BiasLens: A Real-Time Chrome Extension for Multi-Layer News Analysis

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Abstract

BiasLens is a lightweight browser extension and Python backend that performs an instant, multi-layered audit of online news articles. Upon user request, the extension extracts article content and dispatches it to a local Flask server, where multiple large language model prompts carry out information extraction, source-credibility scoring, fact checking against live search results, and the retrieval of alternative perspectives. The analysed results—including clickable reference links—are streamed back to the browser and rendered in an intuitive interface. This architecture balances responsiveness with transparency, empowering readers to make evidence-based judgements while browsing.

1 Team Contributions

Xinyun Ye was responsible for front-end data scraping, interface logic development, as well as the maintenance of the project framework. **Yucong Chen** handled project design, the implementation of various backend modules, and the tuning and evaluation of the LLM and search engine. **Qichen Wang** was in charge of writing the report, drafting documentation and development guidelines, and refining the front-end for improved user experience. **Jiayuan Hong** was responsible for demo testing, performance evaluation, and the design and recording of the presentation.

2 Introduction

BiasLens[1] is a lightweight Chrome extension backed by a Python (Flask) micro-service that performs an instant, multi-layered audit of any news article a reader has open in-browser. With one click, the content script extracts the main text, metadata and canonical URL, then hands them to a local LLM pipeline that

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* ěqual contribution
[1] https://github.com/Eclipsemos/BiasLens

1. **Surfaces hidden framing** and language cues,

2. **Assesses institutional credibility**,

3. **Checks factual claims** against live web search, and

4. **Retrieves concise alternative viewpoints** to balance the narrative.

All findings—together with clickable reference links—stream back to the popup UI within seconds, giving readers an evidence-backed "X-ray" of the story without ever leaving the page.

3 Motivation

The modern information ecosystem bombards readers with partisan agendas and AI-generated content that can outpace traditional fact-checking workflows. Typically, news consumption is shaped by three mutually reinforcing forces as in Table 1.

Recent tools leverage large language models to detect subtle media biases in news coverage, providing insights into how articles are selected and framed (Wang et al., 2025). Integrating LLMs into fact-checking agents enables real-time claim verification by retrieving relevant evidence and explaining reasoning, though accuracy can vary.(Quelle and Bovet, 2024). Several AI-powered browser extensions have been developed to analyze web content on the fly – for example, one plugin automatically flags potential misinformation in news articles without requiring the user to leave the page.(Botnevik et al., 2020) Tools that require copy–pasting text into external services introduce friction and thus see limited adoption.

BiasLens was built to *lower the barrier* to critical analysis by placing contextual insights one click away, allowing casual readers, students, and journalists to scrutinize content without leaving the article.

Challenge	Why it matters
Narrative transportation	The human brain readily "loses itself" in a compelling storyline, suppressing skepticism within minutes.
Algorithmic echo chambers	Platform ranking systems maximise engagement by repeatedly serving similar viewpoints, narrowing exposure to dissenting facts.
AI-accelerated information flows	Generative models enable near-real-time content production, making traditional, manual fact-checking infeasible at web scale.

Table 1: Key challenges of information consumption and their significance

4   Intended Users

BiasLens is targeted at:

- Everyday readers looking for a quick credibility snapshot.

- Students and educators in media-literacy or journalism courses.

- Reporters verifying quotes, data, or institutional reliability.

- Platform moderators flagging potentially harmful narratives.

5   System Overview

BiasLens comprises two cooperating components:

- **Frontend**: a Chrome extension with a popup UI, background script, and content script that extracts article HTML and renders analysis results.

- **Backend**: a Flask server orchestrating LLM calls, web searches (Singh, 2024), and rule-based post-processing to generate structured outputs.
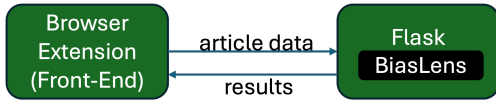

Figure 1: System architecture of BiasLens, showing interaction between Chrome extension and Flask backend.

When the user clicks the "Analyze" button:

1. **Extraction**: Content script isolates the main article body, metadata, and canonical URL.

2. **Analysis**: The backend invokes a series of prompt templates (Section 6) using a configurable LLM (default: gemini-2.0-flash-lite, (Pichai, 2024)).

3. **Aggregation**: JSON results are streamed back and rendered into collapsible sections for easy inspection.
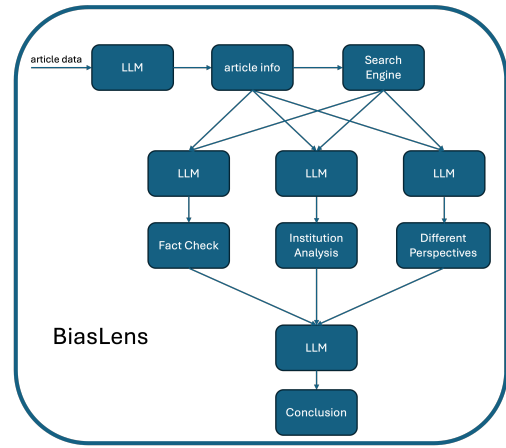

Figure 2: Overall framework of BiasLens, illustrating the various modules and their dataflow interactions.

6   Features and Analysis Components

BiasLens performs five complementary analyses:

Information Extraction Captures title, author, publication date, content type (news, opinion, interpretive, other), language style, and a 1–3-sentence abstract. In this module we also perform narrative analysis on content by giving the author's intent and language style. Framing bias occurs when media emphasize certain aspects of a story over others. Recent NLP methods can automatically detect such framing by analyzing language patterns, identifying the narrative slant in how news events are portrayed(Morstatter et al., 2018).

Institution Analysis: Scores the credibility of the publishing outlet (*Highly Authoritative*, *Generally Reliable*, *Often Questionable*, *Widely Discredited*, or *Unverifiable*) with reasoning and search citations. Algorithms have been proposed to quantify the credibility of news sources by predicting factuality and bias scores based on a source's content

and metadata, aiding the identification of unreliable outlets (Baly et al., 2018).

Fact Checking: Identifies verifiable statements and labels them *Verified True*, *Likely True*, *Partly True / Misleading*, *False*, *Disputed / Inconclusive*, or *Unverifiable*. The use of language models for verifying the truthfulness of news has been extensively studied, as demonstrated by recent work such as Wang et al. (Wang et al., 2024).

Alternative Perspectives: Summarises credible opposing opinions retrieved via live web search, encouraging balanced reading.

Reference Links: Hyperlinks every claim to its supporting evidence for transparency.

These outputs culminate in an **Overall Rating**—*Excellent*, *Good*, *Average*, *Poor*, or *Unverifiable*—with a concise justification spanning factual accuracy, framing neutrality, and evidential sufficiency.

7 Implementation Details

7.1 Frontend

- Vanilla JavaScript plus Chrome Extension APIs handle tab inspection and DOM parsing.

- A popup interface built with HTML/CSS shows loading feedback and collapsible result cards.

7.2 Backend

- Flask with Flask-CORS exposes an `/analyze` endpoint.

- Prompt templates reside in `prompt_lib.py`; orchestration logic in `biaslens.py`.

- Search is powered by Google Custom Search (via API key / CX) and parsed with BeautifulSoup4.

- Article extraction leverages Newspaper3k and fallback heuristics.

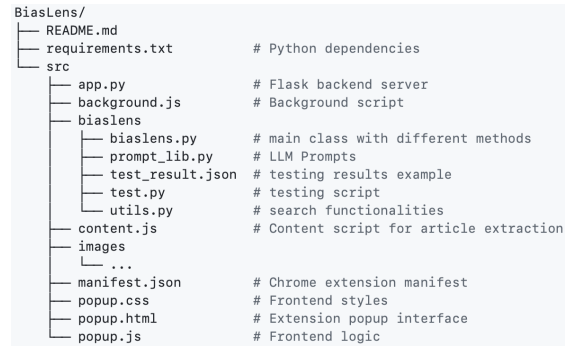- Natural-language tooling includes NLTK for sentence segmentation.

```
BiasLens/
├── README.md
├── requirements.txt        # Python dependencies
└── src
    ├── app.py              # Flask backend server
    ├── background.js       # Background script
    ├── biaslens
    │   ├── biaslens.py     # main class with different methods
    │   ├── prompt_lib.py   # LLM Prompts
    │   ├── test_result.json # testing results example
    │   ├── test.py         # testing script
    │   └── utils.py        # search functionalities
    ├── content.js          # Content script for article extraction
    ├── images
    │   └── ...
    ├── manifest.json       # Chrome extension manifest
    ├── popup.css           # Frontend styles
    ├── popup.html          # Extension popup interface
    └── popup.js            # Frontend logic
```

Figure 3: Project file structure

Dependencies *Frontend*: Chrome Extension APIs, HTML/CSS/JS. *Backend*: Flask, Flask-CORS, Requests, BeautifulSoup4, Newspaper3k, NLTK, Google-generativeai SDK.

8 Installation

Prerequisites

Python 3.8+, Chrome, and `pip`.

Backend Setup

1. Clone the repository and enter the project root:

```
1  git clone https://github.com/
     Eclipsemos/BiasLens.git
2  cd BiasLens
```

2. Install dependencies:

```
1  pip install -r requirements.txt
```

3. Configure API keys by creating `src/.env` and populating, e.g.:

```
1  LLM_API_KEY=YOUR_KEY
2  LLM_MODEL_NAME=gemini-2.0-flash-lite
3  SEARCH_API_KEY=YOUR_SEARCH_KEY
4  SEARCH_ENGINE_ID=YOUR_CX
```

4. Launch the server:

```
1  python src/app.py
```

Chrome Extension Setup

1. Navigate to `chrome://extensions/`.

2. Enable *Developer mode*.

3. Click *Load unpacked* and select the `src` folder.

After installation, an orange BiasLens icon appears in the toolbar.

9 Usage

1. Open any online article.

2. Click the BiasLens icon, then *Analyze*.

3. Wait up to one minute, depending on model latency.

4. Inspect the resulting panels:

   - Article Information
   - Institution Analysis
   - Fact Check
   - Alternative Perspectives
   - Overall Conclusion

10 Ethical Considerations

While BiasLens aims to promote critical thinking and media literacy, we are aware that highlighting ideological bias may inadvertently reinforce users' own biases. Research in cognitive psychology suggests that users may be more likely to dismiss information if it is labeled as originating from a source they perceive as ideologically opposed, potentially increasing polarization.

To mitigate this, BiasLens:

1. **Evidence over Labels** Rather than branding outlets "left" or "right", BiasLens highlights language style, framing, and verifiable facts, allowing users to draw their own ideological map.

2. **Transparent Citation Trails** Every claim, credibility judgment, or fact-check verdict is hyper-linked to its supporting search snippets, so users can verify (or contest) the evidence themselves.

3. **Indeterminate When Appropriate** If sources conflict or evidence is scant, the tool explicitly marks a statement "Disputed / Inconclusive" or "Unverifiable" instead of forcing a binary verdict.

4. **Privacy by Design** All analysis runs locally; BiasLens stores no browsing history, article text, or user identifiers.

5. **No Illusion of Infallibility** The popup disclaimer reminds users that LLM-generated insights are *guidance, not gospel*, and should be used as a starting point for deeper investigation.

We believe these design choices help promote balanced engagement rather than ideological reinforcement.

11 Limitations

Table 2 shows the current limitations and future mitigation work. BiasLens thus delivers practical, real-time media forensics, while remaining candid about the technical and epistemic limits of automated analysis.

12 Model Quality Evaluation

To evaluate the performance of different Gemini models on bias detection and article analysis, we compared the outputs of `gemini-1.5-flash-latest` and `gemini-2.0-flash-lite` on the same BBC article reporting the election of Pope Leo XIV and the reaction it triggered among the MAGA movement(BBC News, 2025). Both models successfully captured the central narrative—the ideological tension between the newly elected Pope and figures within the MAGA movement—but exhibited notable differences in how they summarized, interpreted, and verified the article content.

The **abstracts** generated by the two models illustrate their divergent framing styles. Gemini 1.5 Flash presented a high-level summary, emphasizing "mixed reactions" and maintaining a neutral tone. In contrast, Gemini 2.0 Flash Lite incorporated more detail, referencing specific individuals such as Steve Bannon and highlighting ideological conflict more explicitly. As shown in Figure 4 and 5.

A clear distinction can also be observed in **entity sentiment analysis**. As shown in Figure 4 and 5. Flash 1.5 marked the MAGA movement as *Negative* but retained a *Neutral* stance toward Donald Trump and Steve Bannon. Flash 2.0 assigned *Negative* sentiment to all three entities. This demonstrates Flash 2.0's greater confidence in bias attribution.

In **institutional analysis**, both models rated BBC News as highly credible, but Flash 1.5 labeled it as *Independent*, while Flash 2.0 classified it as *Government Affiliated*. As shown in Figure 4 and 5. This discrepancy may affect perceived objectivity, despite both being technically defensible.

Category	Current Constraint	Mitigation / Future Work
LLM Bias & Hallucination	The underlying model inherits bias from its training data and may "confidently" fabricate sources.	Continuous prompt refinement, chain-of-thought self-verification, and user flagging of suspect answers.
Search Engine Bias	Result ranking skews toward well-indexed outlets, marginalising smaller but credible voices.	Query diversification strategies and incorporation of multiple search providers.
Repeatability	Temperature-driven randomness yields slightly different analyses on each run.	Option to lock model deterministic settings for research-grade audits.
Latency on Large Articles	Long articles trigger higher token costs and slower responses.	Incremental summarisation and streaming UI updates; explore local-only small-model fallback.
Language Coverage	Current prompts are tuned for English; multilingual performance is untested.	Introduce language-adaptive prompt templates and sentence-piece extraction.
Interactivity	Readers cannot ask follow-up questions within the popup.	Road-map feature: chat interface that lets users drill into specific claims or request deeper dives.

Table 2: Current constraints and potential mitigation strategies

Bias Analysis

Article Information

Abstract: The election of the first American Pope, Leo XIV, has sparked mixed reactions, particularly within the US. While some celebrate his appointment, prominent figures in the MAGA movement express disappointment, perceiving his views as at odds with their "America First" ideology. Uncertainty remains about the Pope's exact political leanings, though evidence suggests a more liberal stance than that of the MAGA movement.

Author: Nomia Iqbal

Date: 4 hours ago

Article Intent

Type: Interpretive Reporting

Article Tendency

Language Style: Interpretive Reporting

Entity Analysis:

- Pope Leo XIV: Neutral or No Presetting Tendency
- Donald Trump: Neutral or No Presetting Tendency
- MAGA movement: Negative

Institution Analysis

Institution: BBC News

Type: Independent

Credibility: High

Figure 4: Gemini 1.5 - Content Analysis

Bias Analysis

Article Information

Abstract: Key figures from Donald Trump's MAGA movement expressed disappointment that the newly elected Pope Leo XIV, the first American Pope, may not align with their "America First" agenda, particularly regarding immigration policies. Steve Bannon predicted friction between the Pope and Trump, citing the Pope's past statements critical of Trump's policies and his potential to follow the more liberal stance of Pope Francis. This has led to concern among MAGA supporters, who fear the Pope may challenge Trump's policies.

Author: Nomia Iqbal

Date: 3 hours ago

Article Intent

Type: Interpretive Reporting

Article Tendency

Language Style: Descriptive / Neutral

Entity Analysis:

- Pope Leo XIV: Neutral or No Presetting Tendency
- Donald Trump: Negative
- Steve Bannon: Negative

Institution Analysis

Institution: BBC News

Type: Government Affiliated

Credibility: High

Figure 5: Gemini 2.0 - Content Analysis

The **fact-checking modules** of both models performed well, offering multi-source verification. Flash 2.0 used the label *Verified True*, while Flash

1.5 used *Likely True*, reflecting slightly different certainty thresholds. As shown in Figure 6 and 7.

Fact Check

Fact 1

Statement: Pope Leo XIV's social media activity indicates criticism of President Trump's immigration policies and support for stricter gun control.

Verification: Likely True

Reasoning: Multiple reputable news sources report on Pope Leo XIV's pre-papal social media activity criticizing Trump and Vance's immigration policies, although the specific posts' content is not consistently cited across all sources.

References:
- https://www.usatoday.com/story/news/politics/2025/05/08/pope-leo-xiv-trump-vance-social-media/83516805007/
- https://ignatiansolidarity.net/blog/category/pope-leo-xiv/
- https://newsroom.ap.org/detail/PopeLeohassharedcriticismofTrumpandVanceonsocialmedia/b33c8d213ac447649dc15068a01b1390/video
- https://www.cnn.com/world/live-news/new-pope-conclave-day-two-05-08-25
- https://www.cbsnews.com/news/pope-leo-robert-prevost-voting-records-republican-democratic-primaries/

Figure 6: Gemini 1.5 - Fact Check

Fact Check

Fact 1

Statement: Pope Leo XIV was born Robert Francis Prevost in Chicago.

Verification: Verified True

Reasoning: Multiple credible sources confirm Robert Francis Prevost, the newly elected Pope Leo XIV, was born in Chicago.

References:
- https://www.cbsnews.com/news/new-pope-robert-prevost-pope-leo-xiv/
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Figure 7: Gemini 2.0 - Fact Check

In summary, `gemini-2.0-flash-lite` exhibited deeper contextual reasoning and more assertive language, making it better suited for research applications. `gemini-1.5-flash-latest`, while more conservative, remains a strong choice for general-purpose, neutrality-focused scenarios.

13 Conclusion

BiasLens demonstrates that lightweight, browser-based LLM applications can enhance media literacy without requiring heavy infrastructure. By breaking down news into analyzable components, it helps users develop better awareness of content reliability and framing. Future work includes enabling multilingual support, improving summarization quality, and deploying a hosted backend.

Code Repository: https://github.com/Eclipsemos/BiasLens

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