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A Semantic Analysis-Based Approach for Answer Evaluation

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***Abstract*-In traditional student answer evaluation systems, assessment is primarily based on keyword matching, which often fails to capture the actual meaning and context of a student's response. This leads to inaccurate grading, especially when students express correct answers using different wording. This paper proposes a semantic analysis–based approach for evaluating descriptive answers by understanding contextual meaning rather than relying solely on exact keywords. The proposed system utilizes natural language processing techniques to analyze the similarity between student responses and reference answers at a semantic level. It compares keyword-based evaluation with semantic-based evaluation to highlight the effectiveness of evaluating student responses more accurately. The study demonstrates that semantic analysis provides a more accurate and fair assessment by recognizing synonymous expressions and contextual relevance.**

***Keywords*—Semantic Analysis, Natural Language Processing (NLP), Automated Answer Evaluation, Semantic Similarity, Keyword Matching, Deep Learning.**

I. INTRODUCTION

In the field of education, evaluating student answers accurately is both important and tedious. Traditional evaluation methods, especially in automated systems, mainly rely on keyword-matching techniques. These systems check whether specific words are present in a student's answer and assign marks accordingly. However, this approach has several limitations, as it does not consider the actual meaning or context of the response.

Students often express the same idea using different words or sentence structures. For example, one student may write, *"Plants make food using sunlight,"* while another may write, *"Photosynthesis helps plants produce energy."* Although both answers convey similar meanings, a keyword-based system may fail to recognize them as equivalent.

Let us consider another example: one student may write, *"Plants make their own food,"* while another may write, *"Plants do not make their own food."* In this case, if evaluation is based only on keyword matching, both answers may receive similar marks, even though their meanings are completely different. This leads to unfair evaluation and inaccurate scoring.

Semantic analysis, a branch of natural language processing (NLP), focuses on understanding the meaning of text rather than just individual words. By analyzing context, relationships between words, and overall sentence meaning, semantic techniques can provide a more accurate evaluation of student responses.

This paper proposes a semantic analysis–based approach for student answer evaluation. The aim is to compare traditional keyword-based methods with semantic-based methods and demonstrate how semantic analysis improves accuracy, flexibility, and fairness in grading. The proposed approach can be useful in

developing intelligent educational systems that better understand student responses.

sentence structures and deep context they carry.

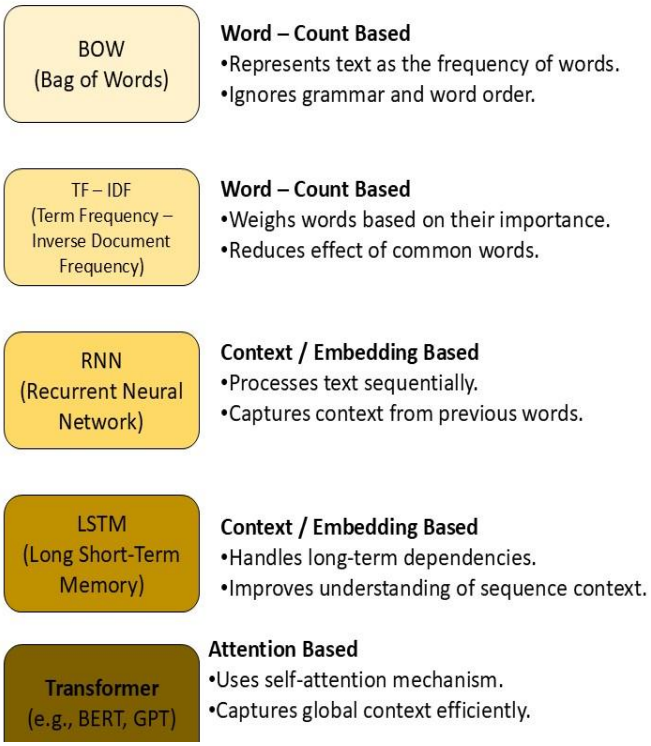

Figure 1 Evolution of Techniques in Semantic Analysis for Text Understanding

II. LITERATURE REVIEW

Several research studies have explored the use of semantic analysis in Natural Language Processing(NLP) for improving text understanding. Early approaches such as keyword matching and rule-based systems were simple to implement but they lacked the ability to understand the context as well as meaning. These methods often resulted in inaccurate outcome(marks) when different words were used to express the same idea or the answer.

To overcome these limitations, researchers introduced statistical methods like Latent Semantic Analysis (LSA), which analyze relationships between words and documents. These techniques enhanced the ability of systems to capture hidden meanings in text. However, they still faced challenges in understanding complex

With the advancement of machine learning, more sophisticated/advancced models such as word embeddings (Word2Vec, GloVe) were developed. These models represent words in vector form, allowing systems to measure similarity between different terms based on their meaning. This significantly improved semantic understanding compared to traditional methods.

In recent years, deep learning models such as BERT and transformer-based architectures have further enhanced semantic analysis. These models consider the context of words within a sentence, enabling better understanding of meaning and relationships. They have shown strong performance in various NLP tasks, including text classification, question answering, and semantic similarity.

Despite these advancements, many existing student evaluation systems still

rely on basic keyword matching techniques. The study highlights the need for integrating modern semantic analysis approaches into educational systems to improve answer evaluation.

III. METHODOLOGY

The proposed system is designed to evaluate student answers using a combination of keyword matching and semantic analysis techniques. The entire process consists of multiple steps which includes data input, preprocessing, keyword evaluation, semantic similarity analysis, and final scoring.

In the first stage, the system takes two inputs: the reference answer provided by the teacher(the answer key) and the student's response. Both texts are then preprocessed by converting them into lowercase, removing stopwords, and eliminating unnecessary symbols and punctuations to ensure uniformity and remove ambiguity.

Next, a keyword-based evaluation is performed. Important keywords are extracted from the reference answer, and the system checks their presence in the student's response. A basic score is assigned based on the number of matched keywords.

After this, semantic analysis is applied to understand the meaning of the student's answer. The system uses vector-based representations of text (such as word embeddings or sentence embeddings) to measure the similarity between the student's response and the reference answer. This allows the system to recognize similar meanings even when different words are used.

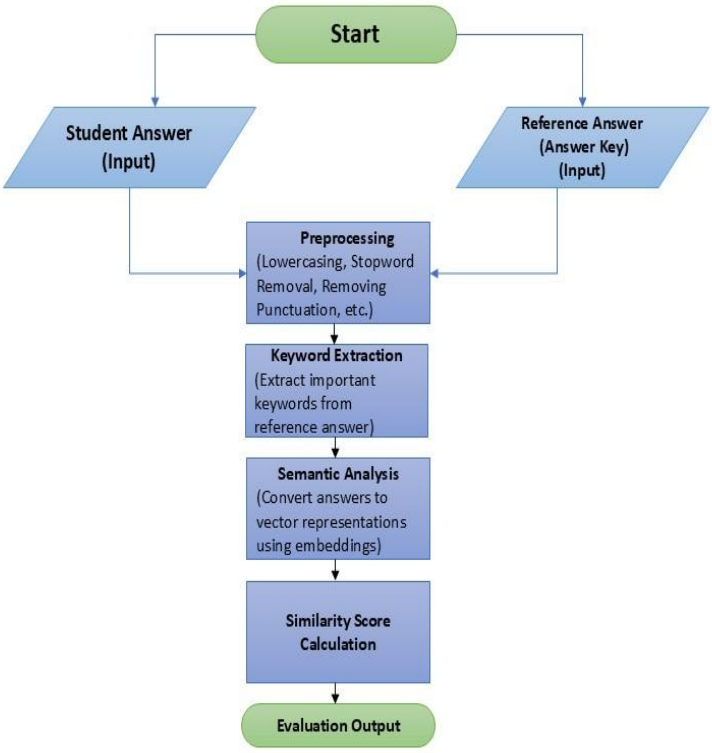

Figure 2. Overview of Semantic Analysis-Based Answer Evaluation Process

IV. RESULTS AND DISCUSSION

The proposed semantic analysis-based system was evaluated by comparing its performance with traditional keyword-based evaluation methods. It was observed that the keyword-based approach works well only when students use exact words from the reference answer. However, it fails to assign proper marks when students express correct answers using different wording. It also fails when student uses same words as per the answer key but different context.

On the other hand, the semantic analysis approach was able to identify similarity in meaning even when different words or sentence structures were used. This resulted in more accurate and fair evaluation of student responses. For example, answers with similar meaning but different phrasing received better scores compared to the keyword-based method.

The hybrid approach, which combines keyword matching and semantic similarity, showed improved performance over both individual methods. It ensures that important terms are considered while also evaluating the overall meaning of the answer.

These results indicate that semantic analysis can significantly enhance automated answer evaluation systems by reducing dependency on exact keywords and improving contextual understanding. The study shows one can rely on semantic analysis for answer sheet evaluation.

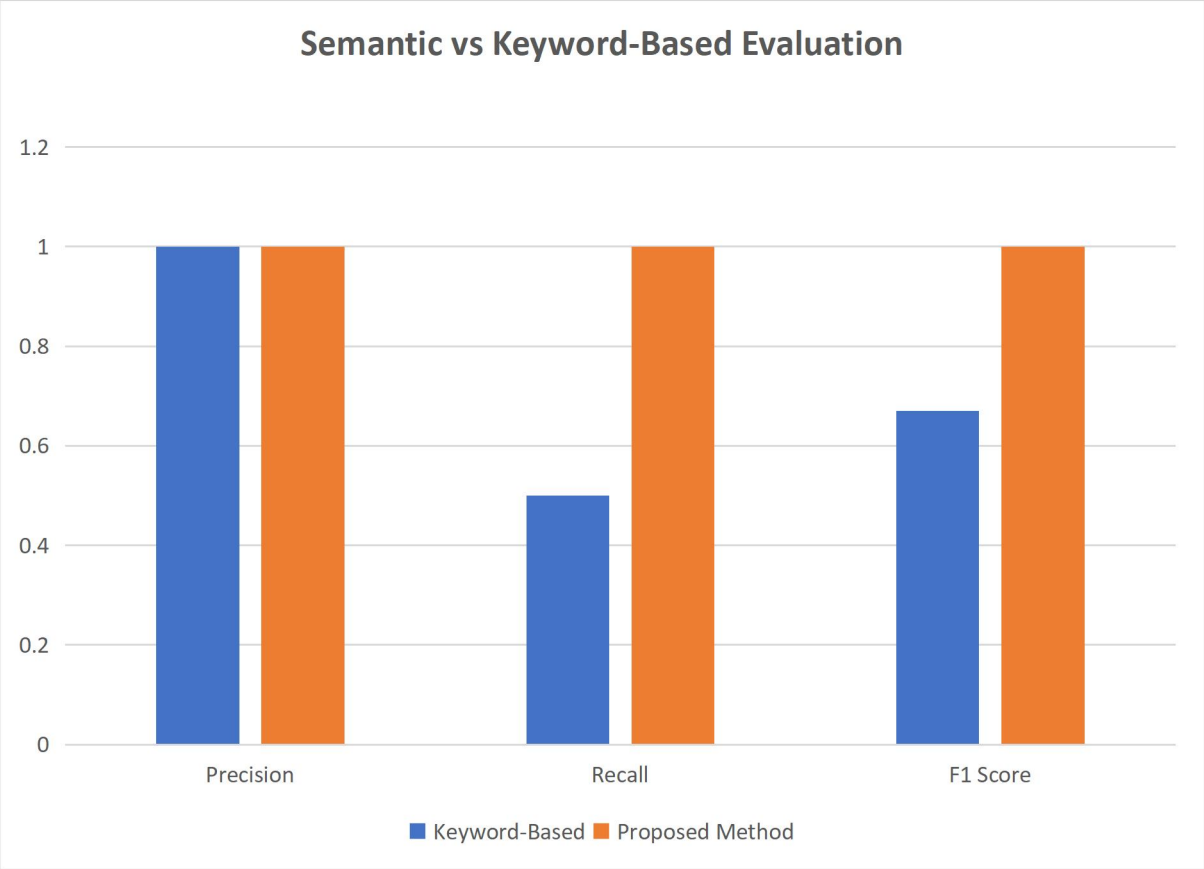

Figure 3. Comparison of Keyword-Based and Proposed Semantic Evaluation Methods

V. CONCLUSION

This paper presented a semantic analysis-based approach for evaluating

answers more effectively. Traditional keyword-based methods were found to be limited in understanding the actual meaning of responses as it completely relies on keyword matching leading to inaccurate grading in many cases.

The proposed system combines keyword matching with semantic similarity techniques to overcome these limitations and gives accurate results by not just comparing words but also understanding the context of the answers given by the students.By considering both important terms and contextual meaning, the system provides a more balanced and fair evaluation of student answers.

The study highlights the importance of integrating natural language processing techniques into educational systems. Future improvements can include the use of advanced deep learning models and larger datasets to further enhance accuracy and performance.

VI. REFERENCES

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