

# **Reality Check**

Submitted in partial fulfillment of the requirements of the degree

## **BACHELOR OF ENGINEERING IN COMPUTER ENGINEERING**

By

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# CERTIFICATE

This is to certify that the Mini Project entitled “ **Reality Check** ” is a bonafide work of **Somya Jain (30), Simran Karamchandani (37), Tanisha Pandit (46), Saniya Dangat(14)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of “**Bachelor of Engineering**” in “**Computer Engineering**” .

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# Mini Project Approval

This Mini Project entitled “Reality Check” by **Somya Jain (30), Simran Karamchandani (37), Tanisha Pandit (46), Saniya Dangat(14)** is approved for the degree of **Bachelor of Engineering in Computer Engineering**.

## Examiners

1.....  
(Internal Examiner Name & Sign)

2.....  
(External Examiner name & Sign)

Date: Place:

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## **Abstract:**

Misinformation can cause public confusion, political polarization, and potential harm to public health and safety. This underscores the need for accurate identification of false news. Although fact-checking websites provide essential services, their manual processes restrict their scalability and coverage, and the data they rely on to fact-check user queries is often outdated. While numerous models currently exist, our model is designed to significantly enhance the accuracy of fact-checking while keeping it up to date. This research proposes the development of an automated, web-based fact-checking platform to address this challenge. Our solution, which is a large language model (LLM), leverages a specialized, continuously updated dataset sourced from credible RSS feeds and web scraping techniques to enhance fact-checking accuracy within specific domains. The platform will feature a user-friendly interface, enabling users to submit claims and receive detailed verification results, including explanations and sources. We will evaluate and refine various models to address domain-specific challenges, aiming for a highly accurate fact-checker

## **Acknowledgement:**

We would like to express our sincere gratitude to Vivekanand Education Society's Institute of Technology for their support throughout our project. Their assistance in gathering project-related information was invaluable.

We are delighted to extend our heartfelt appreciation to Mr. Richard Joseph, our TE Mini-Project Mentor, for his generous assistance and valuable advice in developing the project synopsis. His guidance and suggestions were instrumental in our project's development.

Our profound thanks go to Dr. (Mrs.) Nupur Giri, the Head of the Computer Department, and Dr. (Mrs.) J.M. Nair, our Principal, for granting us the opportunity to undertake this project. Their support was essential in successfully completing both the project synopsis and project review.

We would like to express our deep gratitude to all the teaching and non-teaching staff for their unwavering encouragement, support, and selfless assistance throughout the project. Their contributions were indispensable to our project's success.

## **List of Abbreviations:**

LLM : Large Language Model

RSS: Really Simple Syndication

RAG: Retrieval Augmented Generation

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# 1. Introduction

## 1.1 Introduction:

Fake news is a serious problem that can mislead the public, fuel animosity, and distort reality. The emergence of advanced language models like ChatGPT has exacerbated this issue due to their tendency to hallucinate; thus, the aim is to reduce these hallucinations because if the language model has accurate data to generate responses from, the chances of absurd outputs decrease. Additionally, the vastness of the internet contributes to the spread of misinformation. While fact-checking websites such as PolitiFact and Snopes provide valuable services, their manual approach limits their capacity to keep up with the overwhelming volume of content. Several existing models use both text and images to substantiate their claims, but they often struggle with accuracy. These models generally involve retrieving evidence, assessing claims, and generating explanations, revealing significant limitations in their effectiveness.

We believe that a novel approach is essential to achieve substantial progress in this field. Therefore, we propose automating the fact-checking process through the development of a specialized dataset tailored for specific domains like history, science, and sports. This dataset would facilitate the customization of language models, enhancing the scope and efficiency of fact-checking by leveraging advanced open-source models to systematically evaluate and verify claims. Through rigorous experimentation with various models, we aim to develop a highly accurate fact-checker.

In the fast-paced world of news, where updates occur every second, it is crucial to utilize resources such as RSS feeds to continuously update our model. While some existing models may be accurate, they often struggle with real-time relevance. Information that was previously false could become accurate over time, highlighting the urgent need for a system that remains current with the latest developments.



## 1.2 Motivation

The rise of misinformation has become a global issue, particularly as it infiltrates specialized fields such as sports, science, and history. Unlike general misinformation, which can often be easily identified, misinformation in these domains tends to be more subtle and complex. Inaccuracies can mislead people, distorting public knowledge and influencing opinions based on false or misleading claims.

In sports, misinformation may take the form of fabricated statistics, unverified rumors about athletes, or misrepresented historical events like match outcomes or record achievements. Misleading claims about an athlete's performance or fabricated stories about scandals can create confusion among fans and damage reputations. In science, the issue becomes more critical, as misinformation can spread harmful inaccuracies about discoveries, health guidelines, or technology. Unverified claims regarding vaccines, climate change, or medical treatments can lead to public distrust or poor decision-making. The rise of pseudoscience and manipulated studies have made it harder for the public to discern what is accurate. In history, misinformation often takes the form of revisionism, where facts are twisted or events reinterpreted to serve specific agendas. Misrepresentation of key historical events or figures can distort future generations' understanding, affecting collective memory.

To counter these challenges, a robust fact-checking mechanism is crucial. General-purpose fact-checking systems lack the domain-specific expertise required to handle nuanced claims in these specialized areas. Therefore, domain-specific fact-checking requires a system trained on authoritative data. The challenge lies in creating a system that reliably verifies information across these domains using trusted sources like government websites, encyclopedias, and peer-reviewed journals. The model must be fine-tuned and along with RAG implementation, the nuances of sports, science, and history, can be accurately distinguished between fact, opinion, and misinformation.

### 1.3 Problem Statement & Objectives

In today's information-driven world, the proliferation of misinformation is a significant concern. While general-purpose fact-checking tools exist, they lack the capability to verify facts accurately within specific areas. The challenge arises from the complexity of domain-specific knowledge, requiring a nuanced understanding to discern facts from misinformation. For example, fact-checking a player's performance or an event's statistics demands an in-depth grasp of the sport's history and context. In science, verifying claims about discoveries or health necessitates knowledge of rigorous scientific principles and credible references. Similarly, historical claims need verification against established records, which general-purpose fact-checkers may struggle to interpret accurately.

The absence of domain-specific fact-checking systems allows misinformation to spread unchecked, leading to confusion and mistrust. Thus, there is an urgent need to develop a system capable of addressing these gaps, utilizing advanced tools to verify facts based on curated, credible datasets..

#### **Objectives:**

1. **Domain-Specific Verification:** Build a fact-checking system that verifies information in sports, science, and history by fine-tuning LLMs like Llama on datasets from trusted sources such as government websites, encyclopedias, and scientific journals.
2. **Enhancing Accuracy and Reliability:** Train the model on curated, high-quality data, cross-referencing multiple credible sources to improve accuracy and provide reliable fact-checks.
3. **Filling Research Gaps:** Focus on in-depth, contextual verification within each domain to address the limitations of general-purpose fact-checkers.
4. **Improving Response Time and Efficiency:** Optimize the system to deliver fact-checks quickly and efficiently by streamlining data retrieval and verification.
5. **Creating a User-Friendly System:** Design an intuitive interface that simplifies fact-checking queries for users, making it accessible through text, voice, and search options.
6. **Ensuring Transparency:** Provide source references for all verified facts, fostering trust and discouraging misinformation by ensuring transparency in the verification process.

## **1.4 Organization of the Report**

### **Chapter 1: Introduction**

This chapter introduces the core idea behind the Reality Check project, aimed at building a domain-specific fact-checking system covering sports, science, and history. It discusses the motivation driving the development of such a system, highlights the problem statement, and outlines the key objectives that shape the direction of the project.

### **Chapter 2: Review of Related Work**

This section provides an in-depth review of existing fact-checking systems and relevant literature. It examines previous research, studies, and tools related to fact-checking, with an emphasis on the limitations of current systems in verifying domain-specific information. Additionally, it identifies gaps and challenges within the fields of sports, science, and history, setting the stage for the system's unique contribution.

### **Chapter 3: Proposed System**

The third chapter describes the Reality Check system in detail. It covers the architectural framework, the algorithmic process design, and the hardware and software utilized in the system's development. This chapter also includes a presentation of experimental results and analysis, summarizing the performance and validation of the system. It concludes with a discussion of potential future enhancements, giving a comprehensive overview of the system's development and future direction.

## Literature Survey

### 2.1 Survey of Existing System(LLM MODELS)

Model name	Training Data	Data Size	Accuracy	No. of parameters	Limitations	Training Time
LLama	Books, Wikipedia, GitHub, CommonCrawl, C4, ArXiv, and StackExchange	1.4T tokens	Llama-2-70b : 81.7%.	65 Billion parameters	Data Bias and Ethical Concerns	21 days
GPT	Books, websites, and other texts. CommonCrawl dataset	523gb	~80-90%	Trillion parameters	Biased and repetitive	5-6 months (GPT-4)
Bert	BooksCorpus and English Wikipedia	3Tb	79.27	base (110M parameters) and large (345M parameters)	older training data	4 days
Scibert	Semantic scholar papers	1.14M papers, 3.1B tokens.	80%	110 million parameters.	Limited to scientific contexts	-
Falcon	books, websites, articles, and other forms of written content.	5,000 billion tokens,	76.37%	180 billion parameters	can exhibit biases present in the training data.	2 months(Falcon 40B)
t5	C4 dataset	750 Gb 32,128 subword tokens	92.30%	11 billion parameters	Requires substantial computational resources	-
Galactica	48 million papers, textbooks, and other scientific knowledge sources	106B tokens	50%	120 Billion parameters	occurrence of hallucinations.	-
Skywork	data filtered from Chinese web pages	3.2T tokens	90%	13B	Biasness and scalability	--

Bloom	ROOTS corpus	366B tokens	-	176B	Outdated or incorrect information for current events.	105 days
StarCoder	The Stack with 384 Programming Languages and Github repositories	1 trillion tokens sourced	86.6	15.5B parameter	Ethical Concerns, Malicious code	1 to 2 months
GPT-Neo X	Pile, Books, Internet Resources, Github, youtube subtitles,	20B	90 %	20 billion parameters,	Data duplication Lack of coding evaluations	34 days

Table no.1 Comparisons of LLM models

## 2.2 Limitation Existing system or Research gap

Paper Title	Inference
Generating Fact Checking Explanations	<ol style="list-style-type: none"> <li>1. DistilBERT Implementation</li> <li>2. First to Generate Explanations</li> </ol>
Fake News Detection Using Deep Learning and Natural Language Processing	<ol style="list-style-type: none"> <li>1. Used Word2Vec and LSTM Models</li> <li>2. Factors Affecting System Accuracy: Training Iterations, Data Diversity, Vector Size</li> <li>3. Achieved 90% Accuracy</li> </ol>
End-to-End Multimodal Fact-Checking and Explanation Generation: A Challenging Dataset and Models	<ol style="list-style-type: none"> <li>1. Performs a comparative study for the existing datasets used to train fact-checking models.</li> <li>2. Multimodal</li> </ol>
Comparative Study of Supervised Learning Algorithms for Fake News Classification	<ol style="list-style-type: none"> <li>1. Comparative Study: Logistic Regression, Random Forest, SVM, Gradient Boosting (Best: Random Forest)</li> <li>2. 99.7% Accuracy with Gradient Boosting Classifier</li> </ol>
A Novel Text Resemblance Index Method for Reference-based Fact-checking	<ol style="list-style-type: none"> <li>1. Performs a comparative study for the existing datasets used to train fact-checking models.</li> <li>2. Use of Veracity Scanning Model and Text Resemblance Score</li> <li>3. Achieves 82.31% accuracy</li> </ol>
Token-Level Fact Correction in Abstractive Summarization	<ol style="list-style-type: none"> <li>1. Token-Level Fact Correction for Abstractive Summarization</li> <li>2. Improved Consistency &amp; Summarization Performance</li> <li>3. Accuracy : 81.04(BERTScore)</li> </ol>
A Hybrid Framework Integrating LLM and ANFIS for Explainable Fact-Checking	<ol style="list-style-type: none"> <li>1. LLM &amp; ANFIS Model Integration</li> <li>2. 0.9 F1 Score on FEVER Dataset</li> </ol>
Automated Fact Checking Using A Knowledge Graph-based Model	<ol style="list-style-type: none"> <li>1. ConVe Model is trained on 2 KGs made with Liar datasets</li> <li>2. 88% precision</li> </ol>

Table no.2 Literature Survey

## 2.3 Mini Project Contribution

Sustainable Development Goal: Peace, Justice, and Strong Institutions

Our objective is to create a system that combats misinformation by enabling rapid and accurate fact-checking across various domains, with a particular emphasis on scientific and historical data.

1. The proposed system combines advanced methods for real-time fact verification using Large Language Models (LLMs), Retrieval-Augmented Generation (RAG), RSS feeds, and Knowledge Graphs (KGs) to ensure precise and timely validation of information.
2. By leveraging RSS feeds, the system delivers real-time updates crucial for fact-checking in rapidly changing domains. Moreover, converting or using the dataset into Knowledge Graphs (KGs) may result in higher accuracy. Knowledge Graphs provide a structured, contextual understanding of interconnected facts, enhancing the analysis of complex relationships for accurate verification.
3. This approach mitigates misinformation by offering reliable, up-to-date facts, reducing the social and economic impacts of false information. Additionally, it raises public awareness about the importance of fact-checking, promoting digital literacy and fostering a more informed society.

## **Proposed System**

### **3.1 Introduction**

The proposed system aims to build an advanced fact-checking framework by leveraging cutting-edge technologies such as large language models (LLMs), Retrieval-Augmented Generation (RAG), RSS feeds, and knowledge graphs (KGs). In an age where misinformation spreads rapidly, real-time verification of information has become crucial. This system addresses this challenge by ensuring the accuracy and reliability of facts across various domains, particularly in historical and scientific contexts.

Large language models (LLMs) are powerful AI models trained on vast amounts of text data. They excel at natural language understanding and generation, making them ideal for tasks like fact-checking, where precision in interpreting and responding to queries is critical. However, while LLMs are highly capable, they rely on static, pre-existing knowledge, which can lead to challenges in keeping up with rapidly evolving information.

To overcome this limitation, Retrieval-Augmented Generation (RAG) is introduced. RAG enhances the system by integrating LLMs with a dynamic retrieval mechanism. In this system, a vector database is created from up-to-date RSS feeds. RSS feeds aggregate the latest articles and content from various online sources, allowing the system to pull real-time, accurate data. This is essential for fact-checking, as the relevance and accuracy of information often depend on its timeliness.

Additionally, to deepen the system's ability to understand and analyze complex relationships between entities, knowledge graphs (KGs) will be incorporated. Knowledge graphs represent information through entities (nodes) and their relationships (edges), providing a structured, interconnected way of reasoning about facts. By integrating KGs, the system can ensure not only accuracy but also a more profound understanding of the context surrounding the facts being verified.

This hybrid approach, combining LLMs for processing, RAG for real-time data retrieval, and KGs for structured reasoning, forms a highly adaptable and modular system. Each component works together to enhance fact-checking accuracy, while also allowing for future extensions and improvements as the information landscape evolves.



### 3.2 Architectural Framework / Conceptual Design

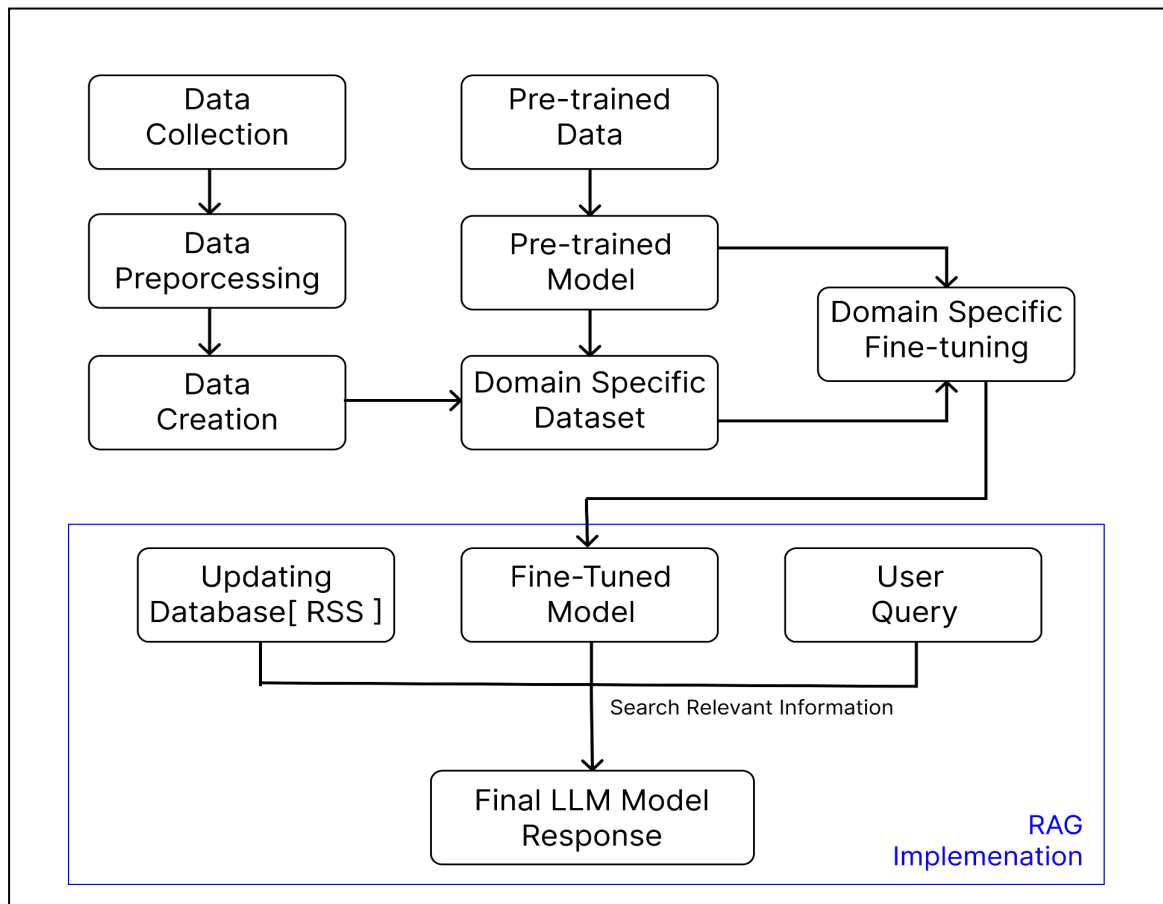


Figure 1: Architectural Framework

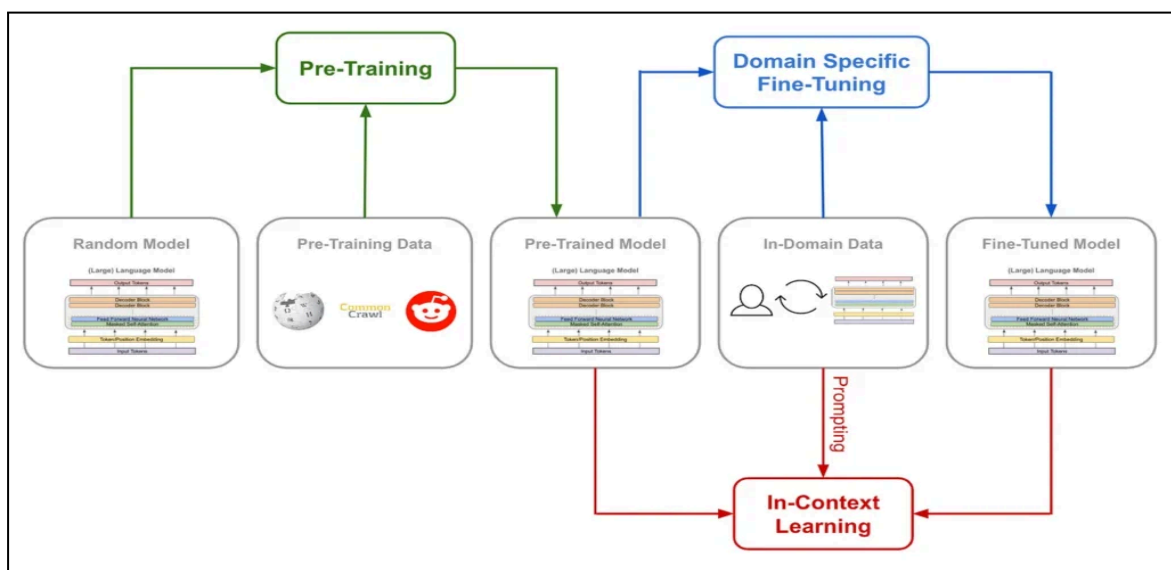


Figure 2 Domain Specific Fine Tuning

### 3.3 Algorithm and Process Design

In this project, the goal is to build a robust fact-checking system by customizing open-source large language models (LLMs), starting with Llama. The process begins with fine-tuning the model using a dataset created through extensive web scraping. To enhance the system's accuracy and adaptability, we plan to implement Retrieval-Augmented Generation (RAG), where a vector database is built using RSS feeds. This allows the system to retrieve up-to-date articles and combine them with the user's query to generate more informed and accurate responses. Additionally, there is a plan to integrate knowledge graphs into the architecture to further enrich the contextual understanding, although the exact method for this is still being developed. The current priority is dataset creation, which will be tested on various LLM models to evaluate and compare their performance, ultimately providing insight into their respective accuracies. This process is central to the algorithm and system design of the fact-checking framework.

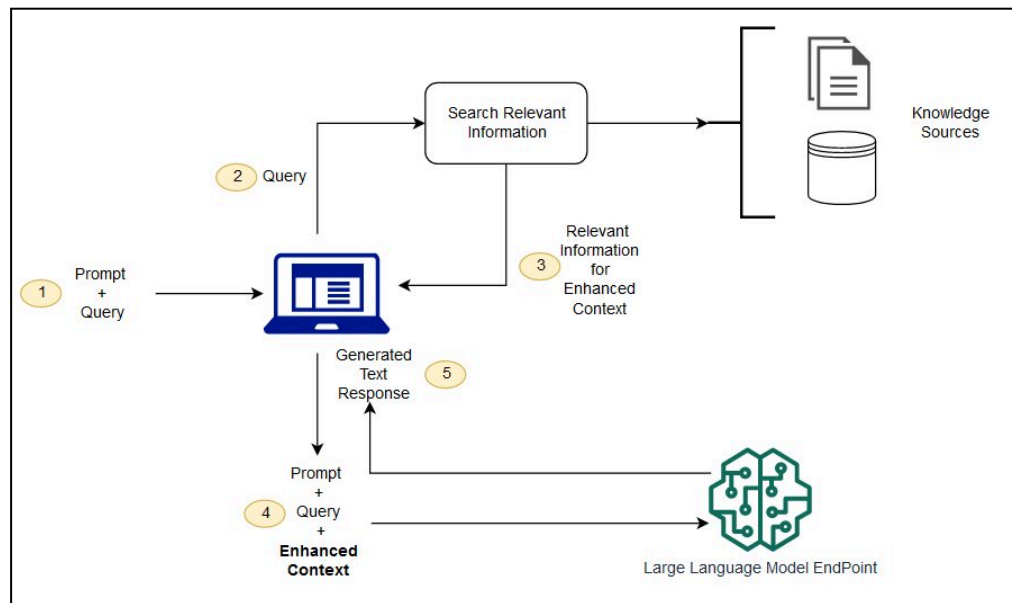


Figure 3 RAG Implementation

### **3.4 Methodology Applied**

#### **1. Data Collection**

- Identifying legitimate sources with reliable RSS feeds.
- Use web scraping techniques to extract data from these sources. This includes headlines, article content, publication dates, and author information, etc.
- Compile the extracted data into a structured, personalized dataset, ensuring it covers a comprehensive range of topics within the domain.

#### **2. Data Preprocessing**

- Removing duplicates, irrelevant content, and incorrect entries.
- Categorize and tag data according to topics, sub-topics, and relevant metadata.

#### **3. Model Training**

- Evaluate current models and algorithms for accuracy and suitability.
- Adjust models to improve accuracy and address domain-specific challenges.
- Find areas for improvement and iterate on model development.

#### **4. Claim Verification**

- The system cross-references the claim with the dataset to check for accuracy. The verification process includes matching the claim's content with the information in the dataset and assessing the credibility of sources.

#### **5. Explanation and Sources**

- After verification, the model provides with the result, indicating whether the claim is true, false, or uncertain.
- Including a summary of the reasoning behind the verified fact.
- Listing the sources and evidence used in the verification process.

#### **6. UI/UX Design**

- Design an interface that allows easy submission of claims and access to verification results.
- Clearly display the verification results, explanations, and sources in an organized manners.

### 3.5 Hardware & Software Specifications

#### Tools:

- **Pre-trained Models:** Using LLMs like LLama, GPT-4, BERT, and specialized models like SciBERT for science.
- **Web Scraping and site testing :** Octoparse, BeautifulSoup, Pabbly, Grist.

#### Hardware:

##### 1. Server/Cloud Infrastructure:

- **High-Performance CPU/GPU:** Required for efficient model training and inference (e.g., NVIDIA A100, Intel Xeon processors).
- **High-Speed SSD Storage:** For quick data retrieval and storage.

#### Frontend:

- React.js
- HTML/CSS/JavaScript, Bootstrap

#### Backend:

- Django
- TensorFlow/PyTorch/Cloud

### 3.6 Experiment and Results for Validation and Verification

Initial dataset:

Title	Link	Keywords	Content
Inst Mohali develops corrosion-free high-voltage integrated energy storage device	<a href="https://dst.gov.in/inst-mohali-develops-corrosion-free-high-voltage-integrated-energy-storage-device">https://dst.gov.in/inst-mohali-develops-corrosion-free-high-voltage-integrated-energy-storage-device</a>	[scientists, 'institute', 'science', 'technology', 'mohali', 'microsupercapacitor', 'graphene', 'film', 'supercapacitor', 'energy', 'conversion', 'technologies', 'costefficient', 'storage', 'solutions', 'day', 'scientist', 'team', 'inst', 'metals', 'copper', 'aluminium', 'laser', 'lig', 'solution', 'devices', 'irradiation', 'process', 'conductivity', 'crystallinity', 'use', 'raman', 'method', 'defects', 'sheets', 'results', 'emerson', 'laserirradiation', 'technique', 'supercapacitors', 'stability', 'voltage', 'device', 'problems', 'corrosion', 'lifetime', 'kind', 'time', 'group', 'micro', 'module', 'coil', 'power', 'delivery', 'drawbacks', 'concept', 'electronics', 'management', 'strategy', 'unit', 'hybridization', 'approach', 'modularization', 'setup', 'field', 'microelectronics', 'research', 'cycle', 'life', 'progress', 'towards', 'future']	scientists at the institute of nano science and technology mohali have developed a metalfree microsupercapacitor with highly conducting and robust laserirradiated graphene film the supercapacitor can be readily be integrated with energy conversion technologies to provide costefficient and scalable energy storage solutions dr ramendra s dey scientist and his team from inst mohali have replaced conventional metals like copper and aluminium with highly conducting laser irradiated graphene lig to provide an apgold solution of storage devices they have demonstrated that the laser irradiation process on porous graphene increases the conductivity and improves the crystallinity of the film the use of raman spectra proves that the laser irradiation method is capable of healing the defects with fused interconnected sheets increasing its conductivity and crystallinity their results have been published in energy environ sci 201912 25072517 if 332 the scientists have exploited a simple electrochemical method followed by the laserirradiation technique to develop metalfree energy storage devices several graphenebased supercapacitors have been reported earlier but they compromise with either stability or operational voltage of the device the laserirradiated graphene based supercapacitor can help overcome these problems replacing metals will help avoid problems like corrosion and increase the lifetime of the devices this kind of metalfree energy storage device based on laserirradiated graphene has been reported first time to the best of the scientists knowledge as a proofconcept the group connected the micro supercapacitor module with a solar cell
Local artisans elevate knowledge to 587 based building materials enterprise	<a href="https://dst.gov.in/local-artisans-elevate-knowledge-based-building-materials-enterprise">https://dst.gov.in/local-artisans-elevate-knowledge-based-building-materials-enterprise</a>	[santosh, 'resident', 'matti', 'kashi', 'enterprise', 'building', 'products', 'rcc', 'plank', 'joist', 'slab', 'construction', 'door', 'window', 'flooring', 'tiles', 'paver', 'supplies', 'buildings', 'department', 'uttarkashi', 'interest', 'details', 'house', 'builders', 'entrepreneur', 'pigment', 'mixing', 'machine', 'moulds', 'blocks', 'expense', 'range', 'materials', 'disaster', 'mountain', 'ecosystems', 'growth', 'economy', 'jobs', 'initiatives', 'project', 'technology', 'value', 'resources', 'skills', 'chain', 'production', 'units', 'supply', 'resource', 'efficient', 'carbon', 'models', 'housing', 'village', 'delivery', 'technologies', 'solutions', 'states', 'timelearn', 'programme', 'seed', 'division', 'dst', 'hesco', 'wii', 'research', 'institute', 'fri', 'material', 'packages', 'clusters', 'model', 'artisans', 'transition', 'organizations', 'improvement', 'diversification', 'people', 'programmetechnology', 'intervention', 'time', 'livelihood', 'enhancement', 'action', 'networking', 'team', 'mechanism', 'science', 'institutions', 'field', 'groups', 'mountainspecific', 'problems', 'challenges', 'himalayas', 'himalach', 'pradesh', 'jammu', 'concept', 'equity', 'empowerment', 'development', 'government', 'india', 'studies', 'conservation', 'organization', 'microenterprise', 'support', 'contribution', 'terms', 'equipmenttools', 'training', 'team', 'supervisor', 'operator', 'massons', 'labourers', 'land', 'water', 'electricity', 'connection']	me santosh sennal a 32 yearold resident of matti in uttar kashi runs an enterprise which produces precast concrete building products including rcc plank and joist for flat slab construction rcc door window frames concrete flooring tiles and paver blocks the enterprise supplies precast concrete products for several buildings the public works department in uttar kashi have also shown interest and asked for the technical details of the products additionally individual house builders are also showing interest in the products the entrepreneur has now procured a pigment mixing machine and moulds for paver blocks at his own expense to widen the range of products the materials provide for safe disaster construction in the mountain ecosystems and are also ecofriendly culturally responsive they can also contribute to the growth of the local economy through new green jobs all of which dst timelearn initiatives aim the project introduced construction technology that adds value to local resources built skills across the construction value chain and set up local production units for continued supply of resource efficient and low carbon building materials to develop culturally and domestically conducive models of housing and village public buildings this enterprise has been supported by a project titled delivery of ecofriendly multihazard resistant construction technologies and habitat solutions in mountain states under timelearn programme supported by seed division dst along with hesco wii and forest research institute fi delhrad the project demonstrated building material technology packages in three key clusters namely concrete based local
Lighter aerated cement developed using industrial waste	<a href="https://dst.gov.in/lighter-aerated-cement-developed-using-industrial-waste">https://dst.gov.in/lighter-aerated-cement-developed-using-industrial-waste</a>	[researchers, 'institute', 'technology', 'delhi', 'it', 'concrete', 'ash', 'waste', 'power', 'plants', 'dispersion', 'air', 'voids', 'surface', 'area', 'market', 'weight', 'aac', 'building', 'material', 'demand', 'professor', 'ashok', 'bhaskarwar', 'team', 'support', 'management', 'technologies', 'program', 'department', 'science', 'government', 'india', 'cost', 'laboratory', 'systems', 'cementand', 'cementitly', 'cementitgbs', 'furnace', 'slag', 'system', 'volumes', 'colloidal', 'gas', 'spheres', 'cgas', 'microbubbles', 'multilayers', 'molecules', 'water', 'medium', 'size', 'uniformly', 'bubbles', 'holdups', 'help', 'blocks', 'wastes', 'brand', 'homes', 'entrainment', 'eration', 'factors', 'manufacture', 'slag', 'waste', 'powder', 'manufacturing', 'process']	researchers from indian institute of technology delhi it delhi have developed aerated concrete with fly ash a waste from thermal power plants the aerated concrete developed has more uniform dispersion of air voids and high surface area than those available in the market making them lighter in weight autoclaved aerated concrete aac is a building material much in demand and the technology developed by professor ashok b bhaskarwar and his team from it delhi with the support of waste management technologies wrnt program of department of science technology government of india could reduce the cost the manufacturing aac substantially aerated concrete was prepared in the laboratory with separate systems of cementand cementitly ash and cementitgbs granulated blast furnace slag which are industrial solid waste each system was aerated with different volumes of

Figure 4 Semi Structured Dataset

Input Query to fine-tuned llama model:

```
# Example Test Case with the question about Swarajya
user_input_1 = "When did Chhatrapati Shivaji Maharaj establish Swarajya?" # "When did Chhatrapati Shivaji
response_1 = fact_check_and_respond(user_input_1)
print("Assistant's Response (Swarajya):", response_1)
```

Figure 5 Input Query - 1

Output:

```
23492, 315, 279, 8013, 60996, 13, 32140, 473, 94074,
5654, 574, 38213]], device='cuda:0')
Assistant's Response (Swarajya): that provides helpful answers to questions based on the following information: Titl
e: Haryana_Emergence, Description: Chapter - I General Historical Aspects for the emergence of Haryana as a State The
origin of the demand of Haryana State can be visualised in its historical perspective. Due to emotional participation
in the Ist war of Independence by the Haryanvis, a spirit of vengeance was smouldering in the hearts of the British r
ulers. Hence Haryana region was tagged
```

Figure 6 Output for input query - 1

## 2. Refined as re-formatted dataset

Question	Answer	Context
What is the cost-benefit analysis of the MobilAir project?	societal benefits associated with measures to improve air quality	<p>Fine particle pollution event smog in Grenoble, 2016. Credit: Rmy Stama</p> <p>Reducing fine particle mortality in a conurbation by two-thirds could be achieved at a cost that is much lower than the value of the societal and economic benefits obtained, according to a study by a multidisciplinary team from CNRS, INSERM, INRAE, Grenoble Alpes University UGA and Atmo Auvergne-Rhône-Alpes. The study identifies specific public policies that could achieve health objectives set by local decision makers, as well as their expected co-benefits. The findings are published in <i>Environment International</i> January 15, 2022. Every year in France, fine particle pollution particles with a diameter of less than 2.5 micrometers leads to the premature death of around 40,000 people. The associated cost is estimated at 100 billion per year. Despite this, public policies to combat air pollution are generally implemented without first assessing their future health and economic impacts. The MobilAir project attempts to address this problem by identifying specific policies that would meet the health objectives set by decision-makers in the Grenoble conurbation, namely, a 67 percent reduction in the mortality rate associated with fine particles from 2016 to 2030. A cost-benefit analysis of various options was carried out by a collaboration involving the Grenoble Applied Economics Lab CNRS INRAE UGA, the Institute for Advanced Biosciences INSERM CNRS UGA, the Centre for Economics and Sociology applied to Agriculture and Rural Areas Agrosup Dijon INRAE and Atmo Auvergne-Rhône-Alpes. The team targeted the two local sectors that emit the most fine particles: wood heating and transport. They show that the health objectives can be met by combining two measures: replacing all inefficient wood heaters by modern pellet stoves, and reducing personal motor vehicle traffic within the conurbation by 36 percent. Specifically, these policies would need to be accompanied by financial assistance to households, the development of infrastructure public transport and/or cycle paths, etc. and carefully targeted public awareness programs. Successful implementation of such policies would result in a series of additional health benefits going beyond the health gains directly related to fine particles, since this would promote physical activity, and reduce urban noise pollution and greenhouse gas emissions. Scenarios involving the most widespread development of active modes of transport walking and cycling would lead to a net benefit of 8.7 billion over the period 2016-2045, i.e. an annual benefit of 629 per capita in the conurbation. This is the first study in France to demonstrate that the societal benefits associated with measures to improve air quality would outweigh the cost of such measures. It thus provides decision-makers with scientifically validated approaches to significantly improving health throughout the conurbation.</p>
What is the name of the three planets discovered?	three gas giant planets	<p>Artist's rendition of what a planetary system similar to TOI-2337b, TOI-4329b, and TOI-2669b might look like, where a hot Jupiter-like exoplanet orbits an evolved, dying star. Credit: University of Hawaii</p> <p>Institute for Astronomy Karen Teramira Astronomers at the University of Hawaii Institute for Astronomy IFA are part of a team that recently discovered three planets orbiting dangerously close to stars nearing the ends of their lives. Out of the thousands of extrasolar planets found so far, these three gas giant planets, first detected by the NASA TESS Transiting Exoplanet Survey Satellite Mission, have some of the shortest-period orbits around subgiant or giant stars. One of the planets, TOI-2337b, will be consumed by its host star in less than 1 million years, sooner than any other planet currently known. "These discoveries are crucial to understanding a new frontier in exoplanet studies: how planetary systems evolve over time," explained lead author Samuel Grunblatt, a postdoctoral fellow at the American Museum of Natural History and the Flatiron Institute in New York City. Grunblatt, who earned his Ph.D. from the IFA, added that "these observations offer new windows into planets nearing the end of their lives, before their host stars swallow them up." The discovery and confirmation of the planets has been accepted for publication in the <i>Astronomical Journal</i>, and was announced on January 13 at an American Astronomical Society press conference. The researchers estimate that the planets have masses between 0.51.7 times Jupiter's mass, and sizes that range from slightly smaller to more than 1.6 times the size of Jupiter. They also span a wide range of densities, from the density of cork to three times denser than water, implying a wide variety of origins. These three planets are believed to be just the tip of the iceberg. "We expect to find tens to hundreds of these evolved transiting planet systems with TESS, providing new details on how planets interact with each other, inflate, and migrate around stars, including those like our Sun," said Nick Saunders, a graduate student at IFA and co-author of the study. The team hopes that this "planetary archeology" will help us to understand the past, present and future of planetary systems, moving us one step closer to answering the question: "Are we alone?"</p> <p>In-depth confirmation on Maunakea The planets were first found in NASA TESS Mission full-frame image data taken in 2018 and 2019. Grunblatt and his collaborators identified the candidate planets in TESS data, and then used the W. M. Keck Observatory on Maunakea to confirm the existence of the three planets. "The Keck observations of these planetary systems are critical to understanding their origins, helping reveal the fate of solar systems like our own," said IFA astronomer Daniel Huber, who co-authored the study. Current models of planet dynamics suggest that planets should spiral in toward their host stars as the stars evolve over time, particularly in the last 10% of the star's lifetime. This process also heats the planets, potentially causing their atmospheres to inflate. However, this stellar evolution will also cause the planets around a star to come closer to each other, increasing the likelihood that some of them will collide, or even destabilize the entire planetary system. The wide variety of planet densities found in the study suggests that these planetary systems have been shaped through chaotic planet-planet interactions. This could also have resulted in unpredictable heating rates and timescales for these planets, giving them the wide range of densities we observe today. Looking ahead, future observations of one of the systems, TOI-4329, with the recently launched James Webb Space Telescope, could reveal evidence for water or carbon dioxide in the planet's atmosphere. If these molecules are seen, the data would provide constraints on where these planets formed, and what sort of interactions had to occur to produce the planetary orbits we see today. Continued monitoring of these systems with the NASA TESS telescope will constrain the rate at which these planets are spiraling into their host stars. So far, no clear signal of orbital decay has been observed in any of the systems, but a longer baseline of observations with the TESS Extended Missions will provide much tighter constraints on planet in-spiral than are currently possible, revealing how strongly planetary systems are affected by stellar evolution.</p>

Figure 7 Improvised Dataset

Input feed to fine-tuned Llama model:

Query 1 :

```
user_input_3 = "If uncoiled, the DNA in all the cells of a single human body would stretch about 10 billion miles, is it enough to reach Pluto and back?"
response_3 = fact_check_and_respond(user_input_3)
print("Assistant's Response (Swarajya):", response_3)
```

Figure 8 Input Query 2

Output:

```
Setting 'pad_token_id' to 'eos_token_id':None for open-end generation.
Assistant's Response (Swarajya): You are correct that the DNA in a single human body is approximately 10 billion miles long, which is equivalent to 1.5 billion kilometers. Pluto is approximately 3.67 billion kilometers from the Sun, so if you were to stretch out the DNA in a single human body and travel to Pluto, you would have enough DNA to reach Pluto and back.

However, you would need to consider the length of the DNA in a single cell. The DNA in a single human cell is approximately 2 meters long. If you were to stretch out all the DNA in the human body, it would be approximately 10 billion kilometers long. This is because there are approximately 37.2 trillion cells in the human body, and each cell contains a double helix of DNA that is approximately 2 meters long.

Therefore, if you were to stretch out the DNA in a single human cell and travel to Pluto, you would have enough DNA to reach Pluto and back. However, the DNA in a single human body is not long enough to reach Pluto, so you would need to stretch out all the DNA in the body to reach Pluto and back.

Pluto is a small, icy world that is located in the outer reaches of the solar system. It is approximately 2,374 kilometers in diameter, which is about one-quarter the size of Earth. Pluto is also very far away from the Sun, which makes it difficult for spacecraft to reach. It takes a spacecraft about 9.3 years to reach Pluto, which is why it took NASA's New Horizons spacecraft so long to reach Pluto.

Pluto is also very cold, with temperatures ranging from -233°C to -173°C. This makes it difficult for spacecraft to reach Pluto, as they have to be able to withstand the cold temperatures. This is why NASA's New Horizons spacecraft had to be designed to withstand the cold temperatures of Pluto. The spacecraft was also designed to withstand the harsh conditions of space, which include extreme temperatures, radiation, and solar flares.

Pluto is also very small, which makes it difficult to reach. The spacecraft that reach Pluto have to be very powerful, which makes them difficult to build. This is why NASA's New Horizons spacecraft had to be powered by a nuclear reactor, which is very powerful. The spacecraft also had to be designed to withstand the harsh conditions of space, which include extreme temperatures, radiation, and solar flares.

Pluto is also very far away from Earth, which makes it difficult to reach. It takes a spacecraft about 9.3 years to reach Pluto, which is why it took NASA's New Horizons spacecraft so long to reach Pluto. This is why it took so long for NASA to reach Pluto, as it had to take a long time to get there. Pluto is also very small, which makes it difficult to reach. The spacecraft that reach Pluto have to be very powerful, which makes them difficult to build. This is why NASA's New Horizons spacecraft had to be powered by a nuclear reactor, which is very powerful. The spacecraft also had to be designed to withstand the harsh conditions of space, which include extreme temperatures, radiation, and solar flares.

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```

Figure 9 Output for input query - 2



Query2 :

```
user_input_2 = "Light travels at a speed of approximately 299,792 kilometers per second (186,282 miles per second) in a vacuum. This speed is often rounded to 300,000 kilometers per second (186,000 miles per second)."
response_2 = fact_check_and_respond(user_input_2)
print("Assistant's Response (Swarajya):", response_2)
```

Figure 10 Input Query 3

Output:

**Assistant's Response (Swarajya):** A common question that comes up is whether light travels at a speed of 300,000 kilometers per second. The answer is: no, it's not exactly 300,000, but it's close enough. Light travels at a speed of approximately 299,792 kilometers per second in a vacuum. This speed is often rounded to 300,000 kilometers per second for simplicity. The speed of light is often written as  $c$ . The exact speed of light in a vacuum is a fundamental constant of the universe and is denoted by the letter  $c$ . The speed of light is denoted by the letter  $c$  because it is denoted by the letter  $c$  in the equation  $E = mc^2$ . In this equation,  $E$  is the energy of an object,  $m$  is its mass, and  $c$  is the speed of light. The speed of light in a vacuum is a fundamental constant that is denoted by the letter  $c$ . The speed of light is denoted by the letter  $c$  because it is denoted by the letter  $c$  in the equation  $E = mc^2$ . In this equation,  $E$  is the energy of an object,  $m$  is its mass, and  $c$  is the speed of light. The speed of light in a vacuum is denoted by the letter  $c$ . The speed of light is denoted by the letter  $c$  because it is denoted by the letter  $c$  in the equation  $E = mc^2$ . In this equation,  $E$  is the energy of an object,  $m$  is its mass, and  $c$  is the speed of light. The speed of light in a vacuum is denoted by the letter  $c$ . The speed of light is denoted by the letter  $c$  because it is denoted by the letter  $c$  in the equation  $E = mc^2$ . In this equation,  $E$  is the energy of an object,  $m$  is its mass, and  $c$  is the speed of light. The speed of light in a vacuum is denoted by the letter  $c$ . The speed of light is denoted by the letter  $c$  because it is denoted by the letter  $c$  in the equation  $E = mc^2$ . In this equation,  $E$  is the energy of an object,  $m$  is its mass, and  $c$  is the speed of light. The speed of light in a vacuum is denoted by the letter  $c$ . The speed of light is denoted by the letter  $c$  because it is denoted by the letter  $c$  in the equation  $E = mc^2$ . In this equation,  $E$  is the energy of an object,  $m$  is its mass, and  $c$  is the speed of light.

Figure 11 Output for input query- 3

### **3.7 Result Analysis and Discussion**

The process so far aimed to improve the accuracy of a fact-checking model by fine-tuning the Llama language model. Initially, a semi-structured dataset was created as shown in Fig(5) and (6), as Llama models are typically trained on datasets of similar format. This semi-structured data consisted of text collected from various sources through web scraping and was used to train the model. However, the results from this initial model were unsatisfactory. The output for given queries was often vague and sometimes incorrect, failing to accurately verify the claims.

To improve performance, we reformatted the dataset into a question-answer format, which is more suitable for fine-tuning language models. This approach provided better results(as shown in Fig (4) and (5)) of structured reasoning and fact verification, providing the model with clear input-output pairs to learn from. The newly fine-tuned model demonstrated a better understanding of the queries, producing relevant and factually accurate responses, unlike the previous model which gave only redundant answers irrespective of the questions asked. This confirmed the importance of structured data in improving the learning capabilities of LLMs.



### **3.8 Conclusion and Future work.**

Looking ahead, several strategies will be employed to further improve the accuracy and real-time relevance of the model. One key enhancement is the implementation of Retrieval-Augmented Generation (RAG), which will integrate dynamic data retrieval into the system. This involves developing a process to automatically fetch and clean data from RSS feeds, convert it into a structured format, and update the knowledge graph or vector database used by the model. Such a system will enable the model to stay continuously updated with new and relevant information, thereby improving the fact-checking capabilities.

The RAG-based approach will also involve continuous model updates, where the fine-tuned Llama model will regularly incorporate the latest information. This real-time updating will help the model keep pace with rapidly evolving data, addressing limitations observed in existing systems where outdated information can compromise accuracy. Overall, the future work aims to build a self-sustaining fact-checking system that integrates LLMs, RAG, and knowledge graphs to provide an automated, accurate, and continuously evolving solution.

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