Project Report

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B.Tech AIML

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<u>Basic Information</u>

Title of Project: First-Order Theorem Proving using Classification

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Project Title: First-Order Theorem Proving using Classification

Abstract:

The goal of this project is to create a first-order theorem proving system that will improve logical thinking skills. The objective is to use machine learning techniques to automate the process of proving logical theorems. The system employs various algorithms to a set of logical statements as input to produce true conclusions. In order to forecast the results of the theorem, the proposed methodology entails dataset preparation, pre-processing, feature extraction, and the use of regression models. The findings and discussions highlight the effectiveness of various regression models and provide light on the reliability of theorem proving. In order to improve the system, conclusions are made and suggested future work directions are made.

Keywords:

First-order theorem proving, Logical reasoning, Machine learning, Regression models, Dataset preparation.

Introduction:

In many fields, such as mathematics, computer science, and artificial intelligence, logical thinking is crucial. A strong tool for expressing logical arguments and generating conclusions based on predetermined axioms and rules is first-order logic. However, it can be time-consuming and error-prone to manually prove difficult theorems. Automated theorem proving systems have been created as a solution to this problem. By utilising machine learning approaches, this initiative intends to advance first-order theorem proving.

Proposed Methodology:

In this section, we present the proposed methodology for first-order theorem proving, along with a pictorial diagram and explanations of each sub-module.

1. Datasets:

The gathering and preparation of datasets represents the initial stage of the methodology. The datasets are made up of axioms, rules, and logical assertions that represent various logical reasoning domains. The regression models used in the theorem proving system are trained and evaluated using these datasets.

2. Pre-processing:

After the datasets are gathered, pre-processing procedures are used to guarantee the accuracy of the data and its suitability for the regression models. Scaling features, encoding categorical variables, and handling missing values are all included in this. The goal of pre-processing is to convert the raw datasets into a format that will work for additional analysis and model training.

3. Feature Extraction:

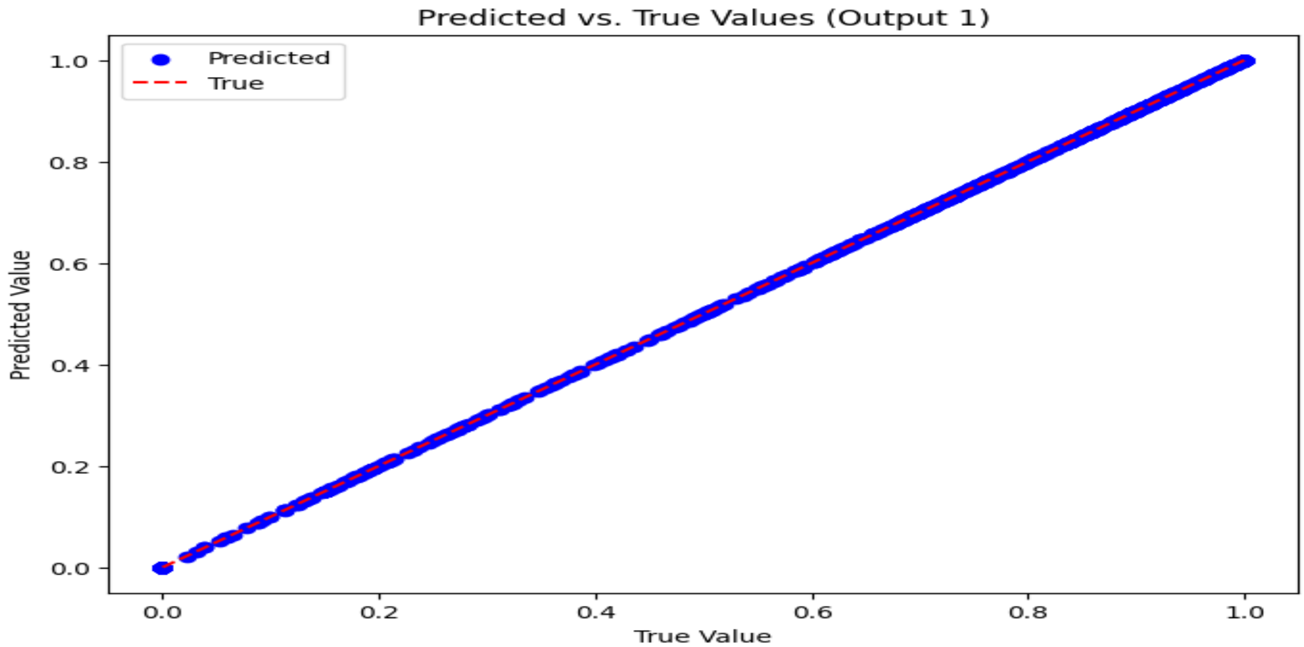
Feature extraction techniques are used to convey the axioms and logical assertions in a format appropriate for regression models. These methods translate logical claims into numerical summaries that contain the necessary data for theorem proof. For feature extraction, a number of techniques can be investigated, including bag-of-words, term frequency-inverse document frequency (TF-IDF), and semantic embedding.

4. Regression Models:

The regression models used to forecast theorem outcomes form the basis of the first-order theorem proving system. To discover the patterns and links between the logical assertions and their related results, multiple regression models, including Linear Regression, Random Forest Regression, and Support Vector Regression, are used. These models are developed using the provided datasets, and their performance is assessed using suitable metrics.

Pictorial Diagram:

The flow of the suggested approach for proving first-order theorems is shown in the pictorial diagram. It demonstrates the pre-processing, feature extraction, and regression model training procedures that must be taken in order. The dependencies between the sub-modules are highlighted by the arrows, which show how information flows throughout the process.


Predicted vs. True Values (Output 1)
Predicted
True
Predicted Value
True Value
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0.2
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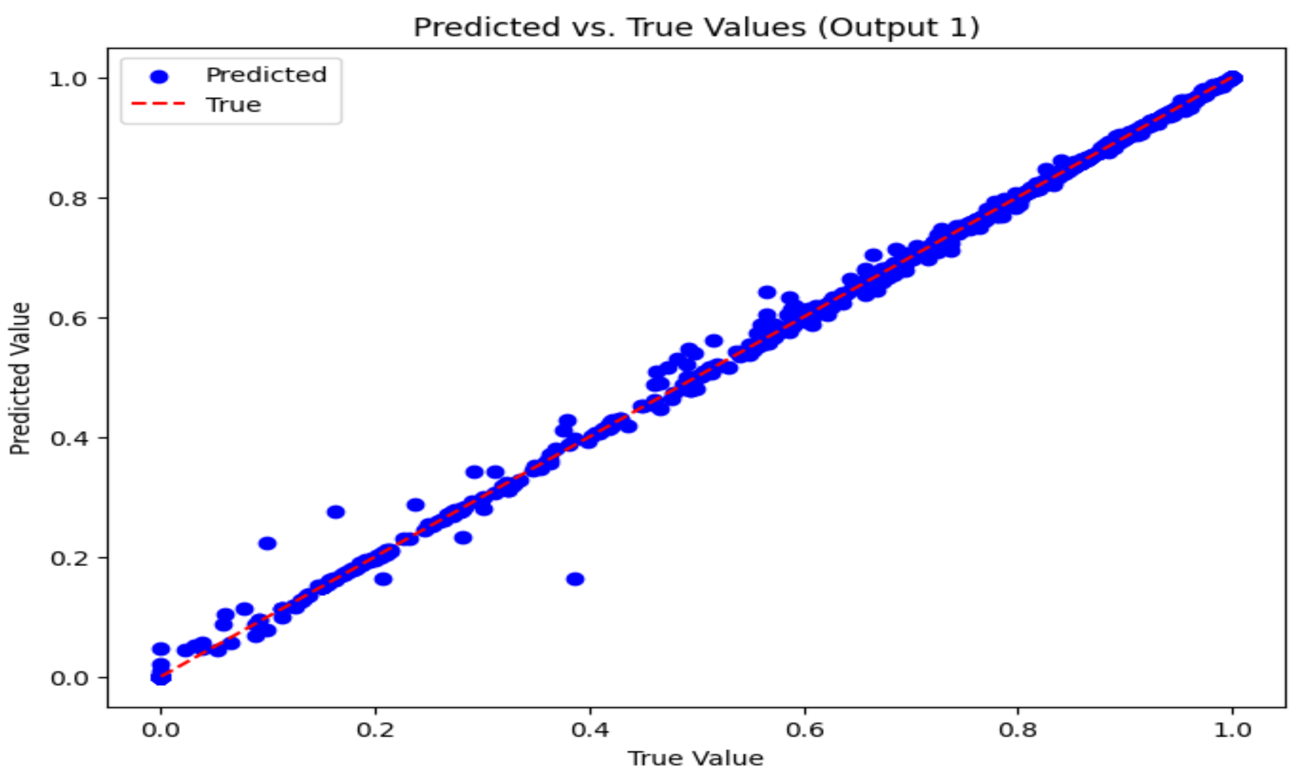
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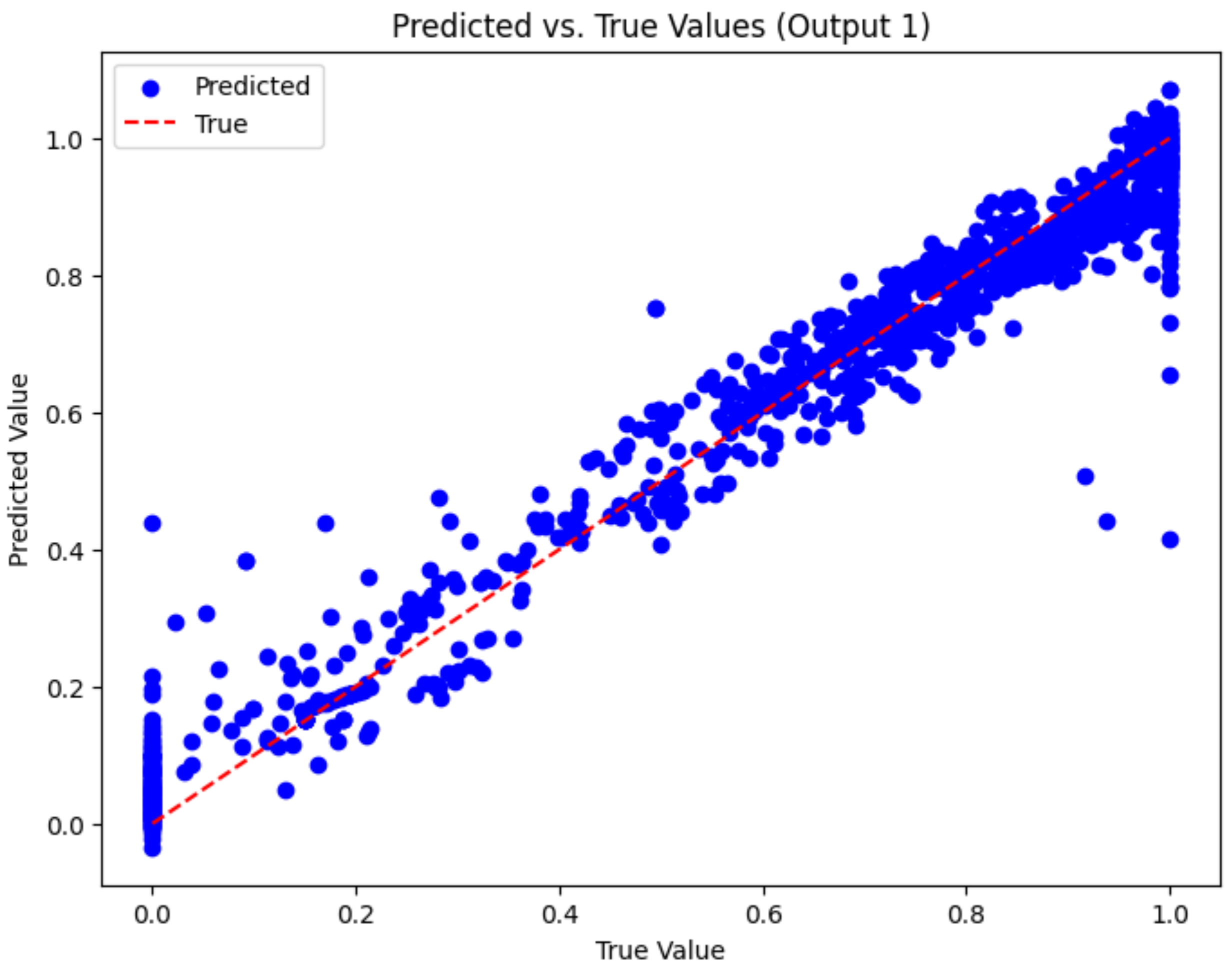

Result & Discussion:

The results and analyses from using the suggested methods to complete the first-order theorem proving challenge are presented in this section. Metrics like mean squared error (MSE) and coefficient of determination (R2) are used to assess each regression model's performance. The outcomes show how well the regression models anticipate the consequences of the theorems. The debate also analyses the effectiveness of various models and sheds light on the approach's advantages and disadvantages.

Conclusion & Future Work:

The methodology for first-order theorem proving utilising machine learning techniques has been proposed in this research, which concludes. In terms of automating logical reasoning and drawing reliable conclusions, the system displayed encouraging results. There is still opportunity for development and additional work, though. Future initiatives could include including expanding the datasets to include more logical domains, using ensemble learning techniques to increase prediction accuracy, and utilising deep learning models for improved feature extraction. The ultimate objective is to build a first-order theorem proving system that is reliable and effective and can contribute to a variety of applications that call for logical reasoning.

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