



Advanced News Aggregation and Content Generation Using LLMs and NLP Algorithms

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ABSTRACT:

The exponential growth of digital information has created a unique opportunity in the media industry to leverage Large Language Models (LLMs) for news aggregation and content generation. This paper explores the application of LLMs and Natural Language Processing (NLP) for the automation of news aggregation and content creation. This study presents a system designed to automatically fetch news headlines and articles from various news portals, with an initial implementation involving four distinct sources. Utilizing a combination of advanced natural language processing techniques, including OpenAI text-embedding-3-large, UMAP, HDBSCAN, and cosine similarity, the system clusters similar headlines to identify overlapping news topics. It then generates a unique, paraphrased headline and relevant content by synthesizing information from all similar news articles, leveraging the gpt-4o-2024-08-06. After generating the new headlines and content, the system takes it a step further by automatically deploying the curated articles to an autonomous news portal. This seamless integration into the news publishing workflow ensures that the system operates entirely autonomously, without the need for human intervention. The AI-based news portal, powered by this system, continuously updates with fresh and unique content, offering users timely and comprehensive news coverage. By automating the entire process—from data collection and clustering to content creation and publication—this approach transforms traditional news aggregation into a fully autonomous, AI-driven news platform, effectively reducing redundancy and enhancing the reader's experience in a fast-paced information environment.

Keywords: Large Language Models (LLMs), media industry, news aggregation, content generation, OpenAI.

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INTRODUCTION

Transformer architecture [1] has revolutionized the field of Artificial Intelligence (AI) through its ability to process sequential data in an efficient and scalable manner. The vanishing gradient issues of its predecessors such as Recurrent Neural Networks (RNNs) and Long Short-term Memory Networks (LSTMs) were solved by transformers with its novel self-attention mechanism [2]. The ability of transformers to efficiently capture contextual dependencies and maintain sequence order through positional encoding ensures superior performance and scalability. Originally designed for tasks such as machine translation and text classification in NLP, transformers soon became widely adopted for a wide range of NLP tasks. Generative AI models, such as Generative Pre-trained Transformer (GPT) trained on extensive datasets, leverage transformer architecture to generate coherent texts and summarize content [3,4]. Due to the transformative potential of generative AI, it has been applied to a wide range of domains including education, healthcare, media, and e-commerce. For the analysis of recommendation bias caused by use of specific YouTube thumbnails [5] used GPT-4 vision to generate captions. In education, generative AI models are used to generate personalized learning materials and content recommendation systems [6]. In healthcare, such models are used in drug discovery and disease diagnosis [7]. Similarly, in the media industry, they are used for content generation and news aggregation [8]. Despite being implemented to solve the issues in the domain of NLP, transformers soon found applications in domains, including computer vision. Vision transformers (ViT) demonstrated high levels of performance in image recognition, segmentation, and object detection tasks with their ability to divide image data into patches and process them as sequences [9]. ViTs soon became a popular choice for image segmentation and object detection and classification in domains including healthcare, agriculture, and robotics, to perform tasks such as disease diagnosis, crop monitoring, and visual navigation [10,13].

The significant evolution of transformer architecture is demonstrated by the recent advancements in Large Language Models (LLMs) that includes models such as GPT series [11]. In recent years, the volume of information generated and shared online has reached unprecedented levels, creating massive opportunities for generating insights from such a large amount of data. Generating new content from a wide range of relevant sources has now become possible by leveraging the strengths of LLMs. Several studies have evaluated the possibility of leveraging LLMs for automated and expedited news generation. One such study provides a detailed analysis of interaction between journalists and LLMs to automate content creation and news generation [12]. Alternatively, LLMs have also been used in news recommendation systems to generate recommendations by using complex semantic information in news texts (Hao et al., 2023; Runfeng et al., 2023). However, there are ethical concerns about the use of AI and LLMs in journalism and several studies also discuss ethical issues as well as best practices on using LLMs in a journalistic context [13].

This study presents an innovative approach to develop a fully automated, AI-based news portal that not only aggregates news from multiple sources but also synthesizes unique content for each clustered topic, leveraging the capabilities LLMs and NLP techniques. The proposed pipeline collects relevant news articles from multiple trusted news portals, clustering similar news titles, and generating a new heading while keeping the originality of the meaning. Then, it paraphrases and summarizes the news before pushing it to an automated news portal, creating a completely autonomous news platform. This paper discusses the implementation of LLMs, the process of content generation, and the integration of the system into an automated news portal. The results of this research highlight the potential of artificial intelligence to transform the way news is aggregated and delivered in the digital age, with the probability of detecting false news as a future implementation.

METHODOLOGY

The research paper consists of creating an autonomous system that performs the entire news aggregation, synthesis, and publishing process. First, it collects news articles, and news headlines from many sources web scraping and APIs. To cluster similar headlines, we use advanced natural language processing techniques including OpenAI's text-embedding-3-large, UMAP, and HDBSCAN, to find overlapping topics between news headlines from different sources. We use GPT-



4 to paraphrase and merge the clustered information into original headlines and coherent articles. The curated content is then automatically deployed on an AI powered news portal for publication with no human intervention.

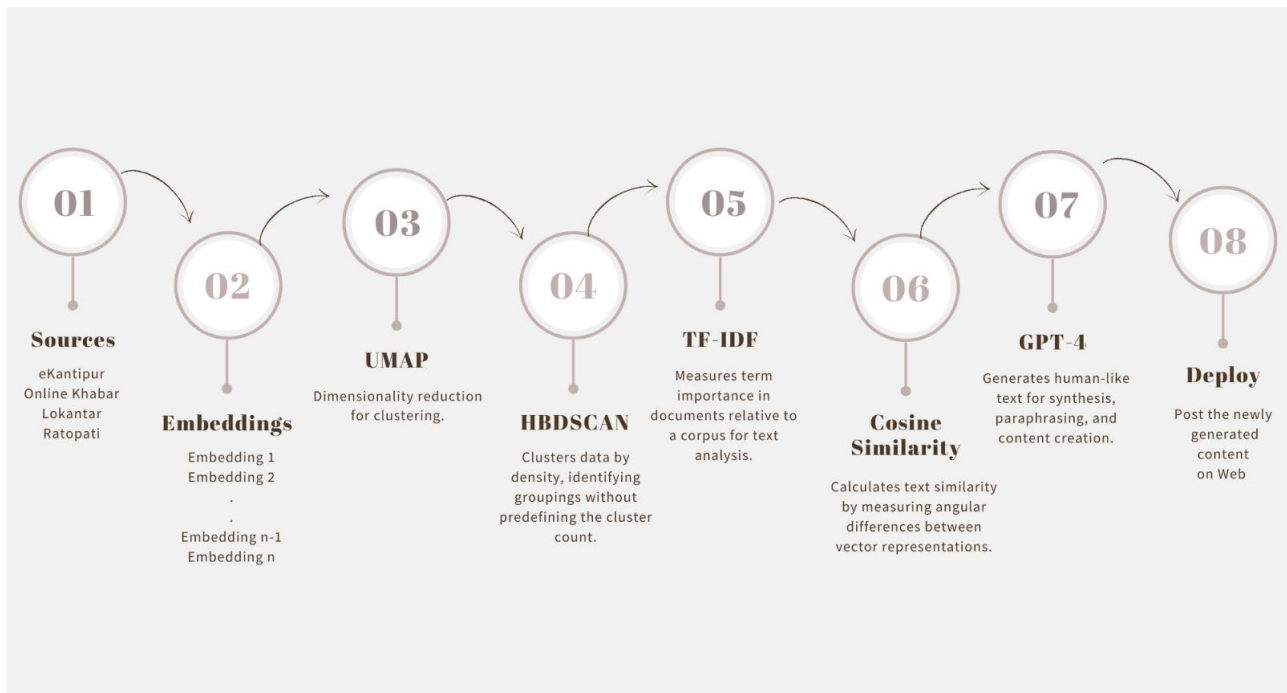


Figure 1. Methodology Steps Diagram

News Scraping

The first step is the methodical extraction of news information from many reliable web sources of Nepal, including eKantipur, Online Khabar, Ratopati, and Lokantar. A backend Node.js environment and several tools and frameworks, such as Express, Axios, Cheerio, and Node-Cron, are used to implement the process. The Express framework is used to build up the server and handle HTTP requests. The server is configured, and HTTP requests and responses are handled via the Express framework. Next, the news portal's RSS feed receives access requests from Axios, a promise-based HTTP client, which provides the response of recent news in XML format. Critical information such as news headlines, publication dates, article URLs, source names, content bodies, and author details are extracted by parsing the data.

Node-cron is a scheduler that uses cron job expressions to automate repetitive activities and schedule the periodic fetching jobs, keeping the news data current and relevant. The gathered information is then organized and saved as a JSON file, which acts as the central source of news data. The solution guarantees consistent and dependable access to the most recent news information by using cron tasks for routine updates and providing the data via an API. For the latter phases of clustering and content synthesis, which depend on precise and timely input, this data pipeline is essential.

Sentence Embedding

Sentence embedding is the procedure used in the project to transform the Nepali sentences into dense vector representations. We utilize the OpenAI text embedding 3 big to do this. The goal of this approach is to provide meaningful embedding that accurately capture the meaning of the phrase. The length of each phrase is encoded into a 3072-dimensional vector. Its concise form makes it especially helpful for large-scale text processing jobs that demand computing efficiency. Also, this conversion helps to use mathematical operations, such as cosine similarity, to determine the



closeness between sentences. This approach allows us to group similar news articles and headlines together based on their underlying meaning, rather than just keyword matching.

Uniform Manifold Approximation and Projection (UMAP) for Dimension Reduction

The next stage uses the UMAP algorithms to apply dimensionality reduction techniques to the high-dimensional sentence embedding produced by the Sentence Transformer model. The 3072-dimensional phrase vectors are reduced to a 2D space using this technique. Its fundamental goal is dimensionality reduction, which involves reducing computing complexity while preserving the data's crucial structure and facilitating simpler processing in subsequent clustering tasks. UMAP maintains the manifold structure of data by describing the high-dimensional graph that corresponds to the manifold and optimizing the lower-dimensional representation of that high-dimensional graph. Each phrase is given a two-dimensional representation at the end of this procedure, which is then used as input for the clustering algorithm in the following stage. The UMAP-implemented system balances a trade-off between computational complexity and data quality to accomplish efficient and accurate clustering of news contents in real time.

Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN)

For clustering the reduced-dimensionality sentence embedding produced by UMAP, Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN) algorithm is employed. It is particularly well-suited for clustering tasks involving data with noise and outliers, such as news articles. It operates by identifying regions of high density in the data and forming clusters around these regions, while also distinguishing noise and outliers that do not belong to any cluster. It does not require a pre-defined number of clusters, allowing it to adaptively find the best cluster structure based on the density of the data. This adaptability makes HDBSCAN more robust in scenarios where traditional algorithms, like K-Means would struggle to identify the correct number of clusters. When dealing with large volumes of news articles, directly comparing each sentence with every other sentence would be computationally expensive and time-consuming. HDBSCAN's density-based approach allows it to quickly identify clusters without requiring pairwise comparisons for every data point, leading to faster clustering results. The ability of HDBSCAN to handle noise, adapt to the data's structure, and operate efficiently ensures that the clustering process is both accurate and scalable, making it a key component of the system's overall functionality. Using HDBSCAN, the project achieves robust and reliable clustering, enabling the synthesis of unique headlines and content for news delivery.

Term Frequency-Inverse Document Frequency (TF-IDF) Vectorizer

The TF-IDF technique is used to transform textual information into numerical vectors. This method is used to show how important a word is in a document when compared to a group of documents, which is essential for efficiently comparing and grouping sentences. Inverse Document Frequency (IDF) gauges a term's rarity or uniqueness across all documents, while Term Frequency (TF) counts how often a word occurs in a text. By multiplying the term frequency by the inverse document frequency, the TF-IDF score is determined. This essentially up weights terms that are more specialized to a certain document and down weights phrases that are frequent in numerous articles. A vector representing the importance of the words in the document in relation to the total corpus is the output. The technique facilitates differentiating between phrases that are more specific to headlines or stories and those that are more frequent in news articles. When combined with cosine similarity, the TF-IDF outperformed Sentence-BERT embedding in capturing the differences between news headlines, making it simpler to recognize similar or distinctive headlines prior to the use of clustering algorithms.

Cosine Similarity

For a further assessment of how similar the sentences are to each other, we use Cosine Similarity to compare sentences in each cluster. In natural language processing, Cosine Similarity is utilized for measuring the similarity of two vectors more specifically in text-based applications and widely used in text vision. The Cosine Similarity is the cosine of the angle between two non-zero vectors in a multi-dimensional space. The cosine of the angle between two vectors ranges from -1 to 1, where a value of 1 indicates that the vectors are identical, a value of 0 indicates that the vectors are



orthogonal meaning they share no similarity and a value of -1 indicates that the vectors are diametrically opposed. Cosine Similarity is particularly useful for comparing text data because it focuses on the orientation of the vectors rather than their magnitude, making it robust to variations in sentence length.

Cosine Similarity allows for a fine-grained comparison between sentences, providing a precise measure of how similar or different they are. This is essential for tasks like synthesizing a unique headline and content, where subtle differences between sentences can have a significant impact on the final output. By calculating the similarity scores between pairs of sentences, the project ensures that only the most closely related sentences are combined when synthesizing new content. This use of Cosine Similarity as a final comparison step contributes to the overall accuracy and coherence of the system, making it a critical component of the text processing pipeline.

Large Language Models (LLMs)

The final phase introduces GPT-4o-2024-08-06. The extremely intelligent large language model from Open AI can create structured material, summarize, and paraphrase. It is renowned for its exceptional comprehension and production of human-like language, including the ability to produce coherent, grammatically correct, and cohesive paraphrases. For activities like synthesizing well-written and organized news stories, this is a very useful function.

A specific prompt for GPT-4o-2024-08-06 rigorously regulates and paraphrases texts in this system. The prompt used is, "I will give you two sentences separated by a colon. Just paraphrase the sentences, nothing else."

With this, the model does not need to fret about adding extra information anywhere. It creates a single paraphrased sentence by combining key concepts and removing repetition from a pair of sentences from the same cluster that meet certain similarity requirements. In addition to its paraphrasing capabilities, GPT-4o-2024-08-06 produces a structured output, or programmed output, which makes it particularly useful for applications that require significant organization. This technology, for example, ensures that each paraphrased sentence and headline is combined into a new structure that is logical in flow and free of repetition. The final news information is easier to read and use because to this methodical approach. It illustrates how AI can be used to automate and enhance content creation processes, notably in journalism, where accuracy, precision, and the ability to make sense of sounds are vital.

RESULTS

Results show how the proposed methodology can successfully cluster and analyze news headlines using dimensionality reduction, clustering, and similarity analysis techniques. As shown in the scatter plot, visualizing the UMAP algorithm demonstrated a successful reduction of high-dimensional embedding to a two-dimensional space that clearly separates clusters formed by HDBSCAN. It was found that the clustering process successfully separated disjoint sets of layers into distinct groups, with most groups almost completely mutually exclusive, suggesting that there were well-separated, meaningful divisions. HDBSCAN excluded outliers labeled as -1 to limit analysis to stable clusters at a persistence threshold of 0.192. Yet we observed some anomalies in clusters labelled 7, 37, and 89, where data points were split into two distinct regions, perhaps indicating subgrouping of these clusters. Only clearly defined clusters were retained for further analysis in order to produce synthesis steps of reliable subsequent results.

The analysis based on the cosine similarity gave further insights into the system's capacity to group the semantically similar headlines. Cosine similarity histogram showed 6 pairs with scores between 0.95 — 1 being indicative of highly similar content and with likely similar news topic being reported by the sources. Furthermore, five pairs produced scores between 0.65 and 0.7, which are moderate similarity and sharing overlapping themes. These results confirm the ability of the algorithm to semantically cluster content, minimizing redundancy and improving synthesized information relevance.



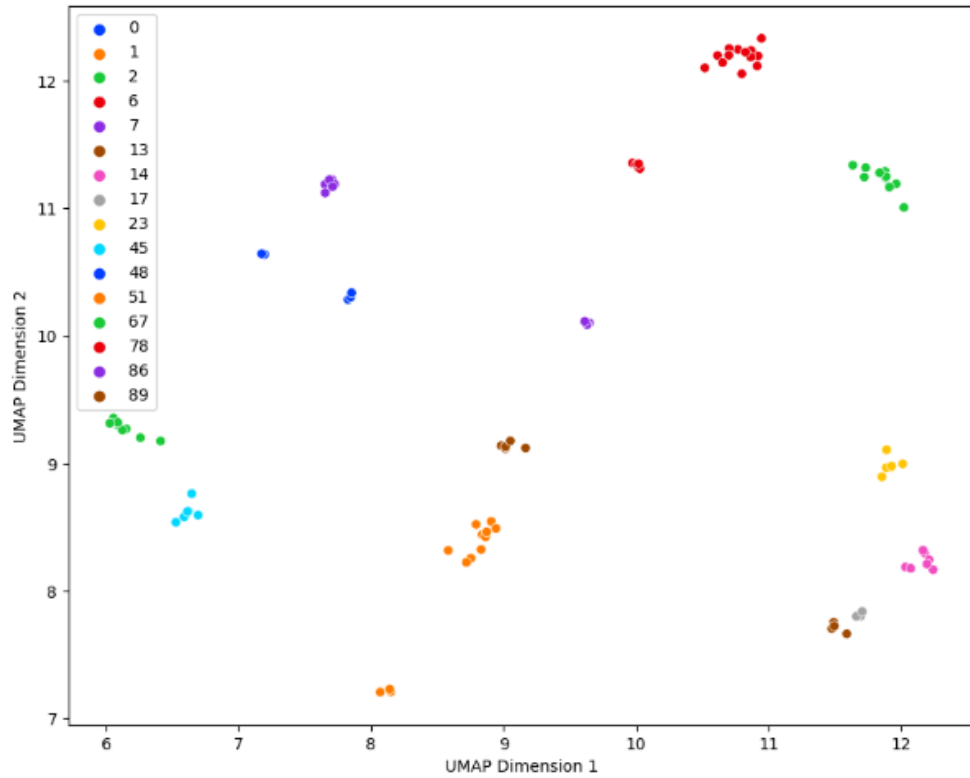


Figure 2. Clustering Diagram

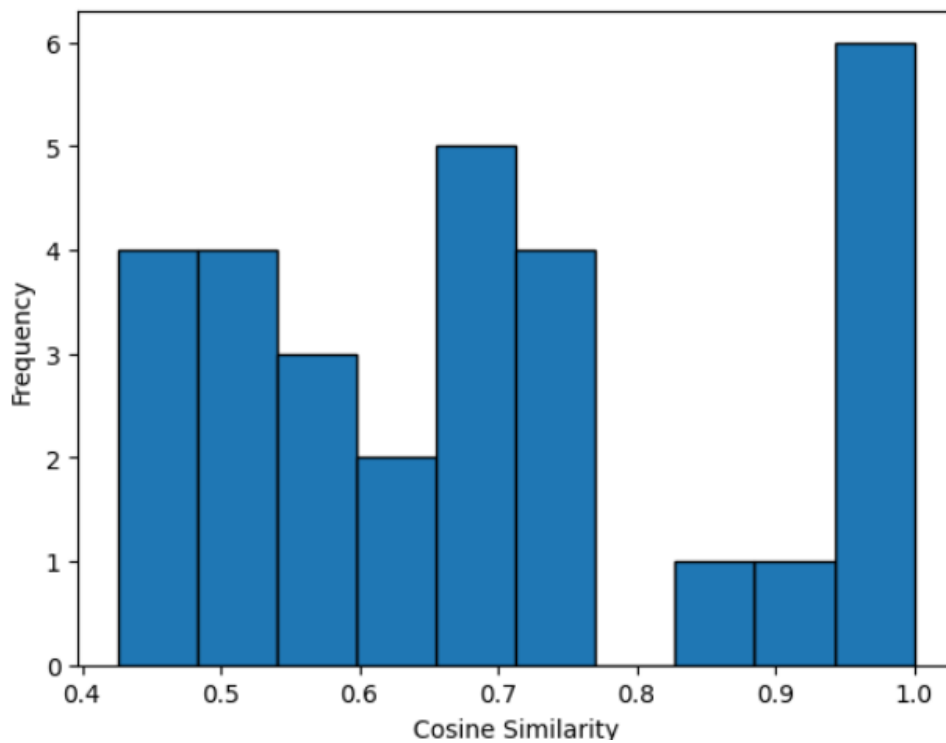


Figure 3. Distributions of Heading Pairs Based on Their Cosine Similarity

In the table, similar headings are effectively identified. For example, headings in cluster 14 show a cosine similarity of 1, while headings in cluster 17 have a cosine similarity of 0.89. Despite having



different wordings, the headings in both clusters are nearly identical. After identifying these similar headings, the corresponding news content is paraphrased using GPT-4o.

Table 1. Cosine Similarity of Clustered News Headlines from Multiple Sources

S.N.	Heading 1	Translated Heading 1	Heading 2	Translated Heading 2	Source 1	Source 2	Cluster Number	Cosine Similarity
1	रवि लामिछानेलाई थप ४ दिन हिरासतमा राख्न अनुमति	Permission to keep Rabi Lamichhane in custody for 4 more days	रविलाई थप चार दिन हिरासतमा राख्न अनुमति	Permission granted to keep Ravi in custody for an additional four days.	eKantipur	Lokantar	14	1
2	दुर्गा प्रसाईको रिट खारेज, बैंकलाई ऋण असुली गर्ने बाटो खुल्यो	Durga Prasai's writ petition dismissed, paving the way for banks to recover loans	दुर्गा प्रसाईको रिट खारेज, ऋण असुली गर्न बैंकलाई सहज	Durga Prasai's writ dismissed, facilitating loan recovery for the bank.	Lokantar	Ratopati	17	0.9

Also, the table below illustrates the paraphrased content, demonstrating the effectiveness of the paraphrasing process for Nepali text. It showcases how well the content was transformed while preserving its original meaning.

Table 2. Original and Paraphrased News Content Generated by GPT-4o

Content	GPT-40 Paraphrased Content
सहकारीको रकम अपचलनमा संलग्न रहेको आरोपमा पक्राउ परेका पूर्वगृहमन्त्री रवि लामिछानेलाई थप ४ दिन हिरासतमा राख्न कास्की जिल्ला अदालतले अनुमति दिएको छ । जिल्ला सरकारी वकिल कार्यालयले मिसिल अध्ययन गर्नुपर्ने भन्दै चार दिनको समय मागेको थियो । जिल्ला न्यायाधीवक्ता कमला काफ्लेले अदालतबाट ४ दिनको अनुमति पाएको लोकान्तरलाई बताइन् । पुस ५ मा सरकारी वकिल कार्यालयले राष्ट्रिय स्वतन्त्र पार्टीका सभापति समेत रहेका रविविरुद्ध अदालतमा अभियोजन गर्दैछ । गैरकानूनी थुनामा राख्न नमिल्ने भएकाले रविलाई हिरासतमा राख्न प्रहरीले अदालतको अनुमति लिएको हो ।सोमबार प्रहरीले अनुसन्धानको मिसिल सरकारी वकिल कार्यालयमा बुझाएको थियो । रविलाई गत कात्तिक २ मा काठमाडौंको वनस्थलीबाट पक्राउ गरिएको थियो । सूर्यदर्शन सहकारीको रकम अपचलनमा संलग्न आरोपमा रवि र पूर्वडीआईजी छविलाल जोशीसहित ५ जना कास्की प्रहरीको हिरासतमा छन् ।	पूर्वगृहमन्त्री रवि लामिछानेलाई सहकारीको रकम दुरुपयोगको आरोपमा थप ४ दिन हिरासतमा राख्न कास्की जिल्ला अदालतले अनुमति दिएको छ। सरकारी वकिल कार्यालयले मुद्दा अध्ययनका लागि समय मागेपछि अदालतले यो निर्णय गरेको हो। न्यायाधीवक्ता कमला काफ्लेका अनुसार अभियोजन दर्ता गर्न पुस ५ सम्म म्याद थप गरिएको छ। गैरकानूनी रूपमा हिरासतमा राख्न नमिल्ने प्रावधानका कारण प्रहरीलाई अदालतबाट स्वीकृति लिनुपर्ने भएको थियो। सोमबार अनुसन्धानको कागजात सरकारी वकिल कार्यालयमा बुझाइएको थियो। रविलाई कात्तिक २ मा काठमाडौंको वनस्थलीबाट पक्राउ गरिएको थियो। सूर्यदर्शन सहकारीको रकम अनियमितताको विषयमा रवि, पूर्वडीआईजी छविलाल जोशी, र तीन अन्य व्यक्ति हाल कास्की प्रहरीको नियन्त्रणमा रहेका छन्।

DISCUSSION

The methodology employed in this project demonstrates a robust and effective pipeline for news scraping, processing, and content synthesis, particularly for Nepali text. By leveraging modern tools and techniques across multiple stages, the system ensures accuracy, scalability, and coherence in its outputs.

The scraping process effectively utilizes a Node.js-based architecture with frameworks like express, axios, cheerio, and node-cron. This combination provides a reliable backend environment for fetching, parsing, and structuring news articles from various online portals. The use of periodic cron jobs ensures that the scraped data remains up-to-date, a critical factor in delivering timely and relevant news content. By structuring and storing the data in JSON format, the project creates a reusable and dynamic data repository, forming the foundation for subsequent analysis.



The transition to sentence embedding with OpenAI's text-embedding-3-large model marks a key step in the pipeline. The 3072-dimensional embedding generated are both meaningful and computationally efficient, capturing the semantic essence of the sentences for tasks such as clustering and similarity comparisons. This approach moves beyond traditional keyword-based methods, enabling a deeper understanding of the relationships between news headlines and content.

To address the computational complexity of working with high-dimensional embedding, UMAP effectively reduces the dimensionality to two, preserving the core structure of the data while enabling visualization and clustering. The application of HDBSCAN further enhances this process, identifying distinct clusters while filtering out noise and outliers. The density-based nature of HDBSCAN, combined with its adaptability, allows for robust clustering, even in noisy datasets like news articles.

The integration of TF-IDF vectorization and cosine similarity adds another layer of precision to the system. TF-IDF helps distinguish key terms in the dataset, and cosine similarity provides a quantitative measure of similarity between pairs of sentences, facilitating accurate clustering and pairing of content. This hybrid approach ensures that clusters are both semantically meaningful and computationally feasible.

The use of GPT-4O-2024-08-06 for paraphrasing and structured content generation highlights the system's ability to produce polished and human-readable outputs. The model's contextual understanding ensures that paraphrased sentences retain their original meaning while eliminating redundancy, enhancing the usability of the final outputs. The structured JSON-based results further streamline downstream applications, such as automated news delivery.

The results demonstrate the system's effectiveness. Clear clusters are formed, with outliers filtered out, ensuring high-quality data for analysis. The observed cosine similarity ranges validate the clustering and paraphrasing processes, with high similarity pairs showcasing the precision of the pipeline. The paraphrased content successfully preserves meaning while improving readability, meeting the project's goals.

CONCLUSION

This project effectively combines advanced tools and methodologies to create a comprehensive pipeline for news scraping, clustering, and content synthesis. The multi-stage process—from data extraction to paraphrased content generation—ensures high-quality, semantically accurate outputs. By leveraging cutting-edge models like text-embedding-3-large, UMAP, HDBSCAN, and GPT-4O-2024-08-06, the system addresses the challenges of processing noisy and unstructured datasets, achieving both scalability and robustness.

Key outcomes include the successful identification and clustering of similar news headlines and content, the generation of paraphrased outputs with preserved meaning, and the ability to handle noise and outliers effectively. These results demonstrate the potential of AI-driven methodologies in automating and refining content creation processes, particularly in journalism. Future enhancements could explore real-time sentiment analysis, multilingual support, and further optimization for computational efficiency, expanding the system's applications and impact.

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