce the same network as a graph on a computer, in what is called a semantic network.

As part of this work, one must understand the use and construction of the CLIPS platform. *C Language Integrated Product System*, a declarative programming language developed by NASA, specifically designed for building expert systems. Based on this understanding, our AI will be developed with a focus on teaching programming logic to undergraduate students in IT fields.

2 OBJECTIVES

The objectives that will be presented are:

- 1- Create a Symbolic Artificial Intelligence for the application of teaching programming logic.
- 2- Verify its effectiveness with students who are beginning their undergraduate studies in Computer Science and similar courses.
- 3- Receive feedback from students who used this Artificial Intelligence.

3 METHODOLOGY

This work adopts a system development approach, based on applied research, of a qualitative and exploratory nature. The methodology involves three main stages: theoretical review, system development, and preliminary evaluation.

Theoretical framework: In this stage, a study of the fundamentals of symbolic Artificial Intelligence, programming logic, and expert systems was conducted. The CLIPS platform, a classic reference in the development of rule-based systems, was also analyzed with the aim of understanding its principles and applying them in an educational context.

System Development: The AI will be developed in the Python language, using concepts of symbolic knowledge representation and logical inference. The system's main functionalities will include: interpreting questions in natural language, explaining programming logic concepts, and generating personalized exercises. The structure will be inspired by the CLIPS production mechanisms, adapted for a more accessible approach for students.

Preliminary assessment: After initial implementation, the system will be tested with a small group of undergraduate IT students, preferably at the beginning of their academic training. Students will use the system in simulated teaching situations, and then a questionnaire will be administered to obtain feedback on usability, clarity of explanations, and usefulness in learning.

This approach aims to validate, albeit initially, the potential of symbolic AI as a tool to support the teaching of programming logic. The data collected will be analyzed qualitatively, seeking to identify perceptions and suggestions for improvement.

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