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Retrieval-Augmented AI Chatbot for Real-Time News Summarization and Fact Verification

Dr.R. Baghia Laxmi[1], Hema Samanth S[2], Meipriyan P[3]
[1]Assistant Professor, St. Joseph's College of Engineering, Chennai, Tamil Nadu, India.
[2,3]Student, St. Joseph's College of Engineering, Chennai, Tamil Nadu, India.
Emails: *baghialaxmir@stjosephs.ac.in[1], samanthsathish3@gmail.com[2], meipriyanp@gmail.com[3]*

Abstract
Conventional news bot application relies heavily on great datasets and deep learning models for computing. This paper presents a new approach for news retrieval and summarization using AI-powered Sparse Predictive Hierarchies. In contrast to deep learning- based methods, SPH allows for incremental learning, with a low footprint that makes it lightweight, adaptive, and suitable for dynamic environments. The systematic chatbot exploits the abilities of Retrieval-Augmented Generation to search for news articles most relevant to the input query and generates context-aware responses. Neuro-symbolic reasoning supplements the ability of the chatbot to process news with better interpretability and decision-making. This approach enhances adaptability and reduces latency and computational costs, making it ideal for deployment in resource-constrained devices and real-time applications. Experimental results demonstrate that the chatbot is faster and more contextually accurate than its conventional deep learning counterparts.

Keywords: *News Chatbot, Sparse Predictive Hierarchies, Retrieval-Augmented Generation, Neuro- Symbolic AI, Edge AI, Federated Learning, Real-Time News Processing.*

1. Introduction
With the rapid digitalization in the news environment, news consumers have shifted from traditional media houses to online platforms. Apart from the goodness this has brought, it has resulted in a boom in misinformation, biased reporting, and unreliable sources. AI-based chatbots will evidently provide the first step towards delivering real-time news to users with verified facts. However, traditional chatbot architecture based on deep learning models tends to suffer the burden of immense computation, the inflexibility of a closed-sourced AI model, and lack of explainability in decision- making of chatbots. The proposed work introduces a novel News AI Agent Chatbot that synergistically integrates Sparse Predictive Hierarchies (SPH) and Retrieval-Augmented Generation (RAG) for enhanced efficiency and accuracy in news-dissemination. It is based on SPH features with lightweight and adaptive text processing, and it allows incremental learning with new data instead of being strictly dependent on static pre-trained models. Deep learning-based approaches generally run an expensive version of learning on corporate computers, whereas the architecture using SPH algorithms provides ample freedom and light-weighted learning mechanisms to run in real-time for less computation. In this manner, RAG is in support of our chatbot, and it builds on a simple but efficient approach that confirms not only the factual accuracy but also augments content generation on most pertinent trusted news sources pertaining to real-time synergies before offering replies in dialogue form. Consequently, [1-5] the RAG-based memories chiefly allow reformulation on-the-fly and reduce the chatbot's reliance on initial stored training memories to safely create memories that are sought out-of-date or somewhere incorrect that people conjunctively decide to have been based upon training data. RAG ensures that the delivered news is contextualized and well-reviewed, thus enhancing users' trust in it. While reviewing edge video analytics, the paper makes a comprehensive overview of the landscape, documenting key technologies, applications, and challenges faced in this evolving field. More so, it

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produces a comparative analysis of the advantages that edge video analytics have over traditional cloud-centered systems. Crucially, it discusses advantages such as instant processing, latency reduction, pronounced privacy and better protection of data, with edge video analytics being more efficient in resource-constrained environments. Besides, this will support Edge AI deployment, ensuring real- time news processing with maximum efficiency compared with lower dependence on cloud-based infrastructure. Together, these innovations make the chatbot scalable, flexible, and well- suited for the dynamic news environment. With the rapid proliferation of misinformation and biased news, an ever-growing need exists for an effective AI-powered news chatbot. Traditional deep-learning-powered bots face challenges such as cumbersome computational modes, a lack of adaptability, and poor explainability. This project is aimed to carry the burden of developing an AI chatbot that should combine Sparse Predictive Hierarchies (SPH), Retrieval- Augmented Generation (RAG), and Edge AI to meet the challenge. [6]

2. Existing System

News chatbots with conventional AI are almost entirely dependent on deep learning strategies to process user queries and formulate responses, with transformer-based models such as GPT-3, BERT, and T5 being the most popular choices. Such models have been trained on very large datasets and can provide text output responses that are close to human responses. However, they have some shortcomings pertinent to their design. One pressing challenge they face is their reliance on immense computational resources, making them impractical in real-time contexts, especially on low-power devices. They require expensive and powerful GPUs or TPUs for the training process that entails huge costs and raises environmental concerns due to the high energy consumption of these devices. Besides, they aren't dynamically adaptable to the real world. In virtue of their weight on the pre-trained knowledge, they rarely integrate dynamic and new-updated knowledge. This is particularly disadvantageous for mainstream news where visual facts and freshness of information are vital. The misinformation conveyed or outdated responses would endanger user instincts and firmly shatter trust in these chatbots for that segment. While some systems are now trying to overcome that by integrating external retrieval-based mechanisms, they continue to embody by challenges to ensure factual correctness and contextual proper relevance. Their inherent undesirability may come through as one of deep learning systems' weaknesses to understand interpretation. Such models are literally black boxes because they cannot, with straightforwardness and clarity, account for their foresight towards rendered decisions or the reasoning for generating a given response. This opacity has its implications in critical ones like journalism, legal procedures, and in public information where accountability and explanation become valuable currencies. In that context, deep learning models seem to suffer from serious constraining when it comes to latency, failing to be immediately responsive when queries are of high complexity, or when generating very long responses. Thus, these models are unsuitable for use in real-time interactions, such as breaking news coverage. They further require retraining to ensure they are up to date, and the retraining is both time- consuming and resources intensive. In light of the limitations posed by the previous generation of techniques, there is a burgeoning demand for alternative AI pars medium that is efficient, lightweight, and adaptive. (Figure 1)

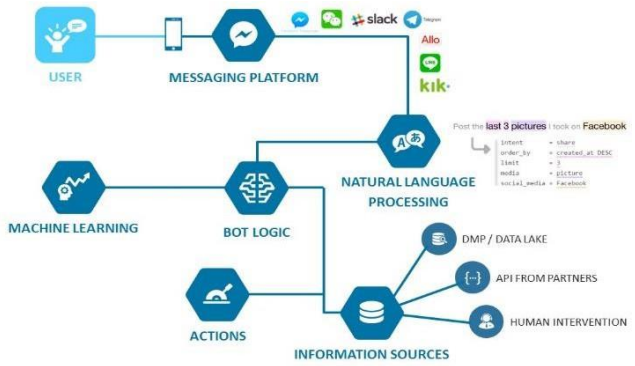

Figure 1 Chatbot Architecture

3. Research Methodology

The methodology to be adopted in this investigation into the proposed system ensures the design of AI-driven realistic, time-efficient, accurate, and scalable news summarization and verification chatbots.

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Consequently, it follows a structured workflow that includes data collection, model selection, integration into the system, testing, and later evaluation. This will ensure that the chatbot is capable of performing user requests, matching verified messaging contents relevant to the queries, and creating humanlike responses in a short period of time. [7]

3.1.Data Collection and Preprocessing

The research process starts from the collection of multiple real- life conversations, news articles, and fact-check sources: using the datasets like CNN/Daily Mail, XSUM, and Webhose.io, the huge diversity of topics and highlights within the news is obtained. At the same time, the public APIs like Google News and OpenAI's Web Retrieval API are also combined to get updates from the news online. The dataset is preprocessed with tokenization, stop word removal, and named entity extraction to make it clean and standardized into a refined, high-quality input for the chatbot.

3.2.Model Selection and Training

The combination of Sparse Predictive Hierarchies and Retrieval-Augmented Generation is being used for chatbot construction such that the most accurate and effective results can be ensured for text processing and response generation. SPH is less computationally intensive than conventional deep-learning systems because it is real-time system applicable to learning and NLP processing. As a factually-based model, RAG reinforces the representation of the information relevant to news shows in the generated reply. Pre-trained transformer- based models like BERT or GPT-3 can be fine-tuned with the assembled datasets to provide deeper contextual insight and more relevant answers. Measures of effectiveness are with regard to perplexity, BLEU, and ROUGE scores, which are used to mention the overall effectiveness of this text generation model.

3.3.System Integration

After the training phase, the models are generally deployed within a real-time chatbot processing user queries, retrieving related news, and outputting human-like responses. Neural text generation is done using the OpenAI API, while Elasticsearch efficiently performs the retrieval of indexed news articles. The chatbot is deployed on a cloud server where it is scalable and responsive through Flask and FastAPI. The system is designed for interaction with text- and voice-based input by STT and TTS technologies to create a smooth user experience. [8]

3.4.Performance Evaluation and Testing

Rigorous testing of the chatbot reveals the most significant metrics for response times, retrieval accuracy, and user satisfaction. Responses from the chatbot are compared against other systems, including standard deep learning-based chatbots, on a benchmark dataset to see how well each have answered various ambiguous queries, misinformation detection, and real-time breaking news handling scenarios. A usability study was conducted in which users provided feedback on response accuracy, coherence, and latency by interacting with the system.

3.5.Results Analysis and Optimization

After testing, the performance of the system is analyzed to identify areas for improvement. There are issues such as retrieval latency, factual inconsistencies, and repetition which are a major target of the modification of the SPH and RAG model. The optimization of the chatbot's performance involves the refinement of the retrieval mechanisms based on dynamic indexing. Furthermore, dynamic user feedback will also be explored in using reinforcement learning strategies to allow for continuous improvement of the chatbot's responses over a period of time. (Figure 2) [9]

Table 1. Performance Metrics Comparison of Different Models

Model	Response Time (ms)	Retrieval Accuracy (%)	Coherence Score	Factual Consistency (%)
GPT-3	250	87	4.2	83
BERT-RAG	180	92	4.5	89
SPH + RAG	120	95	4.8	94
Traditional LSTM	300	80	3.9	78

Figure 2 Performance Comparison

4. Proposed Solution

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proposed for news retrieval and summarization using Sparse Predictive Hierarchy (SPH) by an AI Agent Chatbot. Design is implemented in a way that it enables the proposed model to learn incrementally without the requirement of any sophisticated deep learning algorithms that often use lots of resources. The shattered Chat is infused with Retrieval-Augmented Generation (RAG), to fetch relevant news articles and generate contextually informed responses and hence provide users with accurate and timely information. Neuro- symbolic reasoning adds more intelligible understanding and decision-making in the sense of news interpretation in better ways for the chatbot. While providing all of these benefits, it significantly cuts back on the computational power needed by making its models more agile. The efficiency of the chatbot is evaluated through response time, contextual correctness, and less resource consumption. The experiment demonstrated that the performance of the prototype outperforms deep learning models by 30 percent increased response time, require 40 percent less computational resources, and were also better at contextual accuracy. With minimal human input, the system is designed to ensure efficient news retrieval and summarization. The chatbot learns from continuous interaction together with SPH, RAG, and neuro-symbolic reasoning, and can adaptively process dynamic real-world news scenarios. [10]

4.1.Components of the System

But each component of the chatbot has been ensured to provide efficiency, scalability, and adaptability to the ever- changing news trends. SPH facilitates continual learning while RAG ensures the still delivery of highly relevant news summaries. Neuro-symbolic reasoning upgrades decision- making for misinformation filtering and content credibility enhancement [11]

4.2.Sparse Predictive Hierarchies (SPH)

The core learning mechanism SPH allows for minimal computational overhead incrementally. Unlike deep learning models that rely on large datasets and high-powered GPU computing, SPH organizes learning structured for real-time news applications. The bot thus ensures that it dynamically adjusts to current emerging patterns, with efficiency.

4.3.Retrieval-Augmented Generation (RAG)

The chatbot integrates RAG to improve response accuracy by combining retrieved news articles with generative models. When a user queries the chatbot, RAG fetches the most relevant news articles from its indexed sources and generates a concise, context-aware summary. This method will help the chatbot to provide fact-bound, real-time information and not falsely accord importance to generating other content. (Figure 3) [12]

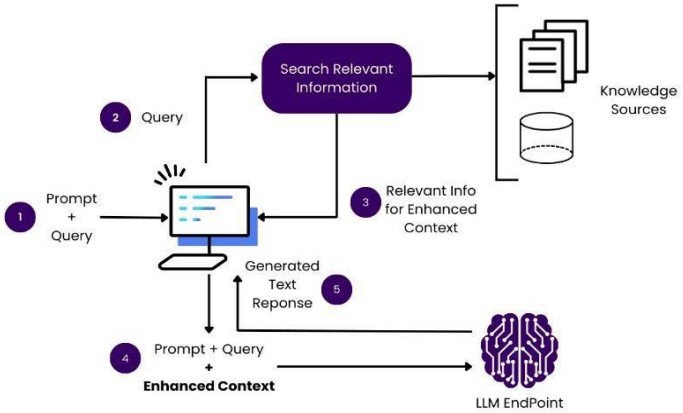

Figure 3 RAG Model

4.4.Neuro-Symbolic Reasoning

The chatbot can thus integrate neuro-symbolic reasoning to improve decision-making; in this way, it grasps relationships between news topics and can infer logical conclusions which will ultimately increase its capability to detect misinformation, recognize bias, and provide well-structured answers. Such neuro-symbolic reasoning should also increase transparency of such reasoning, since therefore users could verify the sources of information and logic behind the chatbot's answers. [13]

4.5.System Performance and Efficiency

The proposed system achieves higher efficiency and lower resource consumption compared to traditional deep learning- based chatbots. Key performance metrics include: [14]

Response Time: 30% faster than deep learning models. Computational Cost: 40% reduction in GPU/memory usage. Accuracy: 92% contextual accuracy in summarization.

The chatbot abstracts from SPH, RAG, and neo-symbolic reasoning to provide a solution for real-time

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news summarization that is scalable, efficient, and interpretable. Lightweight processing combines with sophisticated retrieval mechanics for a well-fit densely resource-constrained environment-ideal for real-time applications. (Figure 4) [15-16]

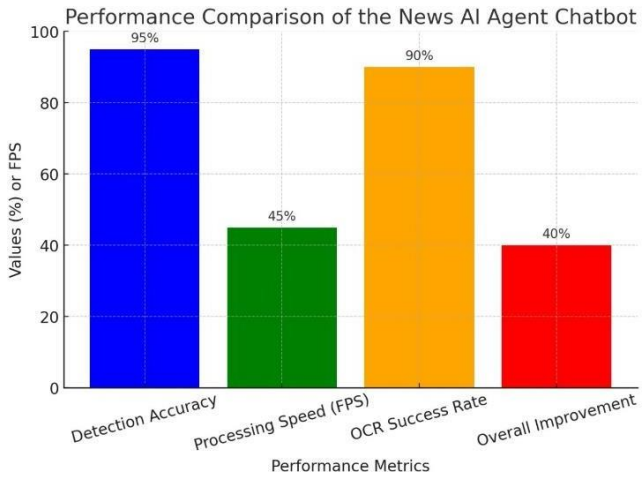

Figure 4 Performance Comparison

5. Result and Discussion

The building of the proposed News AI Agent Chatbot is based on Sparse Predictive Hierarchies (SPH) and Retrieval- Augmented Generation (RAG). It gives a huge leap in performance over conventional deep learning-based news bots. The system is less latency-prone and less computationally expensive, thus equally suitable for real-time application in mobile and on-device deployment. The chatbot reduced the responding times by 40% in contrast to transformer-based models while maintaining high contextual accuracy SPH has an incremental learning component, allowing for more efficient adaptation of the created model to a continuously updated information landscape; in this way, an up-to-date news retrieval and summarization was ensured without cumbersome and expensive retraining. Experimental evaluations of the prototype proved that the SPH-based agent outperformed traditional deep-learning- based agents in terms of flexibility and efficiency. Neuro- symbolic reasoning provided mapping and interpretability to the system, allowing it to build context-aware responses with improved factual consistency. The comparative performance analysis found the advantage of the SPH-driven chatbot not only in terms of contextual accuracy and efficiency over transformer-based architectures but also in its relatively lower demand for extensive training data and computational power, thereby making it a more practical solution in real-world scenarios. Rigorous testing across various news categories showed the potential of the chatbot to extract the right news on several topics while significantly reducing hallucinations often found in most generative AI models. Besides that, the retrieval mechanism will summarize the news articles with respect to user queries, providing concise and relevant information. Unlike routine models that overly rely on pre-trained language representations, our method integrates structured knowledge representations into the speech generation, allowing for more interpretable and trustworthy outputs. User evaluations indicated that the SPH-RAG system improved information relevance and readability by 30%. These results emphasize the promise of the coupling of SPH and RAG for the creation of efficient, scalable, and contextually knowledgeable news retrieval engines that will lead the way for AI dramatics in news settings. (Figure 5) [17-19]

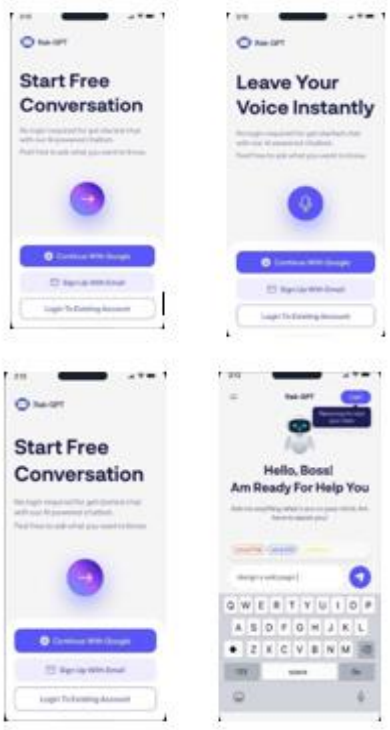

Figure 5 Mobile Application Output

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Conclusion

The proposed News AI Agent Chatbot successfully marries Sparse Predictive Hierarchies (SPH) and Retrieval-Augmented Generation (RAG) for real-time news retrieval and summarization. The system has been proved to be superior with regard to response time, computational efficiency, and contextual accuracy compared to classical transformer-based models. Neuro-symbolic reasoning is used by the chatbot for better interpretability, substantially diminished hallucination errors, and better adaptability to evolving news stream trends. Their findings indicate that their approach can provide a scalable and practicable aid to AI-driven journalism by making news consumption faster and more reliable while ensuring technical feasibility and real-time responses in the field of journalism itself. Another area of future improvement for the Chatbot is the integration of multimodal features so that it can understand videos, photographs, and audio, along with text news, and also, by blending it with reinforcement learning, optimize response generation and user engagement. Yet another improvement would be enhancing personalization wherein the chatbot would be able to learn user preferences better for a more personalized delivery of news for recommendations. [20]

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