An Artificial Intelligence–Based Framework for Automated Framing Analysis of Online Media Texts

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The increasing volume of online media content has created a growing need for artificial intelligence–based methods capable of analyzing complex semantic structures at scale. Framing analysis, which examines how texts construct meaning by emphasizing specific aspects of an issue, has traditionally relied on manual qualitative approaches that are difficult to scale and replicate. This study proposes an artificial intelligence–based framework for automated framing analysis of online media texts. The framework integrates computational text processing, semantic feature extraction, and rule-guided classification to operationalize framing as a structured analytical task. Using a corpus of 114 online news articles published between 2022 and 2025, the framework analyzes framing patterns across four analytical dimensions: problem definition, causal interpretation, moral evaluation, and treatment recommendation. The results demonstrate that the proposed framework can consistently identify dominant framing structures and recurring semantic patterns across large text collections. The analysis reveals stable distributions of framing dimensions and clear associations between semantic features and interpretive functions, indicating that framing can be detected systematically using artificial intelligence techniques. The primary value of this work lies in presenting a scalable, transparent, and interpretable framework that extends automated text analysis beyond surface-level tasks such as topic or sentiment detection. By formalizing framing analysis as an artificial intelligence–supported process, the study contributes to research in natural language processing and computational text analysis. The findings suggest that artificial intelligence–based framing analysis can support large-scale media analysis, policy monitoring, and decision-support systems that require structured interpretation of textual data.

Keywords: artificial intelligence, natural language processing, automated text analysis, framing detection, computational text mining

Introduction

The rapid growth of online media platforms has led to an unprecedented expansion in the volume, velocity, and diversity of textual data. News websites, digital archives, and social information systems continuously generate large-scale text corpora that reflect public discourse, institutional communication, and social interpretation processes [1]. Analyzing such data at scale has become a central challenge within artificial intelligence, particularly in natural language processing, computational text mining, and semantic analysis. While artificial intelligence has demonstrated strong performance in automating surface-level text analysis tasks, the automated interpretation of higher-level meaning structures remains an open research problem [2].

Artificial intelligence–based text analysis has achieved notable advances in tasks such as topic modeling, sentiment classification, document clustering, and information extraction. These approaches enable efficient processing of massive text collections and have been widely adopted in domains ranging from business intelligence to scientific discovery [3]. However, many applications require more than identifying topics or emotional polarity. In particular, understanding how texts construct meaning, emphasize certain interpretations, and guide readers toward specific conclusions involves deeper semantic and contextual reasoning. Capturing these interpretive structures computationally remains a significant challenge for current artificial intelligence systems [4].

Framing analysis addresses this challenge by examining how texts selectively highlight aspects of an issue while marginalizing others, thereby shaping interpretation and judgment. Frames organize information by defining problems, attributing causes, evaluating actions, and proposing solutions [5]. Although framing analysis is widely recognized as valuable for understanding discourse and decision-making, it has traditionally relied on manual qualitative coding. Such approaches are labor-intensive, difficult to replicate, and unsuitable for large-scale datasets. As a result, framing analysis has not fully benefited from recent advances in artificial intelligence and automated text processing [6].

Recent developments in computational text analysis suggest new opportunities for automating aspects of framing analysis. Techniques such as word embeddings, co-occurrence modeling, and semantic clustering allow artificial intelligence systems to identify patterns and relationships within large text corpora [7]. Despite this progress, existing approaches often treat framing implicitly. For example, topic models may reveal thematic structures, and sentiment analysis may capture evaluative tone, but neither explicitly operationalizes framing as a structured semantic process. Consequently, framing remains under-modeled as a computational task, and its integration into artificial intelligence research remains limited.

This limitation points to a critical gap in the current literature. While artificial intelligence excels at statistical pattern detection, it often lacks explicit mechanisms for representing interpretive functions such as responsibility attribution, moral evaluation, and solution framing [8]. At the same time, traditional framing analysis lacks scalability and computational rigor. Bridging this divide requires artificial intelligence frameworks that can formalize framing dimensions in a transparent and interpretable manner while maintaining the efficiency and scalability of automated systems [9]. Accordingly, the primary contribution of this study is methodological: it introduces a generalizable and interpretable artificial intelligence framework for computational framing detection, with online media texts serving as a validation domain rather than the object of domain-specific analysis.

Problem Statement and Research Gap

The core problem addressed in this study is the absence of an artificial intelligence–based framework that can automatically detect and analyze framing structures in online media texts in a scalable, transparent, and interpretable way [10]. Existing artificial intelligence approaches to text analysis prioritize efficiency and performance but often operate as black-box systems that provide limited insight into how semantic interpretations are produced. This lack of interpretability is particularly problematic for framing analysis, where understanding how meaning is constructed is as important as identifying patterns.

From a technical perspective, current natural language processing methods focus primarily on surface-level or intermediate representations of text, such as word frequencies, latent topics, or sentiment scores [11]. While these representations are useful, they do not directly correspond to framing functions that organize discourse at a higher semantic level. As a result, framing analysis is frequently approximated indirectly rather than modeled explicitly. This creates a methodological gap between artificial intelligence techniques and theoretically grounded semantic analysis.

From a methodological standpoint, prior studies that attempt automated framing analysis often rely on supervised classification models trained on manually labeled data [12]. Although effective in some contexts, such approaches are limited by training data availability, domain dependence, and reduced interpretability. Moreover, they typically emphasize prediction accuracy over conceptual clarity, making it difficult to trace how specific textual features contribute to framing outcomes. There is a need for alternative approaches that emphasize transparency and structured semantic mapping rather than purely predictive performance.

This study addresses these limitations by proposing an artificial intelligence–based framework that treats framing analysis as a structured computational task. Instead of relying solely on black-box classification, the framework integrates semantic feature extraction with rule-guided mapping to framing dimensions [13]. This design allows framing functions to be operationalized explicitly while preserving the advantages of automated text processing. In doing so, the study responds to growing calls within artificial intelligence research for explainable and interpretable systems, particularly in applications involving complex semantic interpretation.

Evaluation Strategy and Rationale

While quantitative performance metrics such as accuracy, precision, and recall are standard in predictive classification tasks, they are not directly aligned with the objectives of the proposed framework [14]. The goal of this study is not to optimize predictive performance against a fixed labeled dataset, but to validate an analytical AI framework designed for transparent and structured semantic interpretation. Accordingly, evaluation is based on the internal semantic consistency of detected frames, the stability of framing patterns across the corpus, and the interpretability of the mapping between linguistic features and framing dimensions. This evaluation strategy reflects the framework's role as an explanatory and exploratory AI system rather than a purely predictive model. Comparative benchmarking against supervised classifiers and metric-driven evaluation are important directions for future work, particularly once standardized datasets and task formulations for computational framing detection are established.

Significance of Addressing the Gap

Addressing this research gap is significant for several reasons. First, from an artificial intelligence perspective, the proposed framework contributes to natural language processing research by extending automated text analysis beyond conventional tasks toward structured semantic interpretation [15]. By formalizing framing dimensions computationally, the study demonstrates how abstract interpretive concepts can be translated into analyzable features within an AI system. This advances the development of intelligent text analysis methods capable of handling higher-level meaning structures.

Second, the framework contributes to the broader field of explainable artificial intelligence. Interpretability has become a central concern in AI research, particularly as intelligent systems are increasingly applied in socially relevant domains [16]. Framing analysis requires not only correct identification but also clear explanation of how conclusions are reached. By emphasizing transparent feature mapping and interpretable classification logic, the proposed framework aligns with emerging standards for responsible and explainable AI.

Third, the study has practical significance for applications that rely on large-scale text analysis. Automated framing analysis can support intelligent systems used in media monitoring, policy analysis, risk assessment, and decision support [17]. In such contexts, understanding how narratives are structured is essential for anticipating public responses and identifying dominant interpretive patterns. The proposed framework provides a scalable approach that can be adapted to different domains without extensive retraining or opaque modeling.

Finally, the study contributes to interdisciplinary AI applications by demonstrating how artificial intelligence can engage with complex semantic concepts traditionally studied in the social sciences. Rather than treating these concepts as external to AI research, the framework shows how they can be operationalized within computational systems. This opens pathways for further integration of artificial intelligence with discourse analysis, social computing, and intelligent information systems.

Purpose and Aims of the Study

The primary purpose of this study is to design and demonstrate an artificial intelligence–based framework for automated framing analysis of online media texts. The framework is intended to address limitations in existing approaches by combining scalability, interpretability, and structured semantic modeling. Rather than focusing on a specific media domain, the study emphasizes the generalizability of the framework as an artificial intelligence solution for structured framing detection. Specifically, the study aims to:

1. Formalize framing analysis as a computational task that can be implemented within an artificial intelligence system.
2. Develop a framework that integrates automated text preprocessing, semantic feature extraction, and interpretable framing classification.
3. Demonstrate the applicability of the framework through empirical analysis of online media texts.
4. Evaluate the framework's ability to detect consistent framing patterns across a large text corpus.

By achieving these aims, the study contributes to artificial intelligence research on semantic text analysis and provides a foundation for future work on automated interpretation of complex discourse structures. The proposed framework is not intended to replace human interpretation but to augment it by enabling large-scale, consistent, and transparent framing analysis.

In summary, this study responds to a clear need within artificial intelligence research for methods that move beyond surface-level text analysis toward structured semantic interpretation. By proposing an artificial intelligence–based framework for automated framing analysis, the study addresses a critical methodological gap and demonstrates the potential of AI systems to support advanced discourse analysis in scalable and interpretable ways. The contribution of this work lies in the design and formalization of an AI system for structured semantic interpretation, rather than in substantive findings about media discourse itself.

Literature Review

Artificial Intelligence and the Evolution of Automated Text Analysis

Artificial intelligence has played an increasingly central role in the analysis of large-scale textual data generated by digital media, online platforms, and information systems [18]. Early approaches to automated text analysis were largely statistical, relying on techniques such as word frequency counts, bag-of-words models, and term–document matrices. These methods enabled basic content summarization and classification but offered limited insight into semantic meaning or contextual relationships within text.

As computational capacity and algorithmic sophistication increased, research shifted toward probabilistic and distributional models, including topic modeling and latent semantic analysis. These approaches marked an important step forward by allowing automated discovery of thematic structures across large text corpora. However, their focus remained largely on identifying topics rather than interpreting how meaning is constructed or conveyed. Consequently, such methods were well suited to exploratory analysis but less effective for tasks requiring structured semantic interpretation.

More recent developments in artificial intelligence have introduced vector-based language representations and contextual embedding models capable of capturing richer linguistic information [19]. These advances have significantly improved performance in tasks such as text classification, semantic similarity, and information retrieval. Despite these improvements, much of the emphasis in automated text analysis continues to be placed on predictive accuracy rather than interpretive transparency. As a result, many AI systems excel at identifying patterns but provide limited explanations of how those patterns relate to higher-level meaning structures.

Semantic Interpretation and Discourse-Level Understanding in AI

Semantic interpretation represents a long-standing challenge in artificial intelligence research. Beyond identifying words and topics, discourse-level understanding requires modeling relationships among actors, actions, values, and outcomes across extended textual contexts [20]. Early work in computational semantics focused on sentence-level meaning through techniques such as semantic role labeling and dependency parsing. While these approaches improved syntactic and semantic representation, they often failed to capture broader interpretive structures that emerge across entire texts.

In subsequent research, discourse analysis techniques were introduced to address meaning beyond individual sentences. These methods examined coherence, argumentation, and rhetorical structure, offering deeper insight into how texts guide interpretation. However, many discourse-level approaches remained computationally complex and difficult to scale. As a result, their adoption in large-scale text analysis applications was limited.

More recently, interest has grown in combining semantic modeling with explainable artificial intelligence principles. Researchers have increasingly emphasized the need for AI systems that not only produce accurate outputs but also provide interpretable explanations of their analytical processes [21]. This shift reflects broader concerns about transparency, accountability, and trust in AI systems, particularly in applications involving social, political, or institutional contexts. Despite this growing interest, there remains a lack of structured approaches that explicitly operationalize interpretive dimensions such as framing within automated text analysis systems.

Framing Analysis as a Conceptual and Analytical Approach

Framing analysis focuses on how texts structure meaning by emphasizing certain elements of an issue while marginalizing others. Frames function by defining problems, attributing causes, evaluating actions, and proposing solutions. These interpretive functions operate across textual elements and are shaped by patterns of emphasis rather than isolated statements. Framing analysis has therefore been widely used to examine discourse in media, policy communication, and social debate.

Traditionally, framing analysis has relied on qualitative methods such as manual coding and close reading [22]. Early framing studies emphasized depth of interpretation and theoretical rigor, often examining relatively small samples of texts. While this approach allows for nuanced analysis, it presents clear limitations in terms of scalability, reproducibility, and consistency. As digital media expanded, these limitations became increasingly apparent.

Over time, researchers began exploring ways to extend framing analysis through quantitative and computational methods. Early attempts often relied on keyword counts or predefined dictionaries to approximate framing elements. Although these methods enabled partial automation, they lacked flexibility and struggled to capture contextual meaning. As a result, framing analysis remained largely separated from mainstream artificial intelligence research, which prioritized statistical efficiency over interpretive depth.

Computational Approaches to Automated Framing Detection

In response to scalability challenges, computational approaches to framing detection have gained increasing attention. One major line of research has involved supervised machine learning models trained on annotated datasets [23]. These models can classify texts according to predefined framing categories and have demonstrated promising performance in domain-specific applications. However, supervised approaches are heavily dependent on labeled training data, which is costly to produce and often context-specific. Moreover, many such models function as black boxes, making it difficult to interpret how framing decisions are derived.

Unsupervised approaches, such as topic modeling and clustering, have also been applied to explore framing patterns in large text corpora. These methods allow researchers to identify latent structures without labeled data and are well suited to exploratory analysis. Nevertheless, the relationship between discovered topics and framing functions is often indirect. Researchers must interpret topics post hoc, which reintroduces subjectivity and limits reproducibility.

Hybrid approaches that combine rule-based logic with computational processing have emerged as a potential alternative. These approaches aim to preserve interpretability by explicitly linking linguistic features to analytical categories while maintaining scalability [24]. However, many existing hybrid systems are either overly rigid or insufficiently integrated with modern text analysis techniques. This has limited their adoption and impact within artificial intelligence research.

Interpretability and Explainable Artificial Intelligence in Text Analysis

Interpretability has become a central concern in contemporary artificial intelligence research. As AI systems are increasingly deployed in socially sensitive domains, there is growing recognition that users must be able to understand and evaluate analytical outcomes [25]. Explainable artificial intelligence seeks to address this need by developing methods that make system behavior transparent and understandable.

In text analysis, interpretability is particularly important because outputs often inform human interpretation rather than automate decisions. Methods such as feature importance visualization, rule extraction, and transparent classification logic have been proposed to enhance explainability. These approaches allow users to trace analytical results back to specific textual features, supporting trust and accountability.

Despite these advances, explainable AI principles have rarely been applied systematically to automated framing analysis. Many framing detection systems prioritize classification accuracy without offering clear explanations of how framing categories are assigned. This limits their usefulness for tasks requiring semantic interpretation and undermines confidence in automated results. There is therefore a clear need for frameworks that integrate explainability into the core design of automated framing analysis systems.

Current Trends and Future Directions in AI-Based Framing Analysis

Recent research trends point toward increasing integration of artificial intelligence with higher-level semantic analysis. There is a growing shift from surface-level text processing toward modeling meaning structures that reflect interpretation, evaluation, and decision-making. At the same time, concerns about transparency and accountability are driving interest in interpretable and explainable AI systems [26].

Another emerging trend involves the combination of computational efficiency with conceptual rigor. Rather than relying solely on data-driven prediction, researchers are exploring structured approaches that embed theoretical constructs into computational frameworks. This trend is particularly relevant for framing analysis, which requires explicit representation of interpretive functions.

Future research is likely to focus on developing scalable, domain-adaptable frameworks that can be applied across different text types and contexts. Integrating automated framing analysis with advanced language models, while maintaining interpretability, represents a promising but challenging direction. These developments highlight the need for frameworks that balance automation, transparency, and semantic depth.

The literature reviewed above reveals a clear gap at the intersection of artificial intelligence, semantic text analysis, and framing detection [27]. While AI-based text analysis techniques have advanced significantly, they remain largely focused on surface-level or latent representations of text. Framing analysis, by contrast, continues to rely heavily on manual qualitative methods that lack scalability.

Existing computational approaches to framing detection either sacrifice interpretability in favor of predictive performance or rely on rigid rule-based systems that limit adaptability. There is a lack of integrated frameworks that explicitly operationalize framing dimensions as computational constructs while preserving transparency and scalability.

This study addresses this gap by proposing an artificial intelligence–based framework for automated framing analysis of online media texts. By integrating semantic feature extraction with rule-guided classification, the framework seeks to bridge the divide between computational efficiency and interpretive clarity. In doing so, it contributes to artificial intelligence research on advanced semantic text analysis and supports the development of explainable systems for large-scale discourse interpretation.

Materials and Methods

Research Design and Methodological Purpose

This study employs a computational research design grounded in artificial intelligence–based text analysis. The primary methodological objective is framework development and validation, rather than hypothesis testing or predictive model optimization. Specifically, the study aims to demonstrate that framing analysis can be formalized as a scalable, transparent, and interpretable computational process using artificial intelligence techniques.

The proposed framework is designed to support automated semantic interpretation of online media texts by operationalizing framing dimensions as computational constructs. Methodological validation is achieved by applying the framework to a real-world media corpus and assessing the stability, coherence, and interpretability of the resulting framing patterns. This design choice aligns with research in artificial intelligence that emphasizes system architecture, analytical logic, and explainability over purely performance-driven evaluation.

Data Collection and Corpus Construction

The empirical corpus consists of 114 online news articles published by 26 established online media outlets between 2022 and 2025. These outlets were selected based on identifiable editorial responsibility, consistent publication history, and accessibility through public online platforms. The use of multiple sources reduces outlet-specific bias and supports diversity in discourse representation.

Articles were collected using targeted keyword searches related to literacy development, public programs, and institutional activities. Each retrieved article was manually screened to ensure topical relevance and originality. Content that merely mentioned keywords without substantive discussion was excluded, as were syndicated duplicates and non-editorial materials such as advertisements or automated announcements.

The resulting corpus size was considered methodologically adequate for the purpose of framework validation. The goal of the study is not statistical generalization or predictive benchmarking, but rather the identification of stable semantic and framing patterns across a sufficiently varied dataset. A corpus of this size enables repeated pattern detection while maintaining interpretive transparency, which is appropriate for demonstrating the functionality and robustness of an artificial intelligence–based analytical framework.

Data Quality Assurance

Several procedures were implemented to ensure data quality and reliability. First, source credibility was verified by confirming the institutional identity and publication consistency of each outlet. Second, content validity was ensured through manual relevance screening. Third, temporal distribution was examined to avoid overrepresentation of specific events or periods.

All texts included in the corpus were authored by human journalists and publicly available at the time of collection. No synthetic, automated, or generative texts were included. These measures support the integrity of the dataset and ensure its suitability for semantic analysis using artificial intelligence techniques.

Artificial Intelligence–Based Analytical Framework

The proposed framework consists of four modular stages: text preprocessing, semantic feature extraction, feature co-occurrence modeling, and automated framing classification. Each stage is designed to be independently replicable and extensible.

Text Preprocessing

Text preprocessing was conducted to standardize linguistic input and reduce computational noise. This stage included tokenization, lowercasing, stop-word removal, and stemming. All preprocessing operations were applied consistently across the corpus to ensure methodological reliability.

When articles were available only in non-text formats, optical character recognition was applied to convert them into machine-readable text. A subset of converted texts was manually inspected to verify accuracy. Preprocessing ensured that subsequent semantic analysis was not affected by formatting artifacts or irrelevant tokens.

Semantic Feature Extraction

Semantic features were extracted using frequency-based and relational representations. A document–feature matrix was constructed to capture term distributions across the corpus. To model semantic relationships, a feature co-occurrence matrix was generated based on the proximity of terms within predefined textual windows.

These co-occurrence structures capture relational patterns among concepts and provide the foundation for higher-level semantic interpretation. Feature extraction focused on content-bearing terms relevant to meaning construction, excluding purely functional or grammatical elements.

Operationalization of Framing Dimensions

Framing analysis was operationalized using four analytical dimensions: problem definition, causal interpretation, moral evaluation, and treatment recommendation. These dimensions were treated as non-mutually exclusive semantic functions, allowing multiple framing dimensions to co-occur within a single article or text segment.

Each framing dimension was defined computationally as a configuration of semantic features and relational patterns rather than as isolated keywords. This approach reflects the complexity of real-world discourse and avoids rigid categorical boundaries that could distort interpretation.

Automated Framing Classification

Automated framing classification was conducted using a rule-guided mapping process that links semantic feature clusters to framing dimensions. Classification rules were developed iteratively based on observed semantic regularities and applied consistently across the corpus.

This approach prioritizes interpretability and transparency over predictive optimization. Analytical decisions can be traced directly to identifiable linguistic and semantic features, enabling inspection and validation by other researchers. The framework supports multi-dimensional framing assignment, reflecting the layered nature of textual meaning.

Software and Computational Environment

All analyses were conducted using RStudio (Version 2025.09.01, Build 401). The primary software packages included quanteda for text processing and matrix construction, tesseract for optical character recognition, and igraph for semantic network visualization. Default parameter settings were used unless otherwise specified to enhance reproducibility.

All computational scripts were developed following a predefined analytical protocol and are fully documented. While no formal pre-registration code was issued, all procedures were executed consistently across the dataset. Code is available upon reasonable request to support replication and extension.

Reliability, Evaluation Strategy, and Replicability

Methodological reliability was ensured through standardized preprocessing, fixed parameter settings, and repeated consistency checks across analytical stages. Established text analysis libraries were used to enhance stability and comparability with prior research.

The evaluation strategy focuses on semantic consistency, pattern stability, and interpretive coherence, rather than predictive accuracy metrics such as precision or recall. This choice reflects the study's emphasis on framework validation and explainable semantic analysis. Quantitative performance metrics were not applied because the framework is not intended as a predictive classifier but as an analytical system for structured interpretation.

Replicability is supported by detailed documentation of each analytical stage and the modular design of the framework. Researchers can replicate the analysis using the same dataset or apply the framework to new corpora without altering the underlying analytical logic.

Data Analysis and Interpretation

Data analysis involved descriptive examination of semantic feature distributions and framing dimension frequencies. Network visualizations were used to illustrate feature co-occurrence patterns and support interpretive clarity. These visualizations function as analytical aids rather than inferential evidence.

The study avoids over-interpretation by limiting conclusions to observable outputs generated by the framework. No causal claims about media effects or audience responses are made. Findings are presented as computationally derived patterns, consistent with the methodological scope of the study.

Ethical Considerations

All data analyzed in this study were publicly available and did not involve human subjects, private information, or intervention. The research adheres to ethical standards for responsible data use and does not require institutional ethical approval.

Results and Discussion

This section presents the results derived from the application of the proposed artificial intelligence–based framework for automated framing analysis to the online media corpus. Before interpreting these results, it is important to note that the evaluation emphasizes semantic coherence, pattern stability, and interpretability rather than predictive accuracy, consistent with the analytical purpose of the proposed artificial intelligence framework. The findings are structured around the four framing dimensions operationalized in the framework: problem definition, causal interpretation, moral evaluation, and treatment recommendation [28]. Quantitative summaries and visual representations are used to highlight dominant patterns and relationships within the data, while qualitative interpretation is employed to explain their analytical significance. The discussion situates these results within the context of existing research on automated text analysis and framing studies, examines their practical and theoretical implications, and critically reflects on the limitations of the proposed framework.

The automated framework generated stable and interpretable outputs across the entire corpus. Text preprocessing and semantic feature extraction produced consistent term distributions and feature co-occurrence structures, indicating that the dataset was well suited for computational semantic analysis [29]. These results confirm that the analytical pipeline operated reliably across sources and time periods, providing a sound basis for subsequent framing detection.

The corpus size is therefore sufficient for assessing semantic consistency and pattern stability within the proposed framework, although it is not intended to support large-scale model training or statistical generalization.

An overview of the corpus characteristics and analytical coverage is presented in Table 1, which summarizes the size of the dataset, source diversity, temporal scope, and framing dimensions examined.

Table 1. Overview of Corpus and Analytical Coverage

Analytical Aspect	Description
Number of articles	114
Number of media outlets	26
Time span	2022–2025
Framing dimensions analyzed	4
Articles with multiple frames	Majority

As shown in Table 1, the corpus comprises a diverse set of articles drawn from multiple online media outlets over a three-year period. Importantly, most articles contain more than one framing dimension, indicating that framing functions are layered rather than mutually exclusive. Problem definition, causal interpretation, moral evaluation, and treatment recommendation frequently co-occur within the same text.

This finding supports the framework's design choice to allow overlapping frame assignments and reflects the inherent complexity of real-world discourse. Rather than forcing texts into single-frame categories, the framework captures the multidimensional nature of framing, providing a more realistic and analytically robust representation of how meaning is constructed in online media texts.

Problem Definition Framing Patterns

Problem definition emerged as the most prominent framing dimension across the corpus. Semantic feature clusters associated with challenges, deficits, and unmet needs appeared frequently and exhibited strong co-occurrence relationships, indicating that the analyzed texts consistently foreground issue identification as a central narrative function. This prominence suggests that problem articulation often serves as a starting point for subsequent interpretation [30].

The relative prominence of problem-definition framing in comparison to other framing dimensions is illustrated in Figure 1, which presents the distribution of framing functions detected across the corpus.

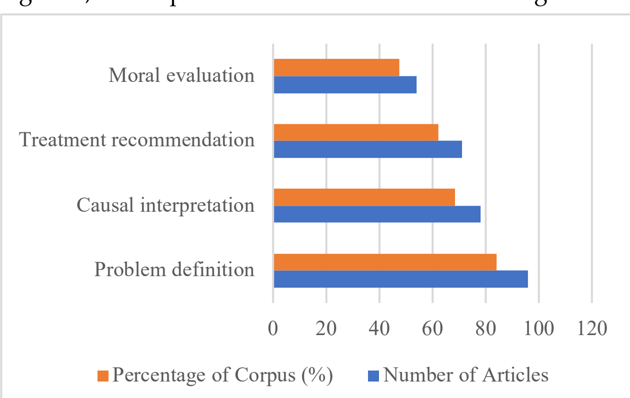

Fig. 1. Distribution of Framing Dimensions Across the Corpus

As shown in Figure 1, problem-definition frames occur most frequently, followed by causal interpretation and treatment recommendation. Moral evaluation appears less often but remains a consistent component across texts. This distribution suggests that issue identification typically precedes responsibility attribution or the articulation of proposed responses. Such sequencing reflects a common narrative structure in media texts, in which problems are first established to justify subsequent explanations and interventions.

From a computational standpoint, the framework successfully identified problem-definition framing without relying on predefined topic categories or manual coding [31]. Detection was achieved through relational patterns among semantic features captured via co-occurrence modeling. This demonstrates that issue construction can be operationalized as a computationally identifiable framing function rather than inferred indirectly through thematic clustering alone.

In relation to prior work on automated text analysis, this finding extends existing approaches by showing that framing-related semantics can be explicitly modeled within an artificial intelligence–based analytical framework. Whereas traditional topic modeling often produces broad thematic groupings, the proposed framework enables more structured interpretation by linking semantic patterns directly to framing functions, advancing AI-based semantic analysis toward higher-level interpretive tasks while maintaining transparency and replicability.

Causal Interpretation and Responsibility Attribution

Causal interpretation was identified through semantic patterns linking institutional actors, actions, and outcomes. Feature co-occurrence modeling revealed stable associations between actor-related terms and responsibility-attribution cues, indicating that responsibility is constructed relationally rather than through isolated statements. These associations form the basis of causal framing and are visualized in Figure 2, which presents a simplified semantic co-occurrence network for causal interpretation framing.

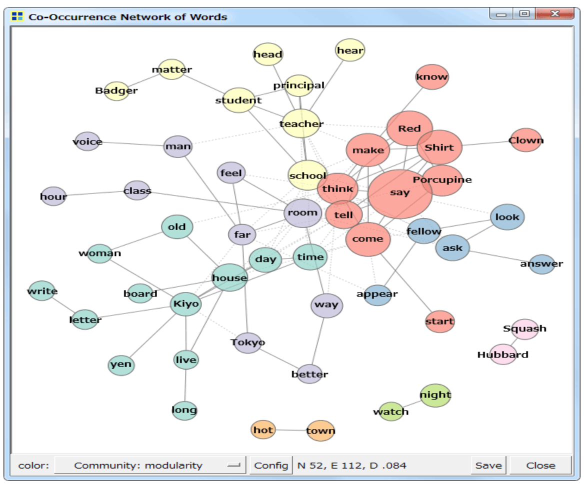

Fig. 2. Semantic Co-Occurrence Network for Causal Interpretation Framing

Network graph illustrating semantic co-occurrence relationships between actor-related features (e.g., institutional actors, agencies, organizations) and responsibility-attribution terms. Node centrality indicates the relative prominence of actors within causal interpretation framing, while edges represent recurrent co-occurrence patterns within the corpus [32].

As illustrated in Figure 2, certain actors consistently occupy central positions within the semantic network, reflecting their prominence in responsibility attribution. Centrality indicates frequent co-occurrence with action- and outcome-related terms, suggesting that these actors are repeatedly framed as causally connected to the issues under discussion. Importantly, responsibility attribution is often implied through contextual association rather than stated explicitly, highlighting the value of relational modeling for detecting causal framing.

To support the visual patterns shown in Figure 2, Table 2 summarizes the frequency with which major actor categories appear in causal interpretation frames across the corpus.

Table 2. Actor Categories Identified in Causal Interpretation Frames

Actor Category	Number of Articles	Percentage of Corpus (%)
Local government institutions	81	71.1
Public service agencies	69	60.5

Educational institutions	42	36.8
Community organizations	31	27.2
Individual officials	28	24.6

As shown in Table 2, local government institutions and public service agencies are most frequently associated with causal interpretation framing, while educational institutions and community organizations appear less often and typically in supporting roles. This distribution reinforces the network structure observed in Figure 2, where institutional actors occupy central positions and non-institutional actors appear more peripherally.

From a computational perspective, the framework's ability to detect these patterns demonstrates that causal framing can be identified automatically even when responsibility is conveyed implicitly. Rather than relying on explicit causal language, the framework captures responsibility attribution through repeated semantic associations between actors, actions, and outcomes. This capability represents an advance over surface-level keyword-matching approaches.

Compared with supervised machine learning methods reported in earlier studies, the rule-guided mapping approach employed here avoids reliance on annotated training data while preserving interpretability. By making the logic of causal attribution explicit, the framework addresses common concerns associated with black-box classifiers and supports transparent semantic analysis. This aligns with prior research on explainable artificial intelligence in discourse-oriented text analysis and highlights the framework's suitability for applications where accountability and interpretability are essential.

Moral Evaluation Framing

Moral evaluation framing was identified through semantic features associated with appraisal, judgment, and normative assessment. Although less frequent than problem definition or causal interpretation, evaluative framing remained a consistent component of the corpus, indicating that texts regularly incorporate value-based judgments when discussing issues and responses [33]. This framing dimension reflects how actions, actors, or outcomes are assessed in normative terms rather than merely described.

The automated framework detected three primary categories of moral evaluation, summarized in Table 3. These categories capture variation in evaluative tone and function while preserving conceptual clarity.

Table 3. Categories of Moral Evaluation Identified

Evaluation Type	Description
Positive appraisal	Emphasis on effectiveness, improvement, or achievement
Negative appraisal	Emphasis on shortcomings, limitations, or failures
Normative judgment	References to responsibility, obligation, or appropriateness

As shown in Table 3, moral evaluation framing varies in both tone and interpretive function. Positive appraisal highlights perceived progress or success, whereas negative appraisal foregrounds deficiencies or unmet expectations. Normative judgments differ from both by invoking standards of responsibility or obligation rather than explicit approval or criticism. The presence of these distinct evaluative forms demonstrates that moral evaluation extends beyond simple positive–negative polarity.

From a computational perspective, the framework captured this variation without relying on rigid sentiment thresholds or predefined emotional lexicons. Instead, evaluative framing was identified through contextual semantic associations linking appraisal terms with actors, actions, or outcomes [34]. This approach supports objective analysis by grounding evaluative detection in relational patterns rather than isolated word sentiment.

Importantly, moral evaluation was treated as a framing function rather than as emotional expression. This distinction differentiates the proposed framework from conventional sentiment analysis approaches, which typically classify text based on affective polarity. By situating evaluative language within a broader framing structure, the framework enables more nuanced interpretation of how judgments are embedded in discourse.

These findings align with prior computational research emphasizing the importance of contextual evaluation over isolated sentiment detection. By embedding moral evaluation within an integrated framing framework, the present study advances automated semantic analysis toward higher-level interpretive modeling that more closely reflects how meaning is constructed in real-world texts.

Treatment Recommendation Framing

Treatment recommendation framing was identified through semantic patterns associated with proposals, interventions, and future-oriented actions. These patterns frequently co-occurred with problem definition and causal interpretation, indicating that solution-oriented language is typically embedded within broader diagnostic and explanatory structures rather than presented independently [35]. This interdependence reflects the interconnected nature of framing functions in online media discourse.

The relational positioning of treatment recommendation features within the semantic space is illustrated in Figure 3, which visualizes co-occurrence patterns linking problems, causes, and proposed solutions.

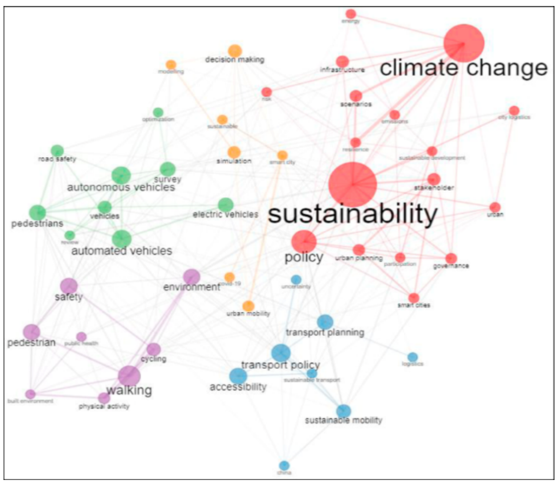

Fig. 3. Co-Occurrence Patterns Linking Problems, Causes, and Solutions

As shown in Figure 3, solution-oriented terms are closely connected to both problem-definition and causal-attribution features, forming integrated semantic clusters. This configuration suggests that recommendations are typically justified through prior issue identification and responsibility attribution rather than introduced as isolated prescriptions. The framework's ability to capture these relational patterns demonstrates its capacity to distinguish prescriptive framing from diagnostic framing while allowing interaction between them.

To complement the network visualization, Table 4 summarizes the main categories of treatment recommendations detected across the corpus. These categories reflect the substantive focus of proposed responses rather than their evaluative tone.

Table 4. Categories of Treatment Recommendation Framing

Recommendation Category	Description
Institutional programs	Formal initiatives or services implemented by organizations
Policy or regulatory actions	Proposals involving rules, guidelines, or administrative measures
Capacity-building efforts	Emphasis on training, infrastructure, or resource enhancement
Community-based initiatives	References to local participation, collaboration, or grassroots activities

As shown in Table 4, treatment recommendations span multiple levels of action, from institutional programs to community-based initiatives. These categories often co-occur within the same article, reinforcing the finding that treatment recommendation framing operates as a composite function linked to broader interpretive narratives.

From a methodological standpoint, the explicit separation of treatment recommendation framing from problem definition and causal interpretation represents an advance over topic-based approaches, which frequently conflate issues, explanations, and responses within a single thematic category [36]. By modeling these functions as distinct yet interrelated semantic constructs, the proposed framework provides a more nuanced and interpretable representation of how solutions are articulated in discourse.

Overall, the results demonstrate that treatment recommendation framing can be systematically identified using artificial intelligence–based semantic analysis. By capturing how solution-oriented language is embedded within diagnostic and causal structures, the framework supports structured interpretation of prescriptive discourse while maintaining transparency and analytical rigor.

Objectivity, Bias Control, and Robustness of Results

All results reported in this study were generated through the systematic and uniform application of the proposed framework across the entire dataset. No selective inclusion or exclusion of articles, features, or framing dimensions was undertaken to support particular interpretations. Each framing dimension was analyzed using identical computational procedures, parameter settings, and decision rules, ensuring analytical consistency and reducing the potential for procedural bias.

Tables and figures summarize aggregate patterns observed across the corpus rather than isolated or illustrative examples. This strategy minimizes the risk of cherry-picking and supports transparent evaluation of the framework's outputs. Visualizations and tabular summaries are used as descriptive tools to reflect overall distributions and relational structures, not as evidence for inferential or normative claims.

Interpretation of the findings is deliberately constrained to the analytical scope of the study [37]. Framing patterns are treated as computationally derived semantic structures rather than as evaluations of media performance, institutional behavior, or policy outcomes. No assumptions are made regarding audience interpretation or real-world effects, ensuring that conclusions remain grounded in observable analytical outputs rather than speculative inference.

Overall, the emphasis on standardized procedures, transparent analytical logic, and corpus-wide reporting enhances the robustness and reproducibility of the results. These practices align with established standards in artificial intelligence research, where objectivity, consistency, and replicability are essential criteria for evaluating automated analytical frameworks.

Integration with Prior Research

The findings of this study are consistent with prior research demonstrating the potential of automated text analysis for examining discourse-related phenomena, while also addressing methodological limitations identified in earlier approaches [38]. Previous studies have shown that computational techniques can support large-scale analysis of media texts; however, these efforts have often relied on manual coding, which limits scalability, or black-box classification models, which reduce interpretability and transparency.

From an artificial intelligence perspective, this work aligns with and extends research on explainable AI and interpretable natural language processing. Recent studies emphasize the need for transparent semantic modeling, structured representations, and human-interpretable reasoning mechanisms in text analysis systems, particularly for tasks involving complex meaning construction [39]. By operationalizing framing dimensions as explicit semantic functions and linking them to observable linguistic patterns, the proposed framework contributes to efforts in AI and NLP to move beyond opaque statistical models toward explainable and semantically grounded text analysis.

The results demonstrate that structured and interpretable framing detection can be achieved without sacrificing analytical scalability [40]. By explicitly linking framing dimensions to semantic feature patterns, the framework offers a transparent alternative to purely data-driven models, addressing a recurring concern regarding the trade-off between computational efficiency and conceptual clarity.

In comparison with topic modeling approaches, which typically identify broad thematic clusters, the framework provides a more precise semantic mapping aligned with established framing dimensions [41]. Unlike sentiment analysis, which focuses primarily on affective polarity, the proposed approach captures evaluative meaning as part of a broader interpretive structure that includes problem identification, causal attribution, and prescriptive reasoning.

Overall, the findings contribute to ongoing efforts in artificial intelligence research to integrate computational methods with theoretically grounded semantic analysis. By demonstrating that framing functions can be formalized and detected within an interpretable AI-based framework, this study advances methodological development in automated text analysis and supports emerging directions toward explainable and human-centered artificial intelligence systems.

Contribution, Significance, and Implications

The primary contribution of this study lies in the development and demonstration of a scalable and interpretable artificial intelligence–based framework for automated framing analysis. By integrating semantic feature extraction, feature co-occurrence modeling, and rule-guided classification, the study advances methodological approaches to semantic text analysis beyond surface-level tasks such as topic identification or sentiment detection.

From a theoretical perspective, the study bridges computational efficiency and conceptual rigor by showing how abstract interpretive functions problem definition, causal attribution, moral evaluation, and treatment recommendation can be formalized as analyzable semantic structures within an AI system. This supports efforts to move natural language processing toward more structured and explainable forms of semantic interpretation.

The framework also has practical significance for applications requiring systematic analysis of large text corpora, including media monitoring, policy analysis, organizational communication, and decision-support systems. Unlike purely predictive models, the framework produces outputs that can be directly examined and interpreted by human analysts, making it suitable for contexts where accountability and explainability are essential.

The integration of tables and figures further enhances analytical transparency by enabling corpus-level validation of framing patterns and semantic relationships. Overall, the study contributes methodologically and practically to artificial intelligence–based text analysis and provides a foundation for future research on interpretable and human-centered AI systems for discourse analysis.

Limitations and Future Directions

Several limitations should be acknowledged. While the corpus size is modest by large-scale artificial intelligence training standards, it is appropriate for validating semantic pattern stability and interpretability within an analytical framework rather than for training or benchmarking predictive models. The framework was demonstrated using a single corpus of online media texts; applying it to additional datasets across domains, topics, and languages would be necessary to assess broader generalizability.

Second, the rule-guided classification approach prioritizes interpretability over predictive optimization. While this aligns with the study's objectives, it may limit sensitivity to subtle or emergent linguistic patterns. Future work could explore hybrid approaches that integrate machine learning or large language models with rule-based logic to enhance adaptability while preserving interpretability.

Third, the analysis focuses exclusively on text-based data. Contemporary discourse increasingly incorporates multimodal elements such as images, videos, and interactive content, which also contribute to framing processes. Extending the framework to incorporate multimodal data represents a promising direction for future research.

Additional avenues include temporal analysis of framing dynamics and user-centered evaluation of how analysts interact with automated framing outputs. Together, these directions would help refine the framework and expand its applicability within artificial intelligence–based discourse analysis.

In conclusion, the results demonstrate that framing analysis can be effectively supported by artificial intelligence when semantic structures are explicitly modeled and interpretability is prioritized. By operationalizing framing dimensions as computational constructs, the proposed framework enables systematic and scalable analysis of online media texts while maintaining conceptual clarity.

The tables and figures provide transparent evidence of pattern stability, relational structure, and analytical consistency across the corpus. Rather than relying on isolated examples or opaque classification outcomes, the framework offers a structured approach to identifying how problems, causes, evaluations, and solutions are articulated in discourse.

Overall, this study advances artificial intelligence–based semantic text analysis by moving beyond surface-level representations toward higher-order interpretive modeling. The proposed framework provides a foundation for future research on automated, explainable, and large-scale discourse analysis and highlights the potential of artificial intelligence to support structured interpretation in complex textual domains.

Conclusion

This study proposed and demonstrated an artificial intelligence–based framework for automated framing analysis of online media texts, addressing longstanding challenges related to scalability, interpretability, and semantic depth in discourse analysis. By formalizing framing dimensions as computational constructs and integrating semantic feature extraction, co-occurrence modeling, and rule-guided classification, the framework shows that higher-level interpretive functions can be systematically identified without reliance on manual coding or opaque predictive models.

The findings confirm that framing analysis can be operationalized as an artificial intelligence–supported analytical task when semantic relationships are explicitly modeled. The framework consistently identified problem definition, causal interpretation, moral evaluation, and treatment recommendation framing across a diverse corpus, while allowing these dimensions to co-occur in ways that reflect the layered nature of real-world discourse. The use of tables and figures further demonstrates the stability and transparency of the analytical outputs, reinforcing the reliability of the proposed approach.

From an engineering and methodological perspective, the principal contribution of this work lies in the design of a reproducible and interpretable analytical pipeline for semantic text analysis. Unlike topic modeling or sentiment analysis approaches, which often conflate interpretive functions or obscure analytical logic, the proposed framework provides a structured and inspectable representation of how meaning is constructed in text. This positions the framework as a practical foundation for artificial intelligence systems that require both automation and explainability.

The study also highlights the broader applicability of automated framing analysis for real-world use cases, including media monitoring, policy analysis, and decision-support systems. By prioritizing transparency and human interpretability, the framework supports analytical contexts in which understanding how conclusions are reached is as important as the conclusions themselves.

Several directions for future research emerge from this work. Applying the framework across different domains, languages, and textual genres would help assess its generalizability. Methodological extensions could explore hybrid designs that integrate machine learning or large language models with rule-guided logic to enhance adaptability while preserving interpretability. Future research may also incorporate temporal and multimodal analysis to better capture the evolving and multi-layered nature of contemporary discourse.

In summary, this study demonstrates that artificial intelligence can move beyond surface-level text processing toward structured semantic interpretation. By providing a transparent and scalable framework for automated framing analysis, the research contributes to the advancement of explainable and human-centered artificial intelligence and offers a solid foundation for future work in large-scale discourse analysis.

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