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The Role of Adaptive Information Systems in Detecting Disruptive Communication Signals

Cătălin-Relu Băsescu[1]

Abstract: This paper analyzes the role of adaptive information systems in the early identification of potentially disruptive communication signals, in a context marked by information instability, digital acceleration and media pressure on institutions. Faced with the intensification of phenomena such as ideological polarization, the dissemination of disinformation and the emergence of radicalizing discourses, the ability of organizations to anticipate and interpret deviations from communication norms becomes essential, in order to protect decisional coherence and public trust. The paper is based on recent contributions from the fields of semantic analysis, natural language processing and machine learning, offering an integrated approach on how digital infrastructures can support contextual analysis of messages and the detection of weak signals. Adaptive information systems are described as complex algorithmic entities, capable of processing large volumes of unstructured data, identifying discursive patterns and generating, in real time, information risk scores. By integrating artificial intelligence and semantic analysis technologies, these systems support rapid, contextually relevant and anticipatory institutional responses. The paper thus proposes a conceptual framework applicable to the development of proactive mechanisms for discursive surveillance and communication instability management, with strategic relevance for educational, administrative and governmental environments.

Keywords: Adaptive Information Systems; Disruptive Communication; Semantic Analysis; Institutional Resilience

[1] Assistant Professor, PhD, The Bucharest Academy of Economic Studies, Romania, Address: Romana Square, no. 6, district 1, Bucharest, Romania, Corresponding author: vulturul2002@yahoo.com.

1. Introduction

In an increasingly complex, unstable and oversaturated information context, the ability of institutions and organizations to detect disruptive communication signals is becoming essential for protecting social balance, strategic decisions and institutional communication systems. Phenomena such as ideological polarization, the dissemination of disinformation, discursive manipulation or extremist discourses circulate rapidly through digital networks and require technological solutions that can analyze, in real time, large volumes of unstructured data. Adaptive information systems are proving increasingly relevant in this process, as they integrate artificial intelligence and semantic profiling to monitor communication deviations and provide decision-makers with early warning indicators. These systems can learn from previous patterns, algorithmically adjust levels of contextual sensitivity and provide strategic visualizations for analyzing disruptive messages (Tewari & Wei, 2023; Sabic et al., 2024).

Several recent studies show that integrating signal detection mechanisms into adaptive information architectures significantly improves the speed of reaction and the institutional capacity to interpret unstable communication flows (Cremene & Crișan, 2021; Shepherd & Romero, 2023). For example, in educational and digital governance environments, these systems facilitate an anticipatory approach to messages with disruptive potential, thus supporting the management of emerging communication risks (Karimi & Walter, 2021).

Amidst the increasing pressure on institutional communication, the specialized literature indicates a clear trend towards the development of agile digital networks, capable of detecting, communicating and collaborating around relevant signals in crisis conditions (Tewari & Wei, 2023). Adaptive signal analysis systems thus become essential infrastructures for discursive monitoring and strengthening organizational resilience.

AI applications in communication contexts are also extended to the Internet of Things (IoT) networks, where system adaptability is crucial for maintaining communication stability in the face of interference or hostile signals (Du & Roussos, 2022). In a comparative approach, Sabic et al. (2024) highlight that reactive AI-based systems have the ability to classify aggressive signals and suggest automated, personalized responses.

This paper aims to analyze the role of adaptive information systems in detecting communication deviations with disruptive impact and to highlight, through case

studies, their value in educational and institutional contexts, with a focus on semantic analysis, machine learning, and strategic visualization.

2. Adaptive Information Systems and Disruptive Communication: Theoretical Foundations

In the post-digital era, communication flows take place in an unstable, information-oversaturated and extremely reactive environment, in which messages are no longer just vehicles for transmitting intention, but active factors in (de)stabilizing institutional, social or political reality. In this context, the concept of disruptive communication acquires an operational meaning: any message, series of messages or discursive form that significantly interrupts, disrupts or reorients the course of normal communication is considered disruptive. Their detection becomes a strategic stake, both for institutions and for digital social ecosystems.

To meet this need, adaptive information systems (AIS) are asserting themselves as infrastructures capable of managing, in real time, the analysis and interpretation of messages with disruptive potential. An adaptive information system can be defined as a set of interconnected computer and algorithmic components, capable of learning and reacting to changes in the communication environment, adjusting its behavior based on historical data and machine learning (Tewari & Wei, 2023; Sabic et al., 2024).

From an architectural point of view, an SIA integrates four fundamental components:

a. Data acquisition and collection component – responsible for extracting messages from multiple communication sources: social networks, media channels, textual databases or real-time streams. This phase includes preprocessing processes (cleaning, segmentation, labeling) and is supported by APIs, crawlers and streaming technologies (Du & Roussos, 2022).

b. Semantic and contextual analysis component – performs the transformation of raw data into semantic vectors through natural language processing (NLP), topic analysis or ideological mapping. This is essential in identifying disruptive communication signals, as it allows the interpretation of the latent meaning of messages, including hostile intentions, extremist discourse or rhetorical ambiguities (Cremene & Crișan, 2021).

c. The adaptive component (learning engine) – incorporates machine learning

algorithms (supervised and unsupervised), which adjust relevance scores, learn from historical patterns and continuously optimize alert levels. This component is what transforms the system from a passive database into an active and evolving decision-making actor (Karimi & Walter, 2021).

d. The visualization and decision-making feedback interface – allows users (institutions, strategic communicators, analysts) to interact with the results of the analysis: adaptive dashboards, semantic maps, automatic discursive risk signaling or communication danger scores. It functions as an augmented communication space between the system and the decision-maker (Tewari & Wei, 2023).

Communication speed and information complexity shape adaptive information systems (AIS) as veritable nerve centers of contemporary decision-making architecture. They are not limited to conventional data collection and processing functions, but integrate advanced components of machine learning, behavioral anticipation and contextualized reaction, capable of adapting in real time to the dynamics of the communication space.

One of the essential functions of an AIS is the detection of communication anomalies, understood as the process of automatically identifying significant deviations from the accepted normative, consensual or institutional discourse. This capacity involves not only a quantitative analysis of the frequency of terms or lexical variations, but also a semantic and pragmatic interpretation of messages, in order to signal the emergence of disruptive patterns – be they disinformative, radicalizing or destabilizing. Also, the ideological and rhetorical classification of messages represents a critical function in the assessment of communication risks. Through natural language processing (NLP) algorithms, SIA is able to attribute ideological vectors to discourses, identify levels of emotional charge, and infer communicational intentionalities – such as persuasion, intimidation, victimization or mobilization. In this way, a dynamic map of the positioning of actors and potential points of discursive conflict is built.

A defining feature of an adaptive system is the ability to adjust alert scores in real time, based on the correlation between previous signals and changes in context. In this sense, SIA does not operate only on the basis of fixed rules, but incorporates algorithmic feedback loops that allow the reconfiguration of sensitivity thresholds and the recalibration of the meaning of terms or expressions according to emerging situations.

In addition, the prediction of discursive impact constitutes a particularly valuable strategic tool, through which SAI estimates the probability that a message–

seemingly trivial or marginal–will achieve a high degree of virality, generate institutional reactions, or fuel public perception crises. This anticipation is based on predictive models that include variables such as the type of sender, the audience's reaction history, and the contextual information climate.

By bringing together these functions, adaptive information systems transcend the traditional technological paradigm and become cognitive nodes with a strategic function, indispensable in managing communication crises, in institutional security and in developing public communication policies. In a saturated, volatile and competitive information ecosystem, integrating an SIA is equivalent to obtaining an advanced capacity for discursive resilience and anticipatory decision-making.

2.1. Typing AreaDisruptive Communication Signals: Characteristics, Institutional and Social Impact

The disruptive communication signal is conceptualized as an autonomous information entity or as a complex discursive construct, capable of diverting the normative course of institutional or social communication. It directly affects decision-making processes, the interpretative coherence of official messages and, implicitly, the perceptual cohesion at the target audience level. In contrast to erroneous, propagandistic or explicitly manipulative messages, the disruptive signal is distinguished by an intentional subtlety that is difficult to detect: it does not always express a clear intention to misinform or provoke, but can be characterized by semantic ambiguity, emotional hyperstimulation, argumentative distortion or accelerated virality, all of which contribute to its destabilizing potential.

Recent studies in the field of digital discourse analysis and communication psychology highlight several defining dimensions of these signals:

- Semantic volatility is a fundamental feature, expressed in the fact that the disruptive signal acquires multiple, sometimes contradictory, meanings, depending on the cognitive, value and cultural configuration of the receiving audience. This high degree of semantic ambiguity amplifies interpretative uncertainty and weakens institutionalized meaning anchors.
- The viral potential of these signals is manifested by their ability to disseminate rapidly, spontaneously and predominantly through affective channels (Karimi & Walter, 2021). This virality is not always correlated with

the truth value of the content, but with its degree of emotional reactivity and ease of integration into pre-existing social narratives.

- Polarizing ideological content is often structured around social, identity, or nationalist cleavages, being designed to mobilize antagonistic emotions and divide the public into conflicting categories. Such signals function as discursive devices for fragmenting consensus, generating conflicting information environments (Shepherd & Romero, 2023).

- Rhetorical anomalies constitute a formal dimension of disruption, being identified by features such as: breaks in tone, the use of threatening metaphors, logical inversions of argumentation, or the use of double-meaning expressions. These rhetorical deviations undermine conventional communication registers and favor discursive confusion.

- Finally, strategic ambiguity allows the sender to maintain a margin of "plausible deniability" of intention, that is, to formulate messages that are sufficiently ambivalent that they can be subsequently reinterpreted, retracted, or reformulated without assuming explicit responsibility. This feature increases the manipulative resilience of the signal, making institutional intervention more difficult and risky.

Therefore, in the analysis and management of communication risks, the disruptive signal must be understood not only as an accidental deviation or as a classic form of manipulation, but as a complex discursive product, capable of influencing perceptions, distorting consensus, and disrupting decision-making mechanisms. In this context, adaptive information systems, along with methodological frameworks for semantic detection and narrative evaluation, become essential tools for the early diagnosis and effective management of these potentially disruptive phenomena.

The impact of disruptive communication signals on institutional systems is profound and multidimensional, directly affecting the coherence, legitimacy and efficiency of contemporary decision-making. In the first instance, these signals weaken the capital of public trust in authority, by generating a climate of uncertainty, contestation and perceptual ambiguity. Constant exposure to such discursive stimuli induces an artificial media pressure, often disproportionate to the real facts, which forces institutions to react in a communicative emergency regime, without having a consolidated analytical framework. In addition, the high volume of competing information – much of which is distorted or hyper-simplified – generates a phenomenon of overinformation and strategic disorientation, diminishing the decision-making capacity of institutional actors (Tewari & Wei, 2023).

At the level of the extended social system, signals of this type can act as factors of ideological polarization, accentuating existing cleavages and contributing to the formation of radicalized micro-communities, discursively closed and refractory to rational dialogue. These emerging social entities, usually stimulated by affective rhetorics and antagonistic narratives, become difficult to detect through classical methods of discursive monitoring, as they are organized on decentralized platforms, through internal symbolic codes and with an accelerated viralization dynamic

3. Integrating Artificial Intelligence and Semantic Analysis into Communication Flows

This chapter explores how artificial intelligence (AI) and semantic analysis are integrated into adaptive information systems, with the aim of detecting disruptive communication signals in real time. The focus is on the technical and analytical functionalities of these systems, without proposing a formal model, but aiming to highlight mechanisms already applied or tested in institutional and educational contexts.

Artificial intelligence is mainly used to recognize recurrent communication patterns, automatically filter messages, and apply adaptive classifiers to identify potentially disruptive content. In this process, machine learning algorithms allow systems to learn from historical data, continuously adjusting alert thresholds and sensitivity levels in relation to context.

Semantic analysis contributes to extracting deeper meanings from textual messages, including the detection of ideological nuances, discourse intent, and latent disruptive potential. This process is based on natural language processing (NLP) techniques, contextual vectorization and recognition of semantic entities associated with communication risks.

Combined, these two components – AI and semantic analysis – allow adaptive systems to efficiently manage large volumes of unstructured data, generate information risk scores and automatically signal significant deviations from pre-established communication norms. The integration of these technical tools is essential in the context of unstable information flows and the need for rapid, anticipatory and contextualized institutional response. The combination of artificial intelligence with advanced semantic analysis gives adaptive information systems an extended capacity to process, understand and react to the discursive complexity

specific to the contemporary communication space. Through this technological synergy, the systems become capable of efficiently managing massive volumes of unstructured data, extracted from heterogeneous sources such as social networks, media platforms, public forums or alternative communication channels. More than just content aggregation, these systems perform contextualized data analysis, identifying recurring semantic patterns, detecting subtle changes in the tone, intent, or content of discourses, and automatically classifying messages according to their associated communication risk.

An essential aspect of this intelligent architecture is the dynamic generation of information risk scores, which allows for real-time assessment of the disruptive potential of messages. These scores are obtained by correlating discursive indicators – such as emotional intensity, ideological polarization, or symbolic density – with predictive models trained on historical data. Thus, the system can signal significant deviations from institutionally accepted communication norms, activating automatic alert protocols, and supporting strategic decision-making.

The integration of these technical tools into the decision-making infrastructure is not only opportune but imperative in the context of an increasingly unstable information ecosystem characterized by discursive volatility, communication acceleration, and the intensification of disinformation risks. In such a framework, the capacity of institutions to react quickly, anticipatively, and contextually depends directly on the degree of automation, precision, and adaptability of digital semantic analysis tools assisted by artificial intelligence. Moreover, this integration contributes to increasing institutional resilience, allowing a better delimitation between informational noise and relevant signals, an efficient distribution of decision-making attention, and, implicitly, a consolidation of communicational authority in the face of emerging crises.

4. Conclusions

The conclusions of this article highlight the strategic importance of adaptive information systems in the context of profound transformations of the contemporary communication ecosystem. In an increasingly volatile, fragmented and dominated by potentially disruptive signals information space, the capacity of institutions to react efficiently and anticipatory becomes an essential condition for maintaining decision-making stability, institutional coherence and public trust.

The integration of artificial intelligence and advanced semantic analysis into the institutional communication infrastructure is no longer an option, but a functional necessity. The adaptive information systems analyzed in this study offer not only tools for automatic detection of discursive anomalies, but also mechanisms for contextual adjustment, impact prediction and strategic visualization, thus becoming true analytical command centers in the management of complex communication.

The paper argues that communication resilience cannot be built without a technological framework capable of filtering informational noise, identifying significant deviations, and transforming unstructured data into operational signals. Thus, a new paradigm of institutional information security is emerging, in which adaptive algorithms become cognitive actors in the decision-making process, directly contributing to protecting social cohesion and discursive order in a profoundly changed communication landscape.

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