AI GRAMMAR CHECKER: AN INNOVATIVE TOOL TO ENHANCE PRIMARY AND SECONDARY SCHOOL STUDENTS' WRITING

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Abstract - In the evolving field of language education, Artificial Intelligence (AI) is increasingly playing a pivotal role in enhancing language writing tools, particularly grammar checkers. These tools provide students with real-time feedback on grammar, sentence structure, and plagiarism, aiding them in improving their writing. However, current writing tools face several challenges, including costly premium subscriptions, accuracy issues, and real-time checking delays. This study aims to address these problems by proposing solutions such as a hybrid grammar checker using rule-based methods and machine learning for better accuracy, and techniques like data caching and prefetching to reduce checking delays. This study aims to develop more effective and affordable writing tools through error analysis and targeted feedback. Moreover, the primary target audience includes primary and secondary school teachers and students, who can benefit from improved writing skills and content structuring with the purpose.

Keywords - Language Education, Artificial Intelligence, Grammar Checker, Rule- Based Method, Machine Learning, Primary and Secondary School Students and Teachers.

I. INTRODUCTION

The rapid advancement of developing the field of language education, a tool called artificial intelligence is significantly gaining attention, providing innovative ways for people to enhance language learning, especially helping students to complete homework or essay writing (Zaragoza N E M et al., 2024). The tool has the potential to revolutionise the process required for writing and improve the proficiency level of users, surprisingly it has attracted great attention from many researchers, educators, and writers (Raad & Anjum, 2023). In addition, due to the revolution in artificial intelligence applications such as grammar checking, plagiarism, and sentence restructuring, it has been popular among lecturers and students because it provides real-time feedback and corrections, as well as improves users' understanding of grammar usage, allowing users to understand the essence of language usage in the simplest and most understandable way (Infante Vera et al., 2024). However, the current writing tools are still lacking on the real-time checking delays, limited functions supported by different versions, and the program may not be able to precisely convey what the user intends to present.

The main issue of the grammar checking program is the real-time checking delays. The program could not process the word in a short time due to the limited memory resources that need to process grammar check, plagiarism and sentence restructure. Therefore, the user could not get the result immediately to understand what grammar mistake which needs to be corrected. A proposal solution can be provided which is using the technique of data caching and prefetching. By implement the smart caching that frequently encounter the grammar patterns or sentence and using prefetching to reload the grammatical model for commonly used language which can speed up the checking process of the program (Lotfi-Kamran P, Sarbazi-Azad H, 2022).

Most of the grammar checker program have free and premium version which you pay for it for complete feature of the system. Some of the premium version has higher subscription cost that user is not willing to pay for it and rather using free version. However free version only has limited feature and resources for user to use and may not as accurately and faster than premium version. A proposal solution has been introduced which can lower down the cost of the premium or increase the available feature and resources for the free version.

Accuracy issue is also one of the serious issues in grammar checker because the program may not present what the user wants to present and cause misleading feedback. However, a solution has been proposed which is hybrid approach. It uses the rule base method and machine learning for predicting the grammatical rules to structure correction and machine learning will aware more context error which can effectively increase the accuracy of correction. Therefore, due to this situation, it prompted me to study related topics and develop a program to solve the current problems of similar programs. (Fahim Faisal et al., 2021).

This paper aligns strongly with several United Nations Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 9

(Industry, Innovation, and Infrastructure), and SDG 10 (Reduced Inequalities).

II. RELATED WORKS

For students' learning process, there are four language skills that needs must master it which is speaking, writing, reading and listening. Writing is one of the hardest skills to learn because it requires students to make a logical text for reader ore examiner to understand the information provided. Even in the generation Z, this skill the most crucial skill to learn for their future. Due to the rapid advancement of technology, student nowadays depends on grammar tools to generate their writing to be more accurate and precise.

One of the famous grammar checker tools is Grammarly which was found by Maz Lytvyn and Alex Shevchenk in 2009 (Fahim Faisal et al., 2021). It is known as the highest accuracy for English grammar checker, and it assists people to improve their grammar mistake and make the writing become more professional and academic. Users can just paste their word or upload document to Grammarly application and allow it to evaluate each word and highlight the word that requires correction (Maulidina & Wibowo, 2022). Initially, Grammarly was used for grammar checker and spelling correction but due to the demand, AI has swiftly implemented into lots of application include Grammarly by using it for AI detect and plagiarism (Sri Rejeki, 2023b). However, there are several issues about these tools which is low accuracy, delay in grammar checking and overpriced subscription plan.

Low accuracy defines the grammar checker could not really generate or suggest a word that close to human intention (Pratama, 2020), (Wang. X & Zhong, 2022). It is said that due to the complexity of natural language processing which the natural language having the issue of understanding human intention (Khurana et al., 2023) and the rule-based method exist the limitation of data detection which could not detect the error widely (Z. Wang et al., 2020) and causing the users to write out a sentence in the system to misspelled and complexity of the sentence that causing corrected sentence' meaning is not what the user what to present (Kowsari et al., 2019).

Delay in checking grammar shows that it could not generate the corrected sentence fast enough (Shadiev & Feng, 2024a) (Da Silva et al., 2010) and the reason that causing this issue is due to the complexity of the algorithm that the natural language processing model requires more time to analysis and modify (Park, 2020a). Another reason may be causing due to system error or limited resources that it cannot check the grammar quickly and display the refresh page (Lotfi-Kamran P, Sarbazi-Azad H, 2022). They are using the grammar checker system and require waiting a long time for the result and may appear refresh page to redo the checking again (Ranalli, 2021).

The current grammar checker offers free and premium versions. But the free version only provides limited features, and premium versions require user to pay for enjoying full features, and the cost is not everyone who is willing to pay. The developer might want to earn some profit from their system; hence they promote the advanced feature in the premium version to encourage user to upgrade to the premium version for additional benefits to enhance the overall experience and writing quality (Dewi, 2023a). This brings the impact of user can only use limited feature if they do not want to pay for the premium version (Fitria, 2021b)

2.1. Summary of previous study

Author (year)	Title	Purposed study	Outcome	Remark (limitation/future work suggestion)
Brody Downs, Oghenemaro Anuya, Aprajita Shukla, Jerry Alan Fails, Maria Soledad Pera, Katherine Wright, Casey Kennington (2020) (Downs et al., 2020)	KidSpell: A Child-Oriented, Rule-Based, Phonetic Spellchecker	To recognise how spell checker tools perform with kid's misspelling	KidSpell outperformed the existing spellchecker.	• Develop ranking algorithms, using features based on age of acquisition and word frequency. • Techniques that consider the context of the given words could further improve ability to correctly rank candidates.
Robert Long (2021) (Long, 2022)	Online Grammar Checkers Versus Self-Editing: An Investigation of Error Correction Rates and Writing Quality	To examine the effectiveness of one online grammar checker, grammarly.com, with that of self-editing	Results showed that there were no significant differences found in terms of the methods of editing	• Grammar checker could not help students express their ideas
Rustam Shadiev, Yingying Feng (2024) (Shadiev & Feng, 2024b)	Using automated corrective feedback tools in language learning: a review study	To observe the accuracy of ACF (n = 10, 12.20%); (2) to investigate the effectiveness of ACF on language learning (n = 46, 56.10%); (3) to explore how students and teachers use these tools (n = 20, 24.39%)	The research has identified 43 ACF tools and 10 main functions of ACF tools	• Reviewed studies published in English, and therefore, most of the ACF tools we identified were specific to English language learning. • Researchers may review studies published in different languages to identify more ACF tools and their applications in different language learning contexts.
Mahabaleshwara Rao, Anita Gain, Shivananda Bhat(2019) (Rao et al., 2019)	Usage of Grammarly – Online Grammar and Spelling Checker Tool at the Health Sciences Library, Manipal Academy of Higher Education, Manipal: A Study	• To find out the users of Grammarly subscribed by the Health Sciences Library, MAHE, Manipal. • To understand the features, facilities, and services available at Grammarly. • To recognise the problems faced by users while using Grammarly.	More number of faculty members have registered themselves for using Grammarly than postgraduate students.	• A need for orientation programme about Grammarly uses and benefits among postgraduate students in regular interval. • The online information brochure also needs to circulate through group mail regarding Grammarly tool and its utility and advantages.

Nuria Haristiani1, Ari Arifin Danuwijaya2, Mumu Muhammad Rifa'i1, Hani Sarila (2019) (Haristiani Et Al., 2019)	Gengobot: A Chatbot-Based Grammar Application on Mobile Instant Messaging As Language Learning Medium	To develop an application for language learning, namely Gengobot integrated with MIM service LINE.	Gengobot has been evaluated and improved to utilises Japanese grammar learning.	• The study has a limitation about the development of applications that are limited to specified users. But further tests and developments for improving the Gengobot program will be conducted.
Lorena Parra G, Ximena Calero S. (2019) (Parra & Calero, 2019)	Automated Writing Evaluation Tools in the Improvement of the Writing Skill	The implementation of AWE programs in the field of English as a Foreign Language (EFL) and the benefits these computer tools provide in terms of improving students' overall writing.	• The learners writing performance significantly increased according to the results of the pre-test and post-test. • These results revealed that new trends of computer technology such as computer AWE tools helped to enhance the language learning process.	• AWE is limited to evaluation content, specific prompts of the program, and process of writing and it discriminates students who are not familiar with technology. • The generic suggestions isa also a limitation to contribute with formative learning. But a future study about the considering the use of AWE tools in EFL and peer feedback for revision of aspects the learners may misunderstand.
Tira Nur Fitria (2023) (Tira Nur Fitria, 2023)	Artificial intelligence (AI) technology in OpenAI ChatGPT application: A review of ChatGPT in writing English essay	To investigate how ChatGPT write English essay	OpenAI uses advanced AI technology to understand questions and provide accurate answers and to help find information they need.	• Further research to find out that the essay results are grammatically accurate.
Auro Del Giglio, Mateus Uerlei Pereira da Costa (2023) (Giglio & da Costa, 2023)	The use of artificial intelligence to improve the scientific writing of non-native english speakers	To conduct a non-systematic review of the most recent literature using the terms "Artificial Intelligence," "Scientific Writing," and "Non-English Speaking" to create a narrative review	Artificial intelligence can be a solution to improve scientific writing, especially for non-native English-speaking scientists.	• The AI should never be expected to write any of the sections of a scientific paper as an author would.

2.2. Rule based method

Rule based method includes a set of if then rules, which can do a lot of services such as decision support and predictive decisions. It is also available in grammar checking system. Rule base method has involved several types of technique which is n-gram-based, frequency-based and finite state automata-based (Singh & Singh, 2019). N-gram-based is to split each string text into a few sets of nearest n-grams value and calculate the probability of error individually to detect search the position of grammar or spelling error with or without the dictionary (Gledec et al., 2019). The probability of sequence k words k S^k = (w1,w2 ,...,wk) is describe as the production of the conditional probabilities.

$$Pr\,(w_i/h_i) = Pr\,(w_i/w_1,\ldots,w_{i-1}) \approx Pr\,(w_i/w_{i-n+1},\ldots,w_{i-1})$$

(Aouragh et al., 2021).

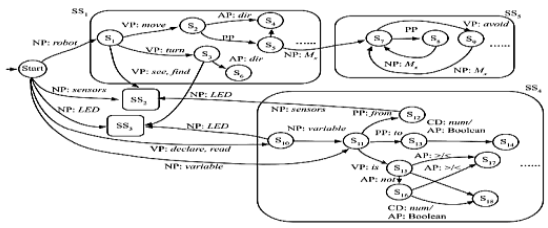
Frequency-based is used to identify the errors and correction, depends on the probability of the common mistake or repetition. Distance-editing method has been implemented inside the frequency-based which proposed a spelling checker based on frequency to examine the grammar checker based on rules of grammatical errors. This method uses a wordbook and bigram to identify the potential spell errors and then choose the word that best suited for the spelling correction and applied rules for grammar checker to determine the grammar of the sentences based on the verb anxious whether it is negative or positive. The frequency-based principle will firstly separately derive for low and high frequency with the formula as below:

$$e_{\text{low}} = \left(\frac{\sum_i |\boldsymbol{y}_i^{\text{low},\delta} - \boldsymbol{h}_i^{\text{low},\delta}|^2}{\sum_i |\boldsymbol{y}_i^{\text{low},\delta}|^2} \right)^{\frac{1}{2}},$$

$$e_{\text{high}} = \left(\frac{\sum_i |\boldsymbol{y}_i^{\text{high},\delta} - \boldsymbol{h}_i^{\text{high},\delta}|^2}{\sum_i |\boldsymbol{y}_i^{\text{high},\delta}|^2} \right)^{\frac{1}{2}},$$

(Xu et al., 2022)

Finite State Automata-based is the computation mathematical models that used for designing the Natural Languages and the text that has passed through the fine state based normally is consider correct in the Natural Language. A process of how the finite state automata based have some simplified action with some states, including terminal states, omitted with the natural language. This FSM based process can help in validate the error reporting frameworks that help in leading user towards a valid input. It provides early detection about the untranslatable and ambiguous language through error reporting and each error providing with teaching example (Zhan & Hsiao, 2021). Rule-based method use inquiry that derived from structure, originating, and other form of text to correct the spelling and grammar. The inserted and deleted letters to correct the error by using the structural rich languages to increase the accuracy and feasibility (Zhan & Hsiao, 2021). Moreover, another based method that grammar checker can use is deep learning-based method. It utilises the Recurrent Neural Network that integrated a long-term memory unit to detect grammatical error in Dravidian language. Therefore, by using the LSTM to detect the misspelled and grammar mistake and location of the error, error correction that process by n-gram based and rules based will be conduct. If the error could not be found in the dictionary, it will select the closest sentence or probable word to correct the errors (Kasmaiee et al., 2023).



2.3. Deep learning

Deep learning is also known as deep neural networks, a combination of multiple processing layers to acquire model of data with multiple levels of extraction. It provides accurate result as it has an ability to process natural data in their own form. There are three main stages which is data pre-processing to filter and transform data for model training, data training and testing to let the model parameters to learn the data, and final stage is to judge based on word confusion, understandability, and similarity with context and were compared with standards of the original content (Yang et al., 2019). The method of recurrent neural network to save data context through recurrent connections in the hidden layer, which increase the performance of the successive data management.

Moreover, pretrained transformer is used to reach the highest level of performance in language generation. It is different from recurrent neural network since the preserve contextual information does not use recurrence for training. Due to this, it does not require to process the word one by one but process the whole sentence or paragraph which is efficient in this training process (Li & Xing, 2021). Besides that, another method called Sequence to Sequence based that convert the possible m from value of input pattern to an output pattern. Basically, it includes the three main components which is encoder, decoder and attention mechanism.

The encoder network takes care of a list of vectors that convert from input pattern. Then, the encoded vectors that processed by the decoder process can produce the understandable output pattern. Lastly, the attention module that connected by encoder and decoder can allow the decoder focus on different type of input during process of decoding. This is typically used for spelling and grammatical error, and the input and output of the model are given by the error and corrected words (Büyük, 2020). Some formulas of the sequence-to-sequence based model has been provided; for encoder it converts the source pattern X = [x1, ..., xn] into a sequence of encoder hidden state which is hi, after reading the last hidden state, h e n is used for converting c in initialise the decoder.

$$h_i^e = g_e(x_i, h_{i-1}^e);$$

Decoder is then using the hidden state that being converted and receive the special start token that begin by the production of the patch as input y0. For each previous output yi-1, the decoder will update accordingly the hidden states by using the learnable recurrent function gd.

$$h_j^d = g_d(y_{j-1}, h_{j-1}^d, c)$$

(*Chen et al., 2019*)

2. 4. Natural language processing

Natural Language Processing (NLP) is a method that allow artificial intelligence and computer to understand, interpret and manipulate with the human language. NLP has been using in wide range of area include the grammar and spelling correction (Fitria, 2021b). However, the processing of human language is a difficult task for machine to operate. It does not only consider about the sentence formulation, but it also needs to include other forms of grammar, for instance, nouns, verbs, adjectives, determiners, etc. to form a complete meaning of sentence. For example, the sentence "he is running right now", and another sentence, "this PC is running faster than I thought".

Both sentences include the word running but it also represents different meaning based on the structure of the sentence. Therefore, it is difficult for computer that need to analyse these types of sentences that contain the ambiguous words (Jain et al., 2019). NLP is implemented to do parsing rule for static parsing method based on probability. Each rule is assigned by probability through machining learning algorithms. All this statistical parsing always parser a maximum likelihood sentences to produce a better result in grammar checker. Normally, NLP is combined by five major components which is structure analysis, grammatic analysis, linguistic analysis, discourse analysis and practical analysis. Parsing rules is the main step of the linguistic analysis by analyse the component word in a text, determine how the linguistic structure look like and understand the meaning of the sentence based on underlying grammar. Semantic analysis also assists NLP to discover the meaning behind the words and their use in a sentence by perform word sense disambiguation to determine the correct sense of the word if it is ambiguity in meaning and lexical semantics to checks for synonyms, antonyms, homonyms (Johri et al., 2021).

2.5. Large Language Model

Large Language Model (LLM) has a massive statistical language model that can be used to predict the next word, phrase, sentence, or paragraph, by giving an input with a similar meaning in context, rather than if words have a static meaning across

contexts. This function of LLM is important because there is no one to one word that can be mapped to human's intention. To understand human intention, LLM needs to have training in the context of words that can influence the meaning of words including topic, register, style, sarcasm, or metaphor. Secondly, LLM through huge number of resources like online digital resources, web, social media and do training models (B. Wang et al., n.d.). This LLM can do better modelling and data, measure the context meaning and generate a text that is more to human intention, gathering information from a wide range of sources, forming a natural dialogue, and even generating different styles and personas.

Therefore, this model has been implemented into grammar checker. The overall performance is being enhanced because generate word that close to human intention is one of the main functions in grammar checker (Demszky et al., 2023). The grammar checker then is capable of processing recursively nested grammatical structures at least as well as humans, through analysis of the structure of the sentence, based on the writer's style and provides the sentence that is more to human style and easy to understand by the reader especially when provided with prompts containing simpler grammatical sentences, this can significantly enhance its ability to form the sentence (Lampinen & Deepmind, 2024).

III. DISCUSSION

From the previous study, the author has discovered that the current existing grammar checker program within some potential issue that may affect the system performance and user experience. From the past research, the author has identified that the current grammar existing systems have the issues of low accuracy on grammatical error detection and hard to understand human intention, delay in real-time grammar checking which causing users have bad user experience, costly premium subscription plan to enjoy the full version of the system which is not for everyone could afford the price. These three major problems exist within this system for long time and therefore the author suggest developing a proposed system that ca utilized and enhance the overall performance of the grammar checker system.

Overall, from this proposed study, a several method and feature of the proposed system have been selected. Method that uses for implementation and develops will be using natural language processing, rule-based method, deep learning and data caching and prefetching to enable the proposed system can process faster, less error and provide correct feedback. But comparing the feature of the proposed system with the existing system, a feature like grammar checking, AI detected, sentence suggestions, word rephases and translator will add on to the proposed system. By adding the methods and features, the proposed system can have a fast processing by using the data prefetching technique to solve the issue of delay in checking, using rule based to improve the accuracy of error detecting of the grammar mistake, use deep learning to let the system able to understand human intention and provide better word suggestion, and using NLP to analyse the unstructured data. The feature of the proposed system will be conducting all the necessary features in the existing system but provide a better service for the user.

IV. CONCLUSION AND FUTURE ENCHANCE MENT

This proposed system brings a range of significant benefits to various users. For educational purpose, it able to help users especially students to improve their grammar skills and reduce the plagiarism risk on their homework.

Also, through AI detector, it can help them to verify their content is AI generated or not. The evaluation and translator can help students understand on what they are writing and how good is their content. From here, the students can learn their mistakes and apply a better content for their homework and assignment. For professional usage, it assists content writer, lecturer or professional can refine their work before publishing. User can do an immediate mistake correction to make their content perfectly. For technological purpose, integrate with the API or pre-train model to make and create another way of using technology to assist in user writing through web application.

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