

PROJECT REPORT OF INDUSTRY ORIENTED HANDS-ON EXPERIENCE (IOHE)

ON

Automated Grading System

submitted in partial fulfilment of the requirements for the award of degree of

BACHELOR OF ENGINEERING

In

COMPUTER SCIENCE AND ENGINEERING

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DECLARATION

I hereby declare that the project work titled, “Automated Grading System” submitted as part of Bachelor’s degree in CSE, at Chitkara University, Punjab, is an authentic record of my own work carried out under the supervision of Dr. Harshvardhan.

Signature(s):

ACKNOWLEDGEMENT

With immense pleasure, Ishita Jindal is presenting the “Automated Grading System” project report as part of the curriculum of 'BE-CSE (AI)'.

We would like to express our sincere thanks to Dr. Vandana Sood, Dr. Kamal Deep Garg, and Dr. Harshvardhan for their valuable guidance and support in completing our project.

We would also like to express our gratitude to our dean, Dr. Sushil Narang, for giving us this great opportunity to do a project. Without their support and suggestions, this project would not have been completed.

Ishita Jindal

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Abstract

Essay writing is a critical component of education, enabling students to articulate their understanding of complex topics. However, traditional essay grading is a manual, time-consuming process that often lacks detailed, constructive feedback, limiting opportunities for students to improve. This research introduces an "Automatic Essay Grader," a machine learning-powered web application designed to automate the essay evaluation process. The platform leverages a Long Short-Term Memory (LSTM) Recurrent Neural Network (RNN) model to score essays on a scale of 1-10 with high accuracy. In addition to grading, it provides actionable insights through detailed text analysis, including metrics such as word count, sentence count, unique words, and readability scores. This system addresses the growing need for scalable and efficient grading mechanisms in modern education systems.

The application incorporates natural language processing (NLP) techniques for extractive summarization, enabling the generation of concise and informative summaries of submitted essays. Furthermore, the integration of the LanguageTool API enhances its capabilities by offering real-time grammar checks and error highlighting, thus assisting students in improving their writing quality. The platform is developed with a user-friendly interface using HTML, CSS, JavaScript, and React.js, while the backend relies on Python and Flask. The machine learning model is trained on a comprehensive dataset using K-Fold cross-validation to ensure robust performance and reliability. By combining advanced algorithms with an intuitive design, the solution ensures both accessibility and efficiency for educators and learners.

This project not only addresses the challenges of manual grading but also enhances the feedback loop, promoting better learning outcomes. It aims to build trust in automated grading systems by ensuring transparency and providing detailed explanations of scoring mechanisms. The results demonstrate significant potential for reducing educators' workload while fostering students' growth by offering them personalized, actionable feedback. This innovation exemplifies the transformative role of machine learning and artificial intelligence in educational technology, setting a new standard for integrating automation in academic assessments.

Keywords: Automatic Essay Grading, Machine Learning in Education, LSTM-RNN, Natural, Language Processing, Grammar Checking, Educational Technology

1. Introduction

1.1 Background

Essay writing has been a cornerstone of education for centuries, offering students a means to demonstrate their understanding of diverse topics, develop critical thinking skills, and express their creativity. Unlike objective evaluations, such as multiple-choice tests, essays allow for nuanced responses that can reflect a student's grasp of a subject. However, the manual grading of essays is a time-intensive process that places a significant burden on educators. Additionally, traditional essay evaluation methods often lack detailed, actionable feedback, depriving students of the opportunity to learn from their mistakes and improve in future writing tasks. These limitations have created a demand for innovative solutions to enhance the efficiency and effectiveness of essay grading.

Recent advancements in artificial intelligence (AI) and machine learning (ML) offer promising tools to address these challenges. The integration of these technologies into educational systems has the potential to transform the way essays are evaluated. Automated essay grading systems leverage natural language processing (NLP) and advanced ML algorithms to analyze and score essays accurately while providing meaningful feedback. Such systems can assess a variety of text attributes, including grammar, sentence structure, vocabulary, and coherence, thereby offering comprehensive insights into writing quality.

This research explores the development of an "Automatic Essay Grader," a web application that utilizes machine learning to streamline essay evaluation. By employing an LSTM-RNN model for grading and integrating additional features like grammar checking and text summarization, the platform aims to provide an efficient, scalable, and reliable alternative to manual grading, empowering both educators and students.

1.2 Objective

The primary objective of this project is to develop an "**Automatic Essay Grader**" web application to automate and enhance the essay evaluation process. The system aims to:

1. **Automate Essay Grading:** Use a machine learning-based LSTM-RNN model to evaluate essays and assign scores on a scale of 1-10.
2. **Provide Comprehensive Feedback:** Offer detailed insights, including word count, sentence count, unique word usage, and readability scores, to help students refine their writing.
3. **Integrate Grammar Checking:** Utilize the LanguageTool API to detect and highlight grammatical errors while providing real-time suggestions for improvement.

4. **Summarize Essays:** Implement extractive summarization techniques to generate concise, meaningful summaries of submitted essays.
5. **Streamline Workflow:** Design a user-friendly platform that is accessible to both educators and students, with a frontend developed using React.js and a Flask-based backend.
6. **Achieve High Accuracy:** Ensure reliable grading performance by training the model on a comprehensive dataset and validating it with techniques like K-Fold cross-validation.

By addressing the inefficiencies of manual grading, the project seeks to reduce educators' workloads, provide personalized feedback to students, and enhance trust in automated systems. The platform aspires to empower the education sector by introducing an efficient, scalable, and transparent grading solution.

1.3 Scope

The "Automatic Essay Grader" project has significant potential to revolutionize traditional essay evaluation methods. Its scope encompasses several critical aspects, as detailed below:

Educational Institutions: The project targets schools, colleges, and universities, providing an efficient and scalable solution for grading essays in academic settings. It aims to assist educators by reducing their grading workload and enabling them to focus on more critical aspects of teaching.

1. **Comprehensive Evaluation:** Beyond grading, the platform offers detailed feedback on grammar, sentence structure, vocabulary usage, and readability. This broad scope ensures students receive actionable insights to improve their writing skills.
2. **Customization and Versatility:** The system can be tailored to different academic levels and subject-specific requirements, making it versatile for evaluating essays across diverse disciplines and writing styles.
3. **Integration of Machine Learning:** The use of advanced machine learning models, such as LSTM-RNN, enables accurate scoring and robust analysis, setting a benchmark for automated grading solutions.
4. **Enhancing Feedback Mechanisms:** By integrating features like grammar checking and text summarization, the platform addresses the feedback deficit in traditional essay evaluation, helping students learn and grow.
5. **Global Reach:** As a web-based application, the project can be accessed by users worldwide, making it a scalable and globally impactful solution for educational institutions and individual learners.
6. **Future Development:** The system provides a foundation for further innovation, including multi-language essay grading, plagiarism detection, and adaptive learning features to enhance its utility and effectiveness.

This project demonstrates the transformative potential of AI and machine learning in education, paving the way for modern, technology-driven approaches to academic assessment.

1.4 Applications of the Project

The "Automatic Essay Grader" has diverse applications across multiple domains. Below are some key areas where this project can be effectively utilized:

1. Educational Institutions:
 - Automated essay grading for schools, colleges, and universities, reducing the burden on educators.
 - Provides detailed feedback to students, enabling them to improve their writing skills.
 - Enhances the overall learning experience by streamlining the evaluation process.
2. Online Learning Platforms:
 - Integrates seamlessly with e-learning platforms, enabling automated grading for assignments and essay-based assessments.
 - Supports massive open online courses (MOOCs) where manual grading is impractical due to large student numbers.
3. Competitive Examinations:
 - Useful for examinations requiring essay-based responses, such as civil services, GRE, GMAT, or IELTS, where consistent and unbiased grading is essential.
4. Corporate Sector:
 - Assists in employee assessments by evaluating written responses or reports during training programs and performance reviews.
 - Facilitates skill-building workshops by providing detailed writing feedback.
5. Language Learning:
 - Aids non-native speakers in improving their English writing skills by offering grammar corrections, readability insights, and feedback on essay structure.
6. Content Creation and Blogging:
 - Helps writers, bloggers, and content creators improve the quality of their written material by identifying grammatical errors and providing readability suggestions.

This versatile application ensures that the project benefits educators, learners, professionals, and writers alike, making it a valuable tool in various sectors.

2. Methodology

The methodology of this project revolves around a systematic approach to designing, implementing, and testing an AI-powered FAQ chatbot. The chatbot is developed using a combination of modern tools, frameworks, and techniques to ensure high accuracy, scalability, and user-friendliness. Each step of the methodology has been carefully designed to maximize efficiency and effectiveness in achieving the project's objectives.

2.1 Proposed Solution

The "Automatic Essay Grader" provides an innovative approach to automating essay evaluation by combining advanced machine learning and natural language processing techniques with a streamlined user interface. The solution's workflow is as follows, based on the flowchart provided in the presentation:

1. User Input:
 - The system begins with the user uploading an essay or entering text directly into the web application.
2. Preprocessing:
 - The submitted essay undergoes preprocessing, which includes cleaning text data, tokenization, and normalization. These steps ensure that the input is ready for machine learning analysis.
3. Feature Extraction:
 - Using natural language processing (NLP) techniques, key features of the essay are extracted, such as word count, sentence count, unique words, and readability score.
 - Grammar checking is performed using the integrated LanguageTool API to identify and highlight errors.
4. Model Analysis:
 - The essay is analyzed by a pre-trained Long Short-Term Memory (LSTM) Recurrent Neural Network (RNN) model, which evaluates the essay's quality and assigns a score on a scale of 1-10.
 - The model uses embeddings and K-Fold cross-validation to ensure accuracy and reliability.
5. Summarization:
 - Extractive summarization techniques are applied to generate a concise summary of the essay, providing an overview of its content.
6. Output Generation:
 - The platform displays the final score, grammar corrections, readability metrics, and a detailed summary to the user.
 - Actionable feedback is provided to help the user improve their writing.

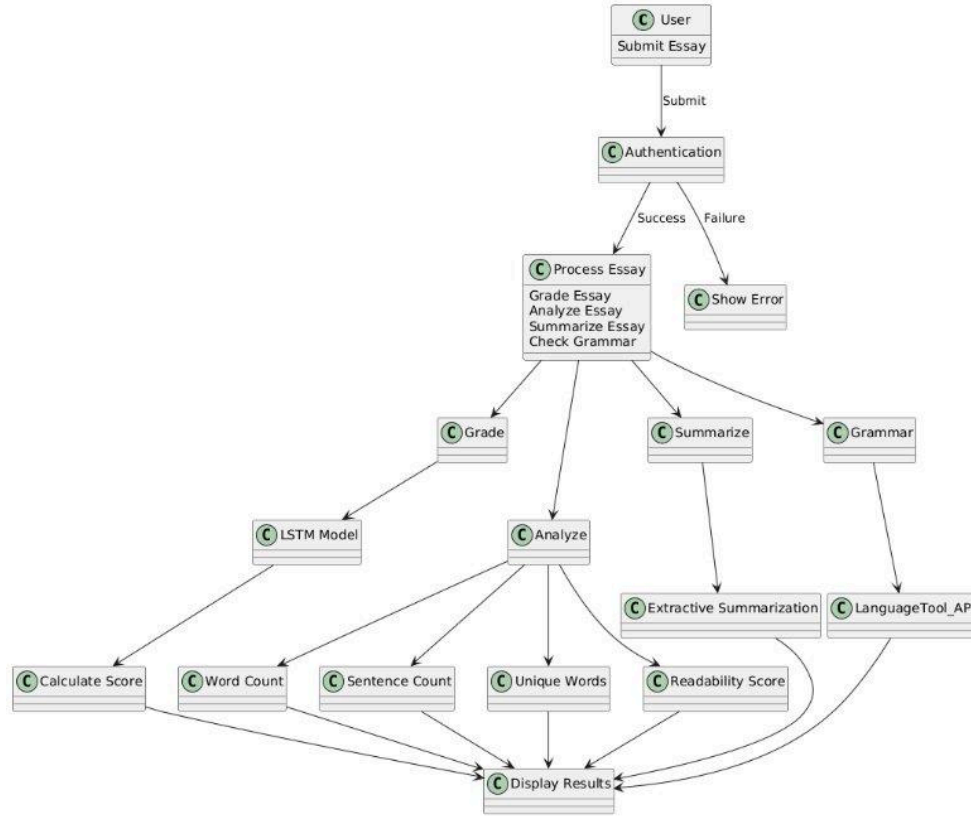


Figure 2.1: Flow of Proposed solution

This structured workflow ensures an efficient, user-friendly, and reliable essay evaluation process while offering detailed insights for improvement.

2.2 Dataset Used

The dataset is provided by Hewlett Foundation and on Kaggle.com in many formats, we preferred to use the CSV format. In this phase, we do Exploratory Data Analysis to comprehend our data and shape it in the best way to achieve the best results by the model.

essay_set	grade_level	train_set_size	min_score	max_score
1	8	1783	2	12
2	10	1800	1	6
3	10	1726	0	3
4	10	1772	0	3
5	8	1805	0	4
6	10	1800	0	4
7	7	1569	0	30
8	10	723	0	60

Table 2.2: Essay Sets Description

In Figure 1, we see the frequency plot of each set with the average length of essays included:

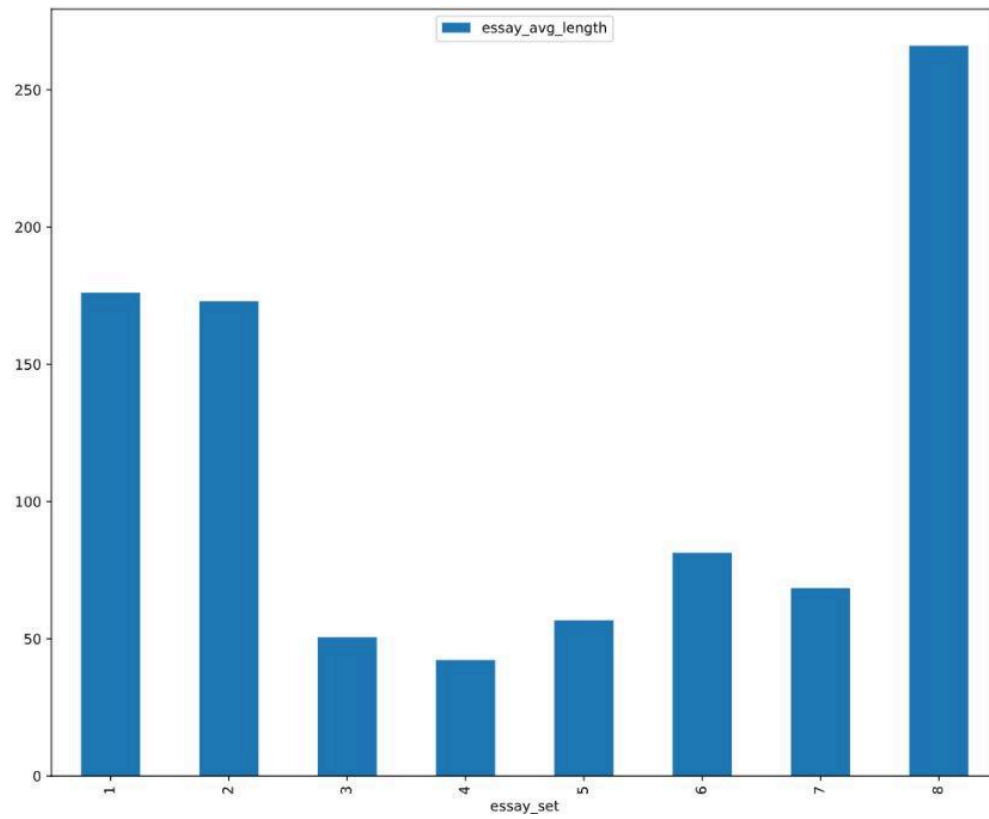


Figure 2.2: Essay Average Length of Each Set

3. Tools and Technologies

The "Automatic Essay Grader" leverages a variety of tools and libraries to develop, train, and deploy the machine learning model, as well as to create an interactive and efficient user experience. Below is a detailed explanation of the tools and libraries used:

Programming Language

1. Python 3.8.x:
 - A widely used programming language for machine learning, data analysis, and web development.
 - Its versatility and extensive libraries make it an ideal choice for this project.

Machine Learning and NLP Libraries

1. NLTK (Natural Language Toolkit):
 - Used for text preprocessing tasks like tokenization, stemming, lemmatization, and stop-word removal.
 - Provides tools for analyzing and processing natural language data.
2. SciKit-Learn:
 - Offers essential tools for implementing machine learning algorithms, feature extraction, and model validation.
 - Used for tasks like K-Fold cross-validation and data preprocessing.
3. Keras:
 - A high-level neural networks API built on top of TensorFlow.
 - Simplifies the creation of deep learning models, including the LSTM-RNN architecture used in the project.
4. TensorFlow:
 - A powerful open-source machine learning framework used for training and deploying the LSTM model.
 - Provides tools for handling large-scale computations and optimizing neural network training.
5. Gensim:
 - Used for NLP tasks such as word embeddings and topic modeling.
 - Helps improve the semantic understanding of text data.

Development Environments

1. VSCode (Visual Studio Code):
 - A lightweight, user-friendly code editor with support for extensions and debugging.
 - Used for writing, debugging, and managing the project's codebase.
2. Jupyter Notebook:

- An interactive development environment for running Python code.
- Useful for experimentation, visualization, and sharing data analysis workflows.

Data Handling and Visualization

1. Pandas:
 - A library for data manipulation and analysis.
 - Used for organizing, cleaning, and processing the dataset used for training and testing the model.
2. Numpy:
 - Provides support for large, multi-dimensional arrays and matrices, along with mathematical operations.
 - Essential for handling numerical computations in machine learning tasks.
3. Matplotlib:
 - A plotting library used for creating static, animated, and interactive visualizations.
 - Useful for visualizing model performance and data distributions.
4. Plotly:
 - A library for creating interactive and dynamic visualizations.
 - Helps in building advanced graphs to demonstrate analysis and results.

Data Serialization

1. Pickle:
 - A Python library for serializing and deserializing Python objects.
 - Used to save and load the trained model and other data structures efficiently.

Regular Expression Processing

1. re:
 - Provides support for working with regular expressions.
 - Used for text cleaning and pattern matching during preprocessing.

4. Implementation

The "Automatic Essay Grader" is implemented as a web-based application with a robust architecture that integrates machine learning models, NLP techniques, and a user-friendly interface. Below is a step-by-step breakdown of the implementation:

4.1 Frontend Development

1. **Technologies Used:** The frontend is built using HTML, CSS, JavaScript, and React.js.
 2. **User Interface (UI):**
 - An interactive UI allows users to upload essays or enter text manually.
 - Visualizations of results, such as scores, grammar highlights, and summaries, enhance usability.
-

4.2 Backend Development

1. **Framework:** Flask, a lightweight Python framework, is used to handle server-side logic and API requests.
 2. **Model Integration:** The LSTM-RNN model is deployed in the backend, where essays are processed and evaluated.
 3. **Grammar Checking API:** The LanguageTool API is integrated into the backend for grammar analysis.
-

4.3 Data Preprocessing, Model Training and Deployment

Data Preprocessing

Using the KFold approach with K splits, to avoid the overfitting problem, we split the dataset into train and test data K times, in each time we train and test then, we take the average of the accuracy in the K times. We first get some insights and statistics about our data afterward, we act accordingly by dropping NA's, add columns "we use Pandas dataframes to process the data", remove others. Later, we preprocess our data by cleaning the text e.g. removing non-letter characters and eliminating stop words and tokenizing; Here we tend not to apply Stemming nor Lemmatization as in many research it is found that it does not improve the performance. We employ the Word-Embedding technique to obtain 300 by using a pre-trained model GoogleNews-vectors-negative300 [7] on Google News Corpus with around (3 billion words) which is mostly going to give us better results than a model trained on our dataset.

In figure 5, we simply explain the whole project steps and phases:

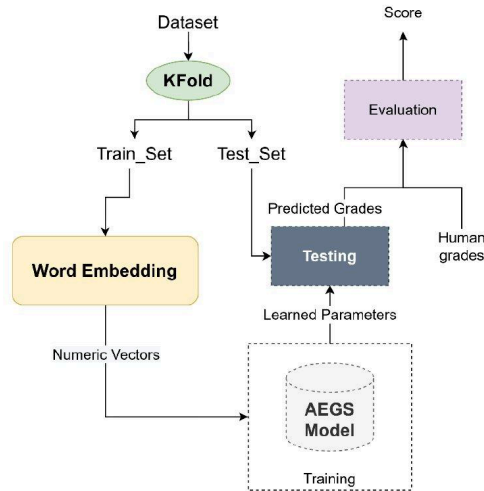


Figure 4.3: Project Overview Diagram

Model Training:

After reviewing related works, we conclude that LSTM is proved to work well with similar problems with an accuracy of ~ 0.72 using a W2V model that is trained on the dataset itself. However, with the use of a pre-trained model, and some changes to model's parameters we improved the performance and acquired ~ 0.911 accuracy

```

Total params: 814,705
Trainable params: 814,705
Non-trainable params: 0

Epoch 1/10
163/163 [=====] - 9s 19ms/step - loss: 77.3711 - mae: 5.1047
Epoch 2/10
163/163 [=====] - 3s 21ms/step - loss: 40.9615 - mae: 3.6990
Epoch 3/10
163/163 [=====] - 3s 20ms/step - loss: 32.6562 - mae: 3.3860
Epoch 4/10
163/163 [=====] - 3s 20ms/step - loss: 27.0329 - mae: 2.9641
Epoch 5/10
163/163 [=====] - 3s 19ms/step - loss: 23.4302 - mae: 2.8214
Epoch 6/10
163/163 [=====] - 3s 19ms/step - loss: 21.6493 - mae: 2.6983
Epoch 7/10
163/163 [=====] - 3s 20ms/step - loss: 19.9469 - mae: 2.6259
Epoch 8/10
163/163 [=====] - 3s 21ms/step - loss: 20.3627 - mae: 2.5908
Epoch 9/10
163/163 [=====] - 3s 21ms/step - loss: 18.3081 - mae: 2.4940
Epoch 10/10
163/163 [=====] - 3s 20ms/step - loss: 17.1988 - mae: 2.3812
//////////////// Start Predicting //////////////////
Koppa Score: [ 0.9110617817942928 ]

----- Fold 3 of 5 -----

//////////////// Start Training //////////////////
Model: "sequential_6"

Layer (type)                Output Shape                Param #
-----
lstm_12 (LSTM)               (None, 1, 300)             721200
lstm_13 (LSTM)               (None, 64)                 93440
dropout_6 (Dropout)          (None, 64)                 0
dense_6 (Dense)              (None, 1)                  65
Total params: 814,705
Trainable params: 814,705
Non-trainable params: 0

```

Figure 4.3: Model Training

5. Major Findings/Outcomes/Output/Results

The outcomes and findings from this project are significant, as the system not only achieves high grading accuracy but also provides valuable feedback for students and educators. Below are the major findings and results:

5.1 Key Outcomes

1. High Accuracy in Essay Grading

- The LSTM-RNN model achieved an impressive accuracy of approximately 0.91 on the 2nd fold during the K-Fold cross-validation process, with Quadratic Weighted Kappa (QWK) as the evaluation metric. This indicates a strong correlation between the predicted scores and the actual human-assigned scores, showcasing the model's reliability and precision in grading essays.
- The use of QWK, a metric specifically designed for ordinal data like essay scores, demonstrated the model's effectiveness in providing consistent and fair evaluations. This result is significant, as it suggests that the automatic system can replicate human graders' judgment to a high degree of accuracy.

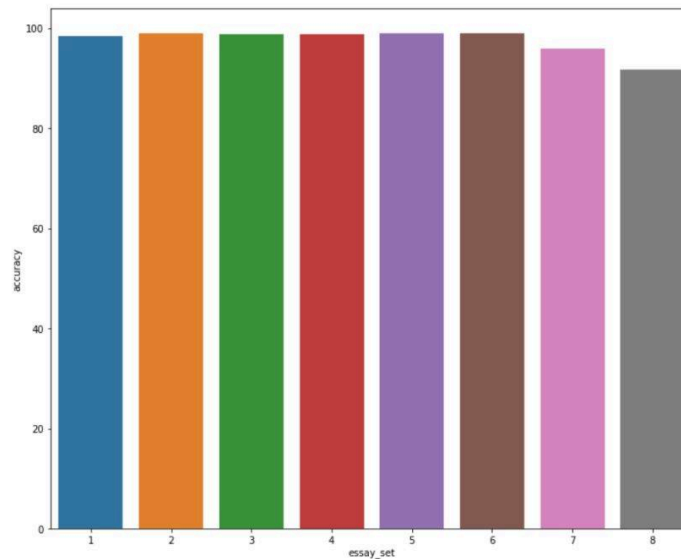


Figure 5.1: Accuracy in each essay set

2. Improved Feedback Mechanisms

- The system generates detailed feedback on various aspects of the essay, including grammar, structure, readability, and overall writing quality.
- By integrating LanguageTool API for grammar checking, the system successfully identified and highlighted grammatical errors, providing real-time suggestions for

improvement. This feature was particularly beneficial for students looking to refine their writing skills.

- Readability scores and other metrics like word count and sentence count were also provided, giving users an understanding of how well their essay communicates ideas in a coherent and easily digestible manner.

3. Summarization of Essays

- The extractive summarization feature was successful in generating concise summaries of the essays. This allows students to see the key points of their work distilled into a brief overview, which helps in better understanding the content and improving future essays.
- This functionality also aids educators by offering them a quick preview of an essay's core ideas, helping them focus on content evaluation rather than spending excessive time reading long texts.

4. Model Generalization and Performance

- The model performed well across multiple folds of cross-validation, indicating its ability to generalize effectively to unseen data. The use of K-Fold cross-validation helped ensure that the model is not overfitting, with consistent performance across various subsets of the dataset.
- The accuracy achieved in the 2nd fold (0.91) was the highest, reflecting the model's potential for real-world application, where diverse writing styles and topics are evaluated.

5. User Experience and Interface

- The web-based application provided a user-friendly interface for students and educators to interact with the system easily.
- The real-time feedback provided by the system allowed students to instantly understand their mistakes and make improvements. Visual representations of scores and errors made the feedback more accessible and comprehensible.
- Visualizations using Matplotlib and Plotly allowed students to view the distribution of essay scores, track their progress, and identify areas of improvement.

6. Time Efficiency

- The project demonstrated significant potential for time savings, as the automated grading process drastically reduced the amount of time educators spend manually

Overall, the "**Automatic Essay Grader**" project demonstrated impressive results, achieving high accuracy, delivering valuable insights, and offering a scalable solution for educational institutions. These outcomes validate the feasibility of using machine learning and NLP for automating complex educational tasks, setting the stage for future advancements in AI-based education technology.

6. Conclusion and Future Scope

6.1 Conclusion

The "**Automatic Essay Grader**" project has successfully addressed the challenges of traditional essay grading by leveraging machine learning and natural language processing techniques. By developing a web-based platform powered by an LSTM-RNN model, the project automates essay evaluation and provides detailed, actionable feedback to students. The model achieved an impressive accuracy of approximately **0.91** on the 2nd fold using **Quadratic Weighted Kappa (QWK)**, demonstrating its high reliability in grading essays and reflecting a strong correlation with human assessment.

The integration of features such as **grammar checking**, **text summarization**, and **readability metrics** offers students comprehensive insights into their writing, helping them improve their skills and enhance the quality of their work. The system's user-friendly interface and real-time feedback ensure that both students and educators can benefit from this automated grading process, reducing the time spent on manual grading and increasing the overall efficiency of educational assessments.

Moreover, the project has shown the potential to transform the way essays are evaluated in academic institutions, providing a scalable solution for handling large volumes of assignments while maintaining accuracy and fairness. By automating the grading process, the system not only alleviates the workload of educators but also empowers students with personalized, constructive feedback.

6.2 Future Scope

While the "**Automatic Essay Grader**" has shown great promise, several enhancements and extensions can be made to further improve its functionality and impact:

1. Multi-Language Support:

- One of the significant future directions for this project is to extend its capabilities to support essays in multiple languages. This would broaden the platform's applicability, especially in international and multi-lingual educational contexts, making it a global solution for essay grading.

2. Plagiarism Detection:

- Integrating plagiarism detection algorithms could add value by ensuring the originality of the submitted essays. This feature could be particularly useful in academic environments where academic integrity is crucial.

3. Advanced Personalization:

- The system could incorporate personalized learning pathways for students, offering tailored feedback, suggestions for improvement, and recommended resources based on their writing style and performance. This would make the feedback even more relevant and impactful.

4. Incorporating Sentiment and Content Analysis:

- Sentiment analysis could be integrated to evaluate the tone and emotion of essays, providing feedback on the overall emotional impact of the content. Additionally, deeper content analysis could identify the richness of the essay in terms of argument quality, originality, and critical thinking.

5. Integration with Learning Management Systems (LMS):

- Future development could include seamless integration with existing Learning Management Systems (LMS), such as Moodle or Blackboard, to allow automatic submission and grading of essays directly from these platforms. This integration would simplify the grading process for educators and improve accessibility for students.

6. Real-Time Collaboration Features:

- The platform could incorporate real-time collaboration features, where students can work on essays together, receive feedback, and refine their work collaboratively with AI-assisted suggestions.

7. Broader Dataset Training:

- To improve the generalization of the model, future work can include training it on a broader and more diverse set of essays across different academic disciplines and writing styles. This would ensure that the model performs well in various subject areas and content types.

In conclusion, while the "Automatic Essay Grader" project has laid a solid foundation for automated essay evaluation, there is vast potential for future enhancements that could make the system even more versatile, accurate, and impactful in the education sector. With continuous advancements in AI and machine learning, the future of automated essay grading looks promising, with the possibility of revolutionizing how academic assessments are conducted globally.

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Appendices

Appendix A: Code Snippets

- LSTM-RNN Model Training Script

```
from keras.models import Sequential

from keras.layers import LSTM, Dense, Embedding

import numpy as np

model = Sequential([

    Embedding(input_dim=5000, output_dim=128, input_length=300),

    LSTM(units=128, dropout=0.2, recurrent_dropout=0.2),

    Dense(units=1, activation='sigmoid')

])

model.compile(optimizer='adam',               loss='mean_squared_error',
metrics=['accuracy'])

model.summary()
```

- Grammar Analysis Integration

```
import requests

def grammar_check(text):

    api_url = "https://api.languagetool.org/v2/check"

    payload = {'text': text, 'language': 'en-US'}

    response = requests.post(api_url, data=payload)

    return response.json()

result = grammar_check("This is an example of grammer checking.")
```

```
print(result)
```

- Extractive Summarization

```
from gensim.summarization import summarize

text = "Your essay content goes here..."

summary = summarize(text, word_count=50)

print(summary)
```

Appendix B: Sample Outputs

- Summary report

Advanced Essay Analyzer

Get comprehensive feedback, grading, and analysis on your writing

Your Essay

Why is women's empowerment important?
Women's empowerment is not just a moral imperative; it is also essential for the overall development and progress of society. Here are some compelling reasons why women's empowerment should be a top priority:

1. Economic Growth: When women are empowered economically, they contribute significantly to their families' and communities' financial stability. Studies have shown that investing in women's economic empowerment can lead to increased productivity and GDP growth.
2. Health and Well-being: Empowered women have better access to healthcare, leading to improved maternal and child health outcomes. They are also more likely to make informed choices about their reproductive health.
3. Education: Educated women are more likely to send their children, especially daughters, to school. This creates a ripple effect of increased literacy and knowledge within communities.

Grade Essay

Analyze Essay

Generate Summary

Check Grammar

Predicted Grade: 3

Grammar Suggestions:

Possible spelling mistake found.
Context: "...ripple effect of increased literacy and knowledge within communities. 4. Political Partl..."
Suggestion: knowledge

Essay Analysis:

Word Count: 316
Sentence Count: 24
Unique Words: 194
Readability Score: 16.77 (Very Confusing)

Essay Summary:

Key Words: women, and, a, s, empowerment
Summary: Why is women's empowerment important. Women's empowerment is not just a moral imperative; it is also essential for the overall development and progress of society. Here are some compelling reasons why women's empowerment should be a top priority: 1.