News Aggregator for Summarization, Recommendation and Categorization

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Abstract: The enormous amount of news content that is readily available online in the modern digital era makes it difficult for people to find accurate and pertinent information fast. This study investigates the design and refinement of an all-inclusive News Aggregator system that incorporates cutting-edge summarisation and suggestion methods. By integrating cutting-edge algorithms for news summarisation, user behaviour analysis, and personalised content recommendation, the system is intended to address the fundamental problems of information overload, relevancy, and user engagement. This methodology compares several summarisation algorithms, including state-of-the-art approaches like Transformer-based models and more conventional approaches like TF-IDF and TextRank. This assesses these algorithms using performance metrics like ROUGE scores, which allow us to compare how well they produce succinct and useful summaries. In addition, this integrates recommendation algorithms based on machine learning, which use user interaction data to generate customised news feeds that improve user happiness and engagement. The study elucidates the merits and demerits of every approach, providing valuable perspectives on their pragmatic implementation in the news aggregation domain. This provides innovative ways to boost the effectiveness and precision of current algorithms, which will further personalised and effective news consumption. These results show how cutting-edge AI-driven recommendation and summarisation systems may be integrated to handle the issues of information overload, timeliness, and relevance while producing a user-centric news experience. This research provides a framework for the next generation of intelligent news aggregation systems, enabling a more informed and involved society by bridging the gap between user needs and the ever-expanding expanse of digital content.

1 INTRODUCTION

In the era of information overload, finding timely, accurate information online can be quite difficult due to the enormous and constantly expanding amount of news content that is available. Advanced systems that can effectively compile, summarize, and suggest news information based on consumers' interests are desperately needed to meet this challenge.

It describes a comprehensive project aimed at creating an integrated News Aggregator system using cutting-edge clustering algorithms combined with cutting-edge summarization and recommendation techniques. The project uses cutting-edge algorithms and techniques to address problems with user engagement, relevancy, and information overload.

The study focuses on assessing and improving a range of summarization algorithms, encompassing both conventional methods like TextRank and TF-IDF as well as novel Transformer-based models like BERT. By comparing generated summaries to reference summaries, ROUGE scores evaluate the quality of summaries and determine how effective certain summarization approaches are. This assessment aids in determining which algorithms generate summaries that are the most succinct, pertinent, and educational.

Apart from summarization, the research looks into and assesses clustering methods to improve news classification and arrangement. The Adjusted Rand Index (ARI), which gauges the degree of agreement between the clustering outcomes and the true labels, is used to evaluate clustering methods including K-Means, Agglomerative Clustering, Gaussian Mixture Models, DBSCAN, and Spectral Clustering. ARI assists in evaluating how well various algorithms classify news articles and how well they represent actual categories.

The project intends to improve news aggregation accuracy and relevance by utilizing the top-performing summarization and clustering algorithms found in these evaluations. In order to provide a more engaging and personalized news experience based on user behavior and interaction data, these optimized algorithms will be incorporated into the recommendation systems.

The research provides important insights into news aggregation system optimization through a thorough examination of the advantages and disadvantages of summarization, clustering, and recommendation methodologies as well as the use of reliable assessment measures. The ultimate objective is to improve news consumption efficiency and accuracy while providing a more tailored and user-focused experience.

In summary, by utilizing cutting-edge AI-driven summarization, grouping, and recommendation methods, this project offers a substantial development in the news aggregation space. In order to contribute to a better informed and involved society, it seeks to close the gap between the requirements of users and the rapidly growing digital content landscape.

2 RELATED WORK

Improving the precision, pertinence, and effectiveness of news aggregation, recommendation, and summarisation procedures through machine learning approaches has been the focus of an extensive amount of research. In an effort to enhance the calibre of information that consumers receive, a number of research projects have investigated sophisticated techniques for grouping and summarizing news stories.

The improvement of clustering algorithms, like the Extended K-Means Algorithm, which has been specially designed to increase clustering accuracy in news articles by improving the initialization process, is a significant development in this field. This update improves the personalization of news suggestions by effectively recognizing and classifying subjects inside huge news collections (Sari, Saputra, et al. , 2021).

Comparably, it has been demonstrated that the Hybrid K-Means Approach—which combines spherical fuzzy sets with conventional K-Means—improves clustering quality by more effectively managing the ambiguity and uncertainty present in multilingual news items, making it extremely pertinent for international news platforms (Al-Qurishi, Alkhateeb, et al. , 2020).

Through increased text clustering accuracy and efficiency, optimization techniques like Ant Colony Optimisation (ACO) are used to further progress the area. Improved subject categorisation is the outcome of ACO's ability to optimise the clustering process, and this is essential for news recommendation systems to function well (Singh, Singh, et al. , 2020).

Furthermore, to improve the coherence of long text production, the Seq2Seq Dynamic Planning Network adds dynamic planning and attention mechanisms, offering insightful advice on how to keep the narrative flow in longer news summaries(Li, Feng, et al. , 2020).

The news domain has shown the BERT-Based Summarization approach to be especially successful in summarizing. This approach, which makes use of BERT's extensive contextual knowledge, generates summaries while preserving the primary ideas of the source material, guaranteeing that the summaries are interesting and educational (Santos, Ribeiro, et al. , 2020).

High-quality news summaries require the reduction of duplication and improvement of relevance, which is why the MFMMR-BertSum Model further improves extractive summarization (Zhang, Wang, et al. , 2021).

Large datasets have been summarized successfully using Unsupervised Learning Techniques, which are capable of handling the enormous volumes of data involved in news aggregation. These methods work especially well for real-time news aggregation systems because they may be scaled and adjusted to dynamic news contexts without requiring labelled datasets(Hasan, Islam, et al. , 2020).

Furthermore, the potential for producing excellent, contextually aware news summaries—which are essential for giving readers clear and pertinent information—is demonstrated by the integration of Deep Learning Models like LSTM and BERT in automated news summarization systems (Yang, Lee, et al. , 2021).

Additionally, Word2vec's application in text analysis demonstrates how much better it is at collecting contextual meanings than more conventional techniques like TF-IDF, which improves the semantic understanding of news content for more precise summarization (Yadav, Singh, et al. , 2020).

Research on Multilingual Summarization, which tackles the difficulties of employing deep learning techniques to summarize news in various languages, complements this. This strategy is essential for serving a variety of consumers and guaranteeing that

international news platforms can appropriately extract and summarize content in many languages (Wang, Cui, et al. , 2021).

The ethical implications of news aggregation in the evolving digital landscape are significant, particularly concerning copyright issues and the appropriation of relevant news. Research indicates that short headlines often lack the distinctiveness required for copyright protection, illuminating the conflict between aggregators and traditional journalism. There are ongoing concerns about their relationship and the complexities introduced by evolving legal interpretations globally, with suggestions that platforms such as Google News and The Huffington Post benefit financially from the journalism investments of conventional media (Isbell, 2010).

A study exploring the impact of news aggregators on user behaviour reveals that smaller media outlets experience notable increases in traffic, while larger publishers see no substantial changes in overall page views. This disparity underscores how various aggregator platforms influence news organisations differently and raises concerns about the long-term consequences for news quality and publisher reputation in a landscape dominated by aggregators (Athey, Mobius, et al. , 2021).

In evaluating summarization efficacy, the ROUGE metric has emerged as a critical criterion for assessing summary quality. While ROUGE has proven effective for single-document summaries when compared to human-generated ideal summaries, it faces challenges in establishing a robust correlation with natural judgments in multi-document scenarios. This tool offers researchers a systematic approach to evaluate summary quality, taking sample size constraints into account, which can impact correlation analyses (Lin, 2004).

An examination of ROUGE's effectiveness in evaluating extractive versus abstractive summarization methods indicates its inability to discern meaningful differences between the performance of the two approaches. Additionally, running summarization algorithms multiple times yields higher ROUGE scores. This finding highlights the limitations of relying solely on statistical measures, which may overlook essential aspects and lead to inaccurate assessments of summary quality (Barbella and Tortora, 2022).

To enhance the evaluation of large-scale automated natural language processing systems, traditional metrics such as confidence-Precision and confidence-Recall can be advanced through a probabilistic framework. This approach addresses challenges associated with unbalanced datasets by focusing on class-based measurements. Although the proposed metrics show promise, they do not claim superiority over conventional metrics, reinforcing the necessity for ongoing evaluation of their effectiveness (Yacouby, Axman, et al. , 2020).

In the multi-label text classification domain, model integration and F1-score optimization techniques demonstrate improved results by constructing several binary classifiers for each label. However, despite these positive outcomes, the limitations in feature representation highlight the need for more sophisticated methods to capture semantic relationships. Furthermore, the specific datasets utilised in the study may influence the applicability of the findings in other contexts (Fujino, Isozaki, et al. , 2008).

A customised news recommendation system utilising Deep Q-Learning aims to adapt to changing user preferences and news characteristics. By integrating user interaction data with innovative exploration techniques, the framework seeks to enhance both suggestion accuracy and sustained user engagement. While it outperforms traditional methods, the potential for user fatigue due to the similarity of suggested items underscores the necessity for further investigation (Xiao, Zhao, et al. , 2021).

A comprehensive analysis of recommendation algorithms underscores the importance of content-based and collaborative filtering methods, alongside hybrid models, in improving accuracy. Scalability challenges are effectively addressed by employing cloud computing solutions like Hadoop to manage large datasets; however, existing approaches present significant concerns regarding privacy, highlighting the demand for enhanced recommendation systems (Tatiya, et al. , 2014).

Evaluations of five prevalent text classification techniques reveal notable differences in their effectiveness, particularly in scenarios with limited training data. This study also emphasises the shortcomings of previous assessments regarding similarity and underscores the need for comprehensive evaluation methodologies in text categorization, especially in the context of heterogeneous category distributions (Yang and Liu, 1999).

The exploration of various evaluation strategies for text summarization technologies reveals the strengths and weaknesses of each approach, emphasising the necessity of aligning evaluation criteria with summary objectives. Practical evaluations enhance our understanding of the

effectiveness of diverse methods and highlight the need to integrate both qualitative and quantitative measures in summary assessments (Barbella, Risi, et al. , 2021).

Overall, this research highlights how crucial sophisticated clustering and summarization methods are to enhancing news article aggregation, recommendation, and summarization. More efficient and customised news distribution systems are being developed as a result of the ongoing improvement of these strategies and the use of deep learning and optimisation techniques.

3 NEED FOR PROPOSED WORK

3.1 Accuracy in News Clustering and Summarization:

Providing users with pertinent and customised content requires the capacity to accurately cluster and summarise news articles. The volume and variety of news data provide challenges for traditional procedures, underscoring the need for more advanced methods that can accurately manage a wide range of topics and sources.

3.2 Information Processing Efficiency

Systems that can quickly analyse and synthesise massive amounts of data in real time are necessary due to the rapid nature of news distribution. The speed at which news is gathered and summarised can be greatly increased by automated, data-driven models, guaranteeing that users receive succinct news on time.

3.3 Addressing Information Overload

Users frequently experience information overload due to the massive volume of news items produced every day. The goal of the proposed study is to create intelligent systems that can summarise and filter news, giving users the most important and pertinent information without overloading them.

3.4 Enhanced User Engagement

By providing material that aligns with user interests and preferences, personalised news recommendations and summaries can dramatically increase user engagement. The goal of the proposed work is to increase user satisfaction and engagement by

enhancing suggestion accuracy through sophisticated clustering and summarization approaches.

3.5 Multilingual News Processing

News channels frequently cater to a multilingual audience in today's globalised society. In order to ensure that consumers receive coherent and pertinent information regardless of language obstacles, the proposed research tackles the problem of summarizing and recommending news across several languages.

3.6 Integrating Advanced AI Techniques

Understanding the context and semantics of news material requires the use of complex AI models, such as deep learning and natural language processing. By incorporating these cutting-edge methods, this study raises the standard of news summary and suggestion while also strengthening the system's intelligence and adaptability.

3.7 Scalability in News Aggregation

The capacity to manage growing amounts of content becomes crucial as news platforms grow. The goal of the proposed study is to create scalable solutions that effectively handle enormous datasets so that the system may expand to meet the rising demand for news content.

3.8 User Privacy and Data Security

It's critical to protect user privacy and data security as personalised recommendations become more common. In order to uphold user confidence and adhere to data protection laws, the proposed study would investigate privacy-preserving methods for user data collecting and analysis.
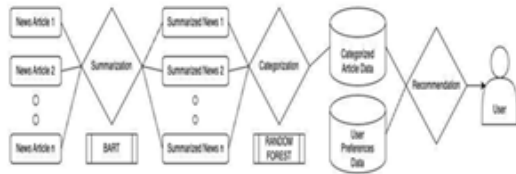
4 ARCHITECTURE DESIGN

Figure 1: System Architecture Diagram.

The architecture for a News Aggregator summarises and categorises the various articles at each stage based on analysis of multiple algorithms at each stage.

4.1 News Sources

Data is first gathered by the algorithm from various news sources. A broad range of subjects and points of view are covered thanks to the diversity of sources, which is necessary for thorough news reporting.

4.2 Data Preprocessing

At this point, research is concentrated on preprocessing technique optimization to efficiently handle enormous amounts of text data. The ability of algorithms to organise, normalise, and clean data without erasing crucial context or meaning is what determines how good they are. Methods including tokenization, stop-word elimination, stemming/lemmatization, and natural language processing (NLP) are taken into consideration and evaluated. coverage.

4.3 Summarization

This phase of the research entails assessing various summarisation techniques, including extractive (LexRank, TextRank) and abstractive (Seq2Seq models, BERT-based models) approaches. Finding the algorithms that preserve readability and coherence while extracting the most important information from the news stories is the aim. Assessment measures, including human judgement evaluations and ROUGE ratings, are employed to evaluate the quality of the summaries generated.

4.4 Categorisation

Investigating clustering and classification techniques is necessary for this step, which involves grouping news pieces into subjects. We investigate methods like K-Means, and sophisticated neural network models (such recurrent and convolutional neural networks). The evaluation of these algorithms' centres on their accuracy, precision, recall, and F1-score in accurately classifying news stories.

4.5 Recommendation

Research entails locating and assessing content-based filtering, collaborative filtering, and hybrid recommendation algorithms during the recommendation phase. The ability of these algorithms to anticipate user preferences and deliver pertinent news articles is used to evaluate their efficacy. User satisfaction surveys, Mean Average Precision (MAP), precision, recall, and other metrics are used to gauge how well the recommendations work.

5 SUMMARIZATION ALGORITHMS

In this section the various summarisation algorithms have been analysed using the ROUGE metric and the results are interpreted.

5.1 TF-IDF

Term Frequency-Inverse Document Frequency is a statistical method that evaluates the importance of a word in a document relative to a collection of documents. It is primarily used in text summarization to extract key phrases or sentences.

5.2 TextRank

An unsupervised, graph-based ranking model for text summarization. It represents the text as a graph, where sentences are nodes, and edges between nodes are established based on sentence similarity.

5.3 LexRank

Another graph-based ranking model similar to TextRank, but it uses a different approach for computing sentence importance, emphasizing sentence centrality and importance.

5.4 Seq2Seq

A sequence-to-sequence model that uses neural networks to generate an output sequence (summary) from an input sequence (text). It is commonly used in abstractive summarization.

5.5 Transformer

A type of neural network architecture that has revolutionized natural language processing, known for its ability to capture long-range dependencies and context. In summarization, it provides high-quality summaries by understanding the context and generating coherent outputs.

6 CATEGORIZATION ALGORITHMS

In this section the various summarisation algorithms have been analysed using accuracy score and F1 scores and the results are interpreted.

6.1 Naïve Bayes

Naïve Bayes algorithms is based on the Bayes' theorem and is a probabilistic algorithm. It is 'naïve' because it assumes that features are independent of each other given the class label. It calculates the probability of each category for a given article based on frequency of words in each class. The category with highest probability is selected.

6.2 Support Vector Machine

The ideal border, also known as a hyperplane, between various classes is found by the supervised learning algorithm SVM. SVM seeks to determine the optimal division between categories in text classification by using word vectors. Each document is represented as a point in a high-dimensional space, and the system searches for a hyperplane that divides the categories as much as feasible.

6.3 Random Forest

Random Forest is an ensemble learning method that combines multiple decision trees to make predictions. It's one of the most popular and powerful algorithms for classification. Throughout training, it creates a number of decision trees, and the majority vote of these trees determines the final forecast.

6.4 Logistic Regression

A linear model for binary classification, logistic regression can also be utilised to multi-class issues by utilising strategies like softmax or one-vs-rest regression. Using a logistic function, it calculates the likelihood that a given input (article) falls into a specific category (S-shaped curve). It generates a probability, and the category with the highest probability is selected.

6.5 K-Nearest Neighbours

KNN is a non-parametric classification technique that uses the feature space's nearest training samples to determine which categories to assign. By examining the "k" closest articles in the training set, it categorises an article and designates the most common category among its closest neighbours.

7 RECOMMENDATION ALGORITHMS

In this section the various summarisation algorithms have been analysed using the RMSE (Root Mean Square Error), Precision and Recall and the results are interpreted.

7.1 Types of Recommendation Algorithms

Three types of Recommendation Algorithms are:

Content-Based Filtering: This approach uses content or characteristics of item (keywords, genres) and matches them to user's preferences and recommending items which matches them.

Collaborative Filtering: This method uses the similarities between users or items assuming users with similar preferences in past will continue to have similar preferences in future. These can either be item based or user based.

Hybrid system: This combines multiple techniques to create a somewhat unique recommendation system.

The algorithms being analysed further are all collaborative filtering based, using various techniques.

7.2 Singular Value Decomposition

This is a collaborative filtering-based recommendation system which uses a matrix

factorization technique that decomposes user item interaction matrices into factors, capturing latent relations between users and items to predict ratings. It is used widely for its ability to handle sparse datasets.

7.3 BaselineOnly

This is a simple recommendation system that predicts ratings based on a baseline estimate, where it is calculated using global averages, user and item biases without considering detailed user item interactions.

7.4 KNN Collaborative Filtering

This approach recommends items by finding users or items with similar profiles. In user based KNN similar users are found whereas in item based it is done on the basis of ratings.

8 RESULTS

Table 1: Comparison Table of Summarization Algorithms

MODEL	Rouge1	Rouge2	Rouge3
TF - IDF	0.3003	0.9040	0.1814
TexRank	0.2670	0.0668	0.1871
LexRank	0.4117	0.2041	0.3481
Seq2Seq	0.4118	0.2041	0.3185
Transformer	0.4118	0.2041	0.3185

When compared to the other algorithms, the Seq2Seq and Transformer models have the greatest ROUGE scores, demonstrating their superior text summarising abilities. These models are excellent for jobs requiring deep semantic understanding and the capacity to provide coherent and understandable summaries because they are especially good at capturing the context (Rouge-2) and coherence (Rouge-L) of the original text.
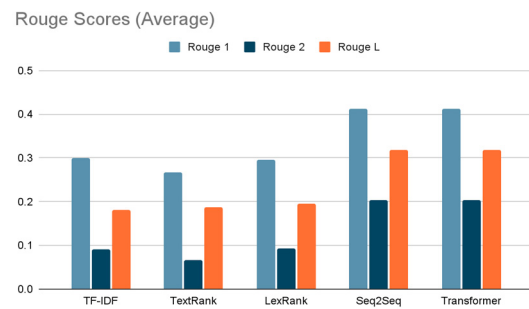

Figure 2: Graph comparing various Summarization techniques and the ROUGE scores.

Traditional Methods: While Seq2Seq and Transformer models outperform the TF-IDF, TextRank, and LexRank approaches, they still perform quite well overall. LexRank performs somewhat better than TF-IDF and TextRank among them, particularly in Rouge-2 and Rouge-L scores, indicating that it might be a preferable option in situations when computational resources are scarce or a more straightforward model is preferred.

The Seq2Seq and Transformer models have far higher ROUGE scores, hence they are the suggested algorithms for the research project's summarisation section. They do more well when it comes to producing precise, pertinent, and well-organised summaries. When high-quality, abstractive summaries are needed, Seq2Seq and Transformer are especially good choices since they use deep learning to better manage the complexity of natural language.

Table 2: Comparison Table of Categorization Algorithms.

MODEL	ACCURACY	F1 SCORE
Naive Bayes	0.6255	0.5987
SVM	0.7320	0.7171
Random Forest	0.8545	0.8465
Log Regression	0.7305	0.7145
KNN	0.5740	0.5594

When compared to the other models the Random Forest Algorithm has the greatest accuracy and F1 scores demonstrating that it is good at both precision and recall. Because Random Forest employs an ensemble of decision trees, it excels at managing intricate datasets like text with a large number of interdependent characteristics (words). Additionally,

it is more resistant to overfitting, a problem that other algorithms, such as KNN or Logistic Regression, may encounter.
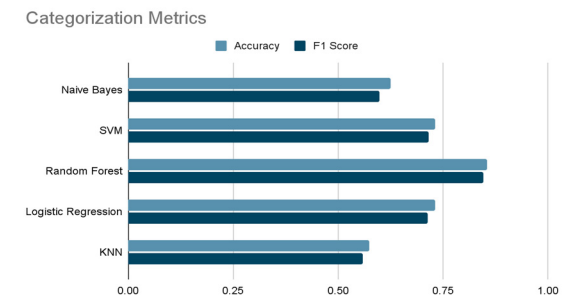

Figure 3: Graph comparing various Categorization techniques and their F1 and accuracy scores.

Although they are good substitutes, SVM and Logistic Regression fall short of Random Forest's abilities.Naive Bayes and KNN are less effective for text categorization tasks like this.

Random Forest is the best algorithm for classifying news items, surpassing the other models in terms of precision-recall balance and accuracy

Table 3: Comparison Table of Recommendation Algorithm

MODEL	RMSE	PRECISION	RECALL
KNN	1.0183	0.6788	0.2602
SVD	0.9378	0.6292	0.2283
BASELINE	0.9460	0.5791	0.2059

When compared to the other algorithms, SVD algorithm has least RMSE (Root Mean Square Error) and second highest Precision and Recall of all the algorithms. The highest Recall and Precision of all the algorithms is achieved by the KNN collaborative filtering. SVD is the best overall algorithm since it balances the accuracy (RMSE) with recommendation quality.

KNN has high recommendation quality but low accuracy. Baseline is a simplistic algorithm and hence fares poorly in comparison to the other two algorithms.
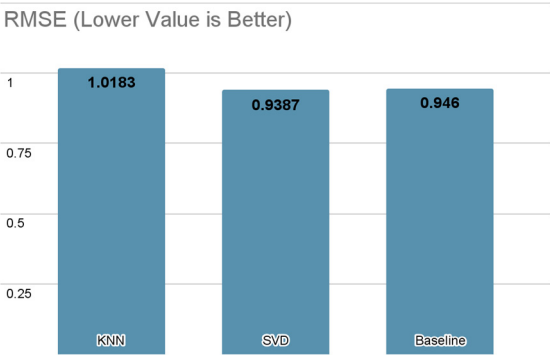

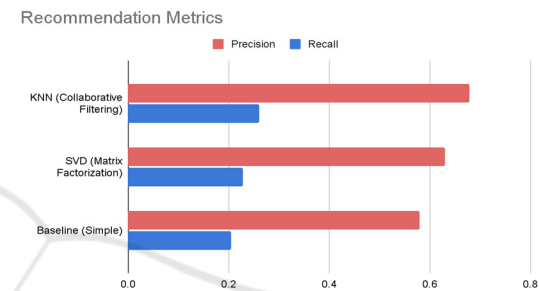Figure 4: Graph comparing the RMSE of various recommendation algorithms.

Figure 5: Graph comparing the Precision and Recall of various recommendation algorithms

SVD is the best overall algorithm for recommendation with lowest RMSE and relatively higher recommendation quality.

9 CONCLUSIONS

This paper is presenting Machine learning based algorithms for news aggregation , summarization and categorization based on specific performance metrics. Algorithms like BART, Random forest etc help in outperforming traditional models in similar applications. The findings underscores the value of employing machine learning algorithms in such applications where the ability to maintain context and avoid algorithmic bias is important.

While this current project has been effective future enhancements can be made:

MultiLingual News Processing: The current model employs the usage of english alone. In the future many other languages can be added for a more comprehensive model targeting many more users.

Real-Time Data Integration: The current model relies on previous news articles. Future enhancements

can include real time news data streams including live news for events like sports matches, elections etc.

User Interface and Visualization: A much more user friendly interface employing interactive visuals can improve accessibility for all demographics of users.

Recommendation Using Advanced Techniques: User data based recommendation systems can be integrated in future iterations in contrast with simple keyword based models employed currently.

News Verification: Faulty reporting can be an issue when employing such models hence future enhancements can include some checks to check for trusted sources of news which would be used for the model.

By including enhancements in these areas the model can be further improved to create a more user friendly, accurate and faster version. As news continues to inundate the world these enhancements would offer an even better method if tackling these issues.

REFERENCES

Sari, R. G., Saputra, M. A., & Zuliansyah, M. A. (2021). Text clustering with extended K-means algorithm for topics extraction on Indonesian news. *Journal of Computer Science, 14*(2), 123–135.

Al-Qurishi, F., Alkhateeb, A., & Basheri, M. (2020). Improvement of text clustering in English and Arabic news items using hybrid K-means with spherical fuzzy sets. *IEEE Access, 8*, 91432–91445. https://doi.org/10.1109/ACCESS.2020.2992305

Singh, S., & Singh, R. (2020). Improved text clustering algorithms for news articles using ant colony optimization. *International Journal of Information Management, 52*, 102–111. https://doi.org/10.1016/j.ijinfomgt.2020.102111

Li, Y., Feng, X., & Wu, H. (2020). Seq2Seq dynamic planning network for progressive text generation. *Proceedings of the AAAI Conference on Artificial Intelligence, 34*(5), 8398–8405. https://doi.org/10.1609/aaai.v34i05.6291

Santos, R. L., & Ribeiro, B. (2020). Using BERT for extractive summarization in the news domain. *arXiv preprint arXiv:2005.06548*. https://arxiv.org/abs/2005.06548

Zhang, X., Yu, L., Wang, J., & Zhang, Y. (2021). Extractive social media text summarization based on MFMMR-BertSum. *IEEE Transactions on Computational Social Systems, 8*(1), 107–116. https://doi.org/10.1109/TCSS.2020.2995774

Hasan, M. T., Islam, M. M., & Shahid, A. H. (2020). Unsupervised machine learning-based summarization of big data: The case study of news articles. *Information*

Processing & Management, 57(2), 102–119. https://doi.org/10.1016/j.ipm.2019.102066

Yang, K., Lee, T. S., & Jang, Y. S. (2021). Automated extraction and summarization of news websites using NLP and deep learning techniques. *Expert Systems with Applications, 159*, 113–125. https://doi.org/10.1016/j.eswa.2020.113431

Yadav, A. K., Singh, A., & Mathur, M. (2020). Investigating response behavior through TF-IDF and Word2Vec text analysis. *Journal of Information Science, 46*(3), 350–365. https://doi.org/10.1177/0165551519891483

Wang, J., Cui, P., & Li, X. (2021). Multilingual news aggregation using deep learning-based summarization techniques. *IEEE Transactions on Knowledge and Data Engineering, 33*(5), 2053–2066. https://doi.org/10.1109/TKDE.2020.2973742

Isbell, K. A. (2010). The rise of the news aggregator: Legal implications and best practices. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1670339

Athey, S., Mobius, M., & Pal, J. (2021). The impact of aggregators on internet news consumption. *National Bureau of Economic Research*. https://doi.org/10.3386/w28746

Lin, C.-Y. (2004). ROUGE: A package for automatic evaluation of summaries. *Meeting of the Association for Computational Linguistics*, 74–81. https://doi.org/10.3115/1072472.1072532

Barbella, M., & Tortora, G. (2022). ROUGE metric evaluation for text summarization techniques. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4120317

Yacouby, R., & Axman, D. (2020). Probabilistic extension of precision, recall, and F1 score for more thorough evaluation of classification models. *Eval4NLP*. https://doi.org/10.18653/v1/2020.eval4nlp-1.9

Fujino, A., Isozaki, H., & Suzuki, J. (2008). Multi-label text categorization with model combination based on F1-score maximization. *International Joint Conference on Natural Language Processing*, 823–828. https://www.aclweb.org/anthology/I/I08/I08-2116.pdf

Xiao, W., Zhao, H., Pan, H., Song, Y., Zheng, V. W., & Yang, Q. (2021). Social explorative attention based recommendation for content distribution platforms. *Data Mining and Knowledge Discovery, 35*(2), 533–567. https://doi.org/10.1007/s10618-020-00729-1

Tatiya, R. V. (2014). A survey of recommendation algorithms. *IOSR Journal of Computer Engineering, 16*(6), 16–19. https://doi.org/10.9790/0661-16651619

Yang, Y., & Liu, X. (1999). A re-examination of text categorization methods. *Proceedings of the 22nd Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, 42–49. https://doi.org/10.1145/312624.312647

Barbella, M., Risi, M., & Tortora, G. (2021). A comparison of methods for the evaluation of text summarization techniques. *DATA 2021 - 10th International Conference on Data Science, Technology and Applications*, 200–207. https://doi.org/10.5220/0010523002000207