

# A Context Aware Deep Learning Framework for Multi-Level Arabic Fake News Detection Using Hybrid Linguistic Representations

Noor Mahmoud Alkudah<sup>1</sup>, Somia Abufakher<sup>2</sup>, Raja Masadeh<sup>1</sup>, Esraa Masadeh<sup>3</sup> and Norma Bataina<sup>4</sup>

<sup>1</sup>Department of Computer Science, The World Islamic Sciences and Education University, Amman, Jordan

<sup>2</sup>Department of Software Engineering, College of Information Technology, The World Islamic Sciences and Education University, Amman, Jordan

<sup>3</sup>Engineering and Artificial Intelligence Department, Al-Salt Technical College, Al-Balqa Applied University, Al-Salt, Jordan

<sup>4</sup>Aqaba University of Technology, Aqaba, Jordan

## Article history

Received: 24-12-2025

Revised: 07-02-2026

Accepted: 09-02-2026

## Corresponding Author:

Noor Mahmoud Alkudah

Department of Computer Science,  
The World Islamic Sciences and  
Education University, Amman,  
Jordan

Email: noor.qudah@wise.edu.jo

**Abstract:** The rapid spread of false information on social media has made it even more important to be able to spot false news, especially in Arabic-speaking areas where language is more complicated and news is organized in a hierarchy. Recent research show that deep learning and transformer-based models work well, but most of them only look at performance metrics and don't look at how alternative contextual representations affect detection behavior. This study presents a context-aware deep learning architecture that amalgamates semantic representations from AraBERT with syntactic characteristics obtained from part-of-speech tagging and emotional indicators to facilitate multi-level Arabic false news detection. The JoNewsFake dataset is used in an ablation-based experimental design to look at how each contextual component affects the main category, subcategory, and fake/real classification levels. The findings indicate that although semantic embeddings offer a solid base, the integration of syntactic and emotional context markedly increases robustness, diminishes ambiguity in nuanced subcategories, and facilitates the differentiation between authentic and fabricated news. Analysis led by visualization shows again how adding information can help fix mistakes that come from rhetorical framing and implicit sentiment. This study transitions from benchmark-oriented evaluation to contextual effect analysis, underscoring the necessity of thorough context modeling for dependable and interpretable Arabic false news detection systems.

**Keywords:** Arabic NLP, Contextual Representation Learning, Fake News Detection, Hierarchical Classification, Deep Learning

## Introduction

Social media has revolutionized how we obtain our news throughout the world. Two examples of social media sites that are easy to use and have a lot of users are Facebook and Twitter. Because of this, they are now places to get news (Alazab et al., 2022). The truth is that social media spreads information very quickly, even what some people call "fake news" (Al-Ahmad et al., 2021). False information propagation is a significant threat to culture, politics and economics. However, people still prefer social networking sites including Facebook and Twitter. The most important issue is the massive spread of false news on these sites in a short period of time. Reports show that disinformation might be more effective than

verified news because it spreads faster and covers a larger audience (Al-Jalabneh et al., 2023). This has made automated identification of misleading content an urgent problem of Natural Language Processing (NLP). The initial studies mainly treated the issue as a two-way classification problem with the use of standard machine learning methods (Al-Taie, 2025). The current improvements in deep learning and transformers have exploited contextual semantic representations of massive data. Even with these developments, a good portion of the literature, especially Arabic literature has been more about the measures of evaluation, including accuracy and F1-score but does not provide much detail about the inner workings of the models (David and Micheal, 2016). It is difficult to detect fake content in Arabic as compared to

English due to the complex morphology, extensive rhetorical instruments, and powerful emotional appeals. Additionally, Arabic news usually deals with several issues at the same time, including political, social, and economic ones (Bsoul et al., 2022). Therefore, straightforward or even binary classification methods could not be applicable to encompass the structural and contextual complexity of the Arabic news discourse. The recent research has started to address these issues with the help of multi-level and multi-label classification techniques (Al-Taie, 2025). In this framework, our prior research presented Jo News Fake, a substantial dataset consisting of 50,000 Facebook posts sourced from verified Jordanian news agencies and categorized with primary and secondary labels, as well as fake/real indicators, accompanied by comprehensive benchmarking of ensemble and deep learning models. Although that study provided robust empirical baselines, it did not specifically investigate the impact of contextual information on model decisions, nor did it evaluate the comparative roles of semantic, syntactic, and emotional cues in hierarchical Arabic false news detection. Driven by these constraints, the current study transitions from comparison benchmarking to context-aware representation learning (Çetiner, 2024). This paper will discuss the way in which contextual enrichment enhances the ability to detect fake news in hierarchically organized Arabic texts and not whether a model will prove to be the best. Our model is a context-dependent deep learning model that combines three sources of information that is, contextual semantic embedding based on AraBERT, syntactic structure represented by part-of-speech tagging, and emotional clues indicating affective signals often linked with misinformation.

The provided study is a comprehensive investigation of the fake news detection procedures in Arabic, with a detailed assessment of the significance of the individual elements of the context and their interrelations (Patil, 2022). The proposed approach increases the interpretability since it illustrates the impact of contextual cues on Arabic news talk. The findings add to the field of Arabic NLP because they indicate that to be able to detect fake news on a multi-level, it is essential to rely on the accuracy of the classification, but also on the multi-level modeling of the context.

This study's primary contributions are as follows:

- We suggest a deep learning approach that takes into account the environment and combines semantic (AraBERT), syntactic (POS), and emotional signals to find bogus news in Arabic at several levels
- We use an ablation-based contextual analysis to measure the impact of each contextual component at several hierarchical prediction levels (main category, subcategory, and fake/real)

- We offer visualization-based proof of contextual impact via sensitivity trends and error-pattern analysis, transcending benchmark-focused assessment

### *Related Work*

#### *Fake News Detection Using Contextual Representations*

As social media has emerged as the primary platform for news transmission, the field of natural language processing has been increasingly focused on the identification of fake news (Nasir et al., 2021). In the early days, most methods used standard machine learning classifiers along with statistical text representations like Term Frequency–Inverse Document Frequency (TF IDF) and n-gram features (Narra et al., 2022). These techniques have a limited grasp of contextual relevance and long-distance semantic connections, albeit offering preliminary benchmarks (Awajan et al., 2022). Recent research has moved to the context-aware representations based on word embeddings and deep learning models to overcome these drawbacks. The context-based false news detector by Amer et al. (2022) integrated word embedding algorithms with deep learning networks such as LSTM and GRU showing that the representations based on context are much higher at detecting false news than the traditional statistical representations. Their results showed that reconstructing semantic context is better than just looking at surface-level lexical patterns. The development of transformer-based models has led to even more progress in contextual representation learning. Models like BERT make bidirectional context modeling possible. They have been shown to improve the ability to find fake news on a number of benchmarks (Himdi et al., 2022). Nonetheless, most context-oriented studies still focus on enhancing performance rather than investigating the influence of contextual information on model selection or identifying the most impactful contextual signals, particularly in low-resource and non-English language contexts (Nassif et al., 2022).

#### *Arabic Fake News Detection: From Binary to Multi-Level Classification*

Research on identifying false news in Arabic has progressed more slowly than in English, attributable to the language's complexity and the lack of annotated datasets (Huang et al., 2023). The conceptualization of misinformation at the earliest phases of Arabic research involved largely a binary classification problem, whereby the analysis of superficial linguistic features or standard machine learning tools that could differentiate between fake and real information is evaluated (Wotaifi and Dhannoon, 2023).

More recent studies have explored deep learning and transformer-based Arabic fake news detectors and

contextual encoders such as AraBERT provide performance improvements that can be discerned (Al-zahrani and Al-Yahya, 2024). Today most contemporary Arabic studies operate in a flat categorization setting despite the adjustments. They do not consider the way the Arabic news is arranged in the real-life situation where a single story could present numerous various theme dimensions simultaneously (Alazab et al., 2022). In response to this issue, our prior research presented the Jo News Fake dataset, a thorough Arabic corpus annotated with primary categories, subcategories, and fake/real labels, alongside a comprehensive assessment of ensemble and deep learning models. The primary objective of this work was comparative evaluation, rather than an exhaustive analysis of contextual representation mechanisms; yet, it provided robust empirical benchmarks for multi-level Arabic false news identification.

*Limitations of Existing Approaches and Research Gap*

Although contextual embedding and deep learning models are used more and more, there are still a number of challenges. To begin with, most researches only highlight models and performance measures without providing an explanation of how different contextual influences affect the falseness of information. Second, despite the accepted importance of syntactic and emotional clues in the process of disinformation analysis, the study of Arabic fake news has generally failed to include them in conjunction with semantic frames (Nassif et al., 2022). Third, the interactions between the contextual factors and the hierarchical news systems are not studied properly (Alhindi et al., 2021; Essa et al., 2023).

These weaknesses indicate a significant research gap: Although there has been an increase in context-aware algorithms that increase the accuracy of detection, there is a paucity of detailed research papers describing the benefit of contextual enrichment to fake news detection, especially on multi-level Arabic news platforms. Bridging this gap would need to leave the benchmark-based evaluation and engage in more analyses of context-based representations.

*Context-Aware Framework*

This section describes the suggested structure of identifying fake Arabic news at the hierarchical levels considering the context. The strategy does not just focus on the performance of the models but emphasizes the role of the contextual knowledge in understanding the accurate classification of the Arabic news content that is hierarchically organized. There is previous research that contextual representations enhance false news detection, especially when the English language context is used. Nevertheless, there is a lack of research on the interaction of various contextual factors in the multi-level context of the Arabic setting (Hocini and Smaili, 2024; David and

Micheal, 2016). Figure 1 presents the suggested context-sensitive framework to identify fake news in the Arabic language at various levels. The framework is based on AraBERT to generate semantic embeddings, complemented with syntactic features provided by Part-of-Speech (POS) tags and emotional features provided by analyzing emotional indicators. The mixed representation facilitates hierarchical classification and therefore the system can distinguish between the authentic and the fake content and categorize it either as the primary or secondary content.

*Motivation for Context-Aware Modeling*

Current algorithms for finding false news mostly use semantic representations taken from text. Contextual embeddings have significantly improved detection accuracy; nonetheless, semantic context alone often proves inadequate for processing Arabic news. Semantic embeddings (Einea et al., 2019) do not work well for Arabic news discourse because they do not capture the grammatical cues, rhetorical framing, and implicit mood that are common in this type of speech.

Moreover, Arabic news stories, especially those shared on social media, sometimes address multiple issues within a single piece. This creates a hierarchy between main categories and subcategories (Al-Salemi e al., 2019).

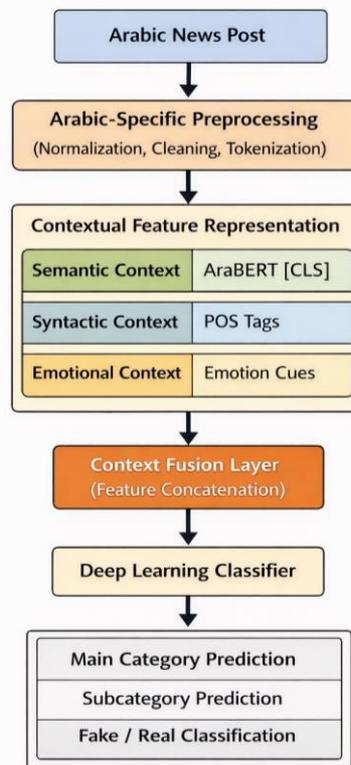


Fig. 1: Show the general idea of the suggested context-aware framework

In these instances, models devoid of explicit contextual augmentation may find it challenging to differentiate between closely related categories or to detect deceptive information signs obscured within syntactical or emotional frameworks.

Because of these problems, a lot of people wish to use a context-sensitive modeling approach that uses more contextual cues instead of only semantic embeddings. These problems are what led to the usage of a context-sensitive modeling technique that employs more contextual signals instead of just semantic embeddings (Pradeep and Krishnamoorthy, 2019; Molina et al., 2021).

### *Framework Overview*

The suggested framework has a modular design that distinctly represents three synergistic forms of context:

1. Semantic context, which shows what news stories mean at the sentence and document levels
2. Syntactic context, explains how grammar and style of writing interact together
3. Emotional context, refers to the emotional signals that are often associated with false or deceitful information

Since the system can make predictions at more than one level, it can model primary categories, subcategories, and fake/real labels all at the same time. This is not the same as approaching finding bogus news as a simple classification assignment. This approach makes it easier to look at how context affects different levels of classification, and it fits with how real Arabic news is structured hierarchically.

### *Arabic-Specific Preprocessing Pipeline*

The preprocessing of Natural Language Processing is a significant important process in Arabic especially because of the rich morphology it has and the extensive variance in the form of the word in orthography. To deal with these issues, the existing structure embraces a preprocessing pipeline that is oriented towards Arabic and attempts to retain the contextual relevance of the text, but eliminate undesirable noise as an example of such textual noise has been proposed in the previous literature (Lazer, et al., 2018; Al-Salemi et al., 2019; Lee et al., 2021; Al-Zahrani and Al-Yahya, 2024).

The preprocessing is divided into a number of operations in series. First, the Arabic characters are normalized in order to harmonize the graphical shapes of the same character, including the multiple forms of the same letter like the different forms. Second, there is the deletion of diacritics and repetitive signs which do not contribute to semantic interpretation. Moreover, non-linguistic features, such as URLs, emoticons, and non-Arabic tokens are removed so that the text remains

consistent. Lastly, the text is tokenized through a mechanism that is compatible with AraBERT subword tokenizer mechanism.

Together, these steps are supposed to reduce the lexical sparsity without sacrificing the syntactic frame and semantic clues that would be used in later modeling phases to realize the analysis of the contextual meaning.

### *Contextual Representation of Features*

Semantic context representation (Jardaneh et al., 2019) view the representation of semantic context as a feature that significantly contributes to the success of the learning process and, thus, the development of the learner. Semantic Context Representation (Jardaneh et al., 2019) perceive representation of semantic context as something that plays a significant role in the success of the learning process and, consequently, the development of the learner.

AraBERT is a transformer-based language model that is pre-trained on large scale Arabic corpora and therefore, AraBERT is able to learn deep semantic and contextual information. In contrast to other common methods of word representation, AraBERT can produce context-specific embeddings, meaning that words can dynamically evolve in terms of their contextual linguistic context. It is this ability that renders AraBERT especially ideal to Arabic fake news detection tasks, in which contextual subtlety is crucial (Sabbeh and Baatwah, 2018).

The [CLS] token, which stands for "contextual semantic representation," fully represents the text of each news story. These embeddings are good at picking up on small variations in meaning, but they could miss important grammatical patterns and emotional cues that are needed to detect if something is wrong.

In this study, semantic context denotes contextualized sentence-level representations produced by AraBERT, wherein each input text is converted into a dense vector that encapsulates meaning derived from adjacent lexical and syntactic indicators. The last hidden-state representation of the [CLS] token is a short semantic embedding that captures the overall meaning of each news post.

### *Representation of Syntactic Context*

The strategy uses the Part of Speech (POS) tags as syntactic features in addition to semantic embeddings. The differences in sentence structure, grammatical patterns, and style between true and fake news have been noted in the POS information (Lee et al., 2021; Almarshay et al., 2023).

The fake news frequently has certain grammatical peculiarities of the Arabic news coverage, such as overuse of adjectives, modal verbs, or imperative forms. The ability to use syntactic context to boost the discriminative capacity, by taking into consideration such patterns, is particularly helpful in assigning content to smaller subcategories.

### Emotional Context Representation

Strong emotive appeals like anger, fear or exaggeration are often used by fake news to persuade readers. The suggested approach incorporates emotional characteristics to examine the sentiment indicators in news articles (Markov et al., 2021). All these characteristics help the model to focus on the intensity of opposing emotions, which aid the model discern objective and factual news against information that is aimed at manipulative emotions. The emotional context is especially important in the context of social media when popular content is likely to proliferate false information. To produce these emotional indicators, lexicon-based or affective feature extraction methods are frequently used in Arabic sentiment analysis (Jardaneh et al., 2019; Guo et al., 2019).

### Context Fusion Strategy

At this phase, the combination of the semantic, syntactic and affective features is formed in one feature representation that gives a more detailed contextual interpretation of the text. The fusion strategy enables the model to represent the interrelationships between the various contextual dimensions at the same time in comparison to treating them separately, which makes it more effective in explaining complex linguistic patterns (Samih et al., 2019).

The various contextual layers allow the framework to identify fine details that otherwise would not be evident when it is based only on semantic embeddings. With the help of such a combined representation, the model will be more sensitive to the patterns related to misinformation in Arabic news materials and better able to recognize the similarities between the news of close categories or similarities (Abdelaal et al., 2018).

As seen in Eq. 1 vector concatenation combines the three contextual components into a single representation:

$$C = S \oplus P \oplus E \quad (1)$$

Where  $S \in R^{ds}$  denotes the semantic embedding derived from AraBERT,  $P \in R^{dp}$  is the syntactic feature vector that comes from POS tags, and  $E \in R^{de}$  the vector that shows how you feel, and  $\oplus$  means putting two vectors together.

### Multi-Level Classification Design

The last part of the architecture uses a deep learning classifier that uses the fused contextual representation. It is possible for the classifier to make predictions at more than one level. This means it can give different but related outputs for: Sorting primary categories, secondary categories, and true/false differences. This design makes it easy to examine how adding context impacts how

predictions work at different levels of detail. This is not a benchmark-oriented architecture; it does not aim for the highest raw accuracy but seeks to understand how contextual features can enhance hierarchical fake news detection (Ahmed et al., 2015; Al-Ayyoub et al., 2016; Al-Salemi et al., 2019; Aljedani et al., 2020).

### Summary of the Proposed Framework

In conclusion, the proposed context-aware framework enhances current false news detection techniques by explicitly integrating semantic, syntactic, and emotional context into a unified architecture. By combining contextual representation learning with the hierarchical structure of Arabic news, the system lays the groundwork for a more in-depth look at patterns of disinformation that go beyond surface-level performance indicators.

## Materials and Methods

### Experimental Objective

The aim of the experimental design is to examine the function of contextual enrichment in the detection of Arabic false news within a multi-level framework, rather than to compare various classifiers. The main objective of the tests is to investigate the influence of different contextual factors including the semantic, syntactic and affective factors on model behavior, resilience and sensitivity in different levels of hierarchical classifications. The methodology used in the assessment is experimental, which is founded on the principle of ablation and includes and evaluates the contextual variables in detail. To attain this, the assessment is conducted on an experimental procedure of ablation, where contextual features are added and tested separately.

### Dataset and Experimental Set-Up

The experiments are based on the JoNewsFake dataset (Alkudah et al., 2026) which is a large Arabic news corpus of 50,000 posts on Facebook profiles associated with verified Jordanian news media. Each post has a main category, a subsection, and a label that says whether it is real or fake. We have already talked about how to make a detailed dataset, how to add notes to it, and how to set a baseline.

The current study uses the dataset as a contextual case study, prioritizing representation analysis rather than exhaustive classifier comparisons, so differentiating it from previous benchmark-focused experiments. You can find out everything you need to know about the JoNewsFake dataset in Table 1. It shows the main features, how the annotations are grouped, and how the samples of real and fake news are spread out. JoNewsFake is a good way to test fake news detection algorithms that know about context because it has labeled major categories, subcategories, and veracity labels that let you do more than just binary fake news datasets.

One type of fake news in the proposed dataset posts that use very emotional language and make statements that can't be backed up by credible evidence. For instance, a post can state that a big national event has happened without mentioning any official sources and use scary language to terrify or anger people. People who lie typically use these kinds of emotional and stylistic tendencies, and the people who developed the dataset paid close attention to them. Table 2 shows some examples of fake news posts that show these tendencies in real samples from the Jo News Fake dataset (Alkudah et al., 2026).

### Model Architecture and Training Configuration

The proposed method generates context-enhanced feature vectors, subsequently integrated into a deep neural classification model capable of multi-level prediction. The architecture consists of fully interconnected layers that process integrated semantic, syntactic, and affective information. To train the model, we use the Adam method with a learning rate of 0.001 and categorical cross-entropy loss for multi-class outputs and binary cross-entropy loss for fake/real classification. Training can last for up to 30 epochs, but it is stopped early if the validation loss shows that it should cease. There are 32 tests in each batch. The computer can use the GPU to speed up the work during all of the tests. All of these were made with Python and libraries for deep learning.

The final prediction is made using a fully connected classification layer and the fused contextual representation:

$$\hat{y} = \text{softmax}(WC + b)$$

Where  $W$  is the weight matrix that can be learned,  $b$  is the bias vector, and  $\hat{y}$  represents the predicted class probability distribution.

### Contextual Ablation Scenarios

Four experimental scenarios are established to evaluate the impacts of contextual enrichment:

- In Scenario S1 (Semantic Context Only), AraBERT-based semantic embeddings are employed without any added linguistic features
- Scenario S2 (Semantic + Syntactic Context) adds syntactic structure by combining part-of-speech (POS) elements with AraBERT embeddings
- Scenario S3 (Semantic + Emotional Context) blends semantic embeddings with emotional markers to pick up on emotional cues
- In Scenario S4 (Full Context), semantic, syntactic, and affective representations are combined into a single feature vector that contains more information

**Table 1:** gives an overview of the suggested context-aware framework

Aspect	Description	Value
Dataset Name	JoNewsFake	-
Platform	A social networking site meant to gather information	Facebook
Language	Language of the news posts	Arabic (MSA with Jordanian context)
Data Type	Type of textual content	News posts
Total Instances	Total number of news posts	~50,000
Real News	Verified news published by official Jordanian news agencies	44,229
Fake News	Misleading or fake news identified during annotation	5,796
Main Categories	High-level thematic categories	22
Subcategories	Fine-grained thematic labels	75
Annotation Structure	Labeling strategy	Multi-level hierarchical annotation
Veracity Labels	Credibility classification	Fake / Real

**Table 2:** Examples of Fake News from the JoNewsFake Dataset

No.	Arabic Fake News Example	English Translation	Main Category	Subcategory
1	صيفٌ سَقَرٌ يبدأ في اجتياح شتاء القطب الشمالي... درجات حرارة غير مسبوقه ستؤدي إلى كوارث طبيعية عالمية خلال أيام	"A scorching summer begins to invade the Arctic winter... unprecedented temperatures will lead to global natural disasters within days."	Weather	Natural Disasters
2	من كواليس الحرب على غزة... معلومات خطيرة تؤكد قرب انهيار دول إقليمية بسبب أحداث سرية لم تُعلن بعد	"From behind the scenes of the war on Gaza... dangerous information confirms the imminent collapse of regional countries due to undisclosed secret events."	Politics	International Relations
3	سؤال موجه إلى أهل اليمن خاصة: هل تعلمون أن زلزالاً مدمراً سيضرب البلاد خلال ساعات وفق مصادر غير معلنة؟	"A question directed especially to the people of Yemen: Did you know that a devastating earthquake will strike the country within hours according to undisclosed sources?"	Weather	Natural Disasters

It is important to note that S2 and S3 introduce complementary but independent contextual dimensions (syntactic and emotional, respectively), rather than representing a strict linear progression. This ablation strategy allows for a controlled examination of the contribution of each contextual component to detection performance and the minimization of errors.

To show how context affects the numbers, Figures 2-5 show the trends in Table 3.

Figure 2, based on Table 3 illustrates the performance trends associated with progressively context-aware representations, ranging from non-contextual characteristics to a fully integrated hybrid context, thereby emphasizing the impact of incremental contextual enrichment.

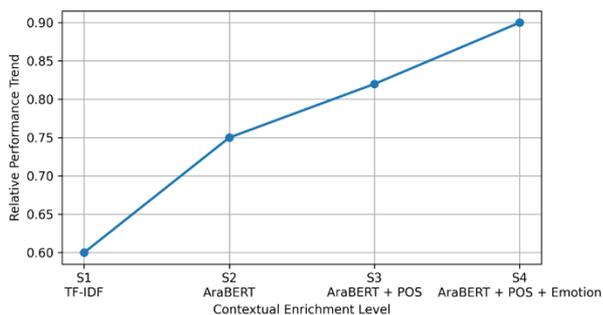


Fig. 2: Trends in the performance of contextual ablation

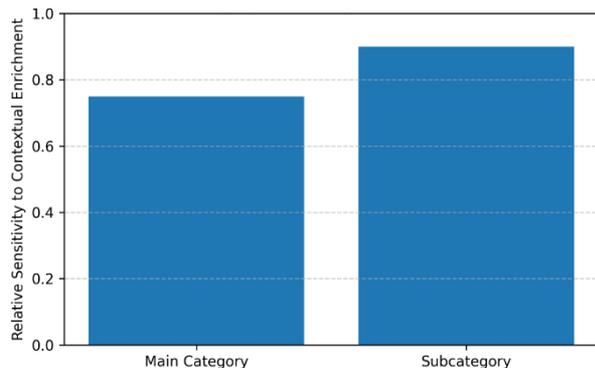


Fig. 3: Main vs Subcategory Sensitivity to Contextual Enrichment

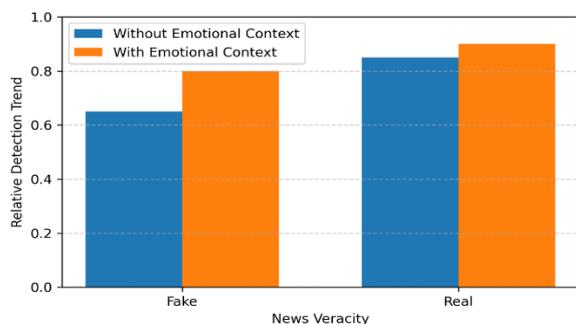


Fig. 4: Effect of Emotional Context on Fake/Real Detection

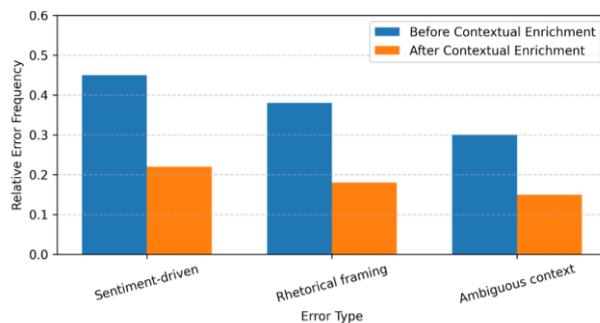


Fig. 1: Error Distribution Before and After Contextual Enrichment

Figure 2 shows how adding syntactic and emotional context to semantic representations makes the model more robust across all levels of hierarchical categorization. This shows how important holistic context modeling is compared to isolated feature representations.

### Evaluation Perspective and Metrics

The evaluation gives greater weight to contextual impact analysis than to fundamental performance optimization. The only reason to show standard classification metrics like accuracy, precision, recall, and F1-score is to make sure they can be compared to earlier studies. However, the analysis will focus on three aspects. The first one is an investigation of the variations of performance in different contextual ablation environments. Second, it examines how category and subcategory level classifications react variously to the added richness of contextual information. Third, it examines the error changes with the introduction of more contextual information to the model. By taking this point of view, the importance of contextual characteristics in hierarchical fake news detection can be viewed in an alternative way than focusing solely on absolute performance scores.

### Contextual Impact Analysis

The category classification is mainly influenced by the effect on the main category, which itself is impacted by the influence of the many category classifications.

Experimental data show that primary category predictions are more stable in case contextual enrichment is used, particularly in the case of categories that are characterized by overlapping thematic content. Syntactic and emotional cues can be added so that the closely related categories would be easier to distinguish, as they are demonstrated in the difference in style and emotion. Semantic embeddings, in their turn, indicate bare topical meaning.

### Impact on Subcategory Classification

Subcategory classification derives greater advantages from contextual enrichment compared to main category

prediction. Fine-grained subdivisions often differ in small linguistic patterns instead of using distinct topic keywords. When the model looks at both the syntactic and emotional context, it becomes more sensitive to these small changes. This helps make it clear which subcategories are quite similar.

### *The Effect on Fake/Real Detection*

The emotional context is quite significant when you want to be able to know whether something is real or fake. Misleading information is more frequently indicated emotionally in messages, by a high tone or passionate words. The algorithm is more concerned with detecting the disparity between true and false information in cases where there is an emotional connotation, particularly in social media.

### *Error Analysis*

An error analysis is performed across ablation scenarios to better evaluate contextual influence. The study found that posts with implicit sentiment or rhetorical framing are associated to a lot of misclassifications when simply semantics are used. Adding syntactic and emotional context reduces these inaccuracies, which show important it is to use multi-dimensional context modeling to find Arabic fake news.

## **Results and Discussion**

The ablation-based investigation reveals that contextual enrichment helps in different ways at different classification levels. Syntactic and emotional signals provide additional information that enhances resilience and interpretability, even when semantic context serves as a strong foundation. These findings support the primary hypothesis of the study: To effectively identify fake news in Arabic, contextual information must be explicitly modeled with semantic embeddings.

This part talks about the experimental results from the contextual ablation situations in part 4 in both a qualitative and analytical way. The given paper places importance on the comparative tendencies, behavior changes, and error tendencies that can be analyzed in a variety of contextual frames, rather than on absolute performance scales. This view intends to expound on the role of the contextual enrichment in identifying multi-level Arabic false news.

### *Visualization of Contextual Impact*

To explain how contextual enrichment affects performance, we offer comparative charts that exhibit performance patterns over the four ablation situations (S1 S4). Figure 3, based on Table 3 illustrates the comparative sensitivity of main-category and subcategory

categorization to contextual enrichment, so enhancing the contextual understanding of this conclusion.

As Figure 3 shows, subcategory prediction is sensitive and main-category classification receives the enrichment of the context. This demonstrates the significance of syntactic and emotional cues in the fine-grained separation of themes. Figure 4 based on Table 3 illustrates the possibility of emotional cues to provide the distinction between authentic and fake news. Emotionally loaded representations are useful in social media where the use of emotional language is rampant enough to create a distinction between genuine and fake material.

Figure 5, based on Table 3 shows how errors were spread out across different types of errors before and after contextual enrichment. When semantic, syntactic, and emotional context are combined, there is a noticeable drop in mistakes due to implicit sentiment, rhetorical framing, and confusing contextual indicators.

### *Comparative Trend Analysis Across Ablation Scenarios*

#### *Only Semantic Context vs. Context-Enriched Representations*

The semantic-only version (S1) is a very good reference point since it is based on contextual embeddings to depict the overall topical meaning of news content. Nonetheless, the visual analysis of the findings shows that there are evident constraints especially in handling posts that demonstrate overlapping themes, indirect sentiment, or persuasive rhetorical patterns. Such deficiencies are more explicit in the field of fine-grained subcategory classification, in which semantic clues alone tend to fall short of separating closely related issues.

The more contextual layers that are added, the more the model is seen to have gotten stronger. The incrementality of adding syntactic and affective data contributes to the less ambiguity and improves the capability of the model to separate the similar classes. This development indicates that the use of semantic context is not sufficient to capture the complexity of the Arabic news discourse that is determined by a number of intersecting linguistic aspects.

#### *Effect of Syntactic Context on Hierarchical Classification*

Relative visual displays of the S1 and S2 condition shows that the addition of syntactic information has a positive effect on classification performance, especially on the subcategory level. Part-of-speech characteristics, specifically, can help to draw the line between those categories that have similar lexical material and differ in their grammatical structures.

**Table 3:** Trends in relative performance across different contextual ablation settings

Scenario	Context Used	Main Category Trend	Subcategory Trend	Fake/Real Trend
S1	Semantic only	Baseline	Weak	Moderate
S2	Semantic + Syntactic	Improved	Noticeable improvement	Slight
S3	Semantic + Emotional	Stable	Moderate	Strong
S4	Full Context	Highest stability	Strongest	Highest

Consequently, syntactic patterns provide useful hints of the detection of thematic nuances that may not be obtained by the semantic representations.

In addition, it seems that the presence of syntactic context can increase prediction stability in the processing of structurally complex news texts. This further robustness minimizes the chance of inaccurate classification due to stylistic differences among different sources of news, underlining the role of syntax in enabling more stable hierarchical classification results.

#### *Emotional Context in Fake/Real Detection*

The introduction of emotional indicators (S3) has a great impact on distinguishing genuine and fake materials. According to visual trend analyses, emotionally enriched representations prove superior in identifying fraudulent news that is typified by exaggerated or emotive language. This is especially strong in the social media posts, which aim at creating a strong emotional appeal instead of being informative. The model also better predicts sentiment with the addition of semantic embeddings and emotional context, which enhances the difference in real and fake content in the results of visualization.

#### *Full Context Integration and Synergistic Effects*

Contextual enrichment advantages are also in line with error analysis visualizations. Semantic only misclassification can easily happen when posts contain persuasive text or implicit sentiment. These errors are minimized by the addition of syntactic and emotional context suggesting that context-aware representations can help to understand subtle linguistic cues better. Also, the cross-category confusion in heatmaps is lower, which shows that the framework is more concerned with hierarchical connections between categories.

#### *Visualization and Analysis of Patterns of Errors*

Patterns of errors illustrated boost the usefulness of context enriched representation. In semantic-only environments, a lot of mistakes are made in posts containing implicit sentiment (s) or persuasive wording, that is similar to genuine reporting. The misclassifications can be reduced by the introduction of syntactic and emotional situation, demonstrating that the model is able to better comprehend delicate linguistic cues. The reduced cross-category confusion in heatmaps further indicates that hierarchical categorization is increased.

#### *Discussion*

Context-aware modeling is a paradigm concept that alters the meaning of Arabic news content used in the detection of fake news. Via visualizations, the contextual enrichment is demonstrated to aid in clarifying the decision-making process, with a greater emphasis on emphasizing the verbal and emotional objects instead of merely increasing the classification scores. Key conclusions include:

- Semantic embedding is a good starting point that lacks the ability to detect fake news on multiple levels in Arabic
- The roles that syntactic and emotional cues play in it are different, but complementary in the fine-grained sentiment based classification
- A combination of all contextual elements in a synergistic manner promotes performance in different hierarchical levels

These results show that context-sensitive frameworks not only get detection right but also increase interpretability which is critical to reliability and practical application. They offer a basis upon which subsequent studies can be done on the explainable context-sensitive detection of disinformation in Arabic social media.

#### **Conclusions on Applications to Arabic Fake News Detection**

These findings demonstrate that context-sensitive methods must be used to supplement performance-oriented evaluation methods to develop Arabic fake news detection models. Contextual enrichment enhances strength and understanding that is paramount to reliable real-world systems. These knowledge areas can inform future research and context-aware disinformation detection on the Arabic social media.

#### *Limitations and Future Work*

Although the suggested context-sensitive framework provides useful information, certain weaknesses should be mentioned. First, the experiments are based on one data set of the Jordanian news media. Even though the JoNewsFake dataset offers rich hierarchical annotations and focus on contextual variations, it is limited in that the data is only on particular geography and type of news, and can be limited to other Arabic dialects or types of news.

Second, the study fails to include multimodal signals, including pictures, videos, or metadata on user interaction, which are prevalent in social media misinformation. The use of text alone can reduce the ability to detect fake content that manipulates graphical or interactive features.

Third, the paper does not explicitly tackle model explainability on the case level, despite offering qualitative information and visual representation of contextual influence. The future studies may also utilize explainable AI to provide elaborate explanations of the reason behind certain predictions. The nature of emotional features employed in this case, though valuable in general sentiment indication, might not be suitable in sarcasm or subtle sentiments common in the Arabic social media. Better emotion modeling would help to add sensitivity to the framework.

Further research will bring the framework to cross-dialect Arabic datasets, multimodal and social-contextual characteristics and testing in the real deployment context. Real time or streaming testing may also be conducted to evaluate its usefulness in misinformation early detection.

### Conclusion

This paper introduced a context-sensitive deep learning architecture for tiered Arabic false news detection, aiming to shift from performance-centric evaluation to a more profound comprehension of how contextual aspects influence detection processes. The suggested methodology mitigates critical shortcomings of existing solutions to the problem of detecting Arabic fake news by incorporating semantic, syntactic, and emotional contexts in a unified framework, where the solutions are based on semantic embedding or basic classification.

The results show that adding contextual information to the models is essential to enhance both robustness and interpretability on the number of different levels of hierarchical classification. This was shown through an experimental setup based on ablation and an analysis that is visualization-centered. The use of syntactic and emotional indicators will make the ambiguity lower, the subcategory differentiation stronger, and the distinction between real and fake news better, especially in emotionally colored material in social media, despite the already strong semantic representations.

Instead of making the overall gains in performance after which this research activity focuses, this study emphasizes the contribution of each of the contextual dimensions to the knowledge of Arabic news discourse. The findings highlight the importance of the fact that to effectively detect fake news in Arabic, numerous contextual modeling needs to be undertaken, including the content, stylistic characteristics, and emotional framing. The research is not limited to traditional benchmark comparisons, and instead, it analyses contextual representations, which helps bring previous studies on the topic of Arabic fake news detection to new levels and has

a basis to develop more interpretable, reliable, and context-dependent misinformation detection systems.

Regarding the contribution of research, the study enhances Arabic false news identification by moving away the performance-based evaluation to the analysis based on the context of behavior. It shows that semantic embeddings alone are not enough for reliable multi-level classification in Arabic. It also shows how combining syntactic and emotional context makes the system more stable, easier to understand, and more consistent across levels. The suggested framework offers a replicable context-aware modeling approach and an ablation-based analysis technique that may be adapted for other low-resource and morphologically complex languages.

### Future Work

Despite the presented framework providing useful information about the context-aware detection, there are still a number of possible directions to follow. First, it would be desirable to incorporate more Arabic datasets that would represent different dialects and regions and media type to provide more generalizability and reliability to the framework. Second, multimodal context, i.e., images, videos and social media interaction data may enhance detection, especially when it comes to misinformation spread by visual or interactive materials. The ways of explaining particular instances, such as attention visualization or post-hoc explanation methods, may also be explored in the future to understand the logic behind every prediction. A more intensive emotion modeling, e.g. contextual emotion dynamics or sarcasm-conscious representation use, could be more effective to detect fine emotional signals that are common in Arabic social media. Lastly, testing the framework on real-time or streaming would give some understanding about its applicability in quick detection and efficient use of fake news.

### Funding Information

No outside funding was obtained for the research project.

### Authors Contributions

All authors contributed equally to this study.

### Ethics

This study exclusively looks at social media data from Facebook pages of verified Jordanian news sources that are open to everyone. No private, personal, or sensitive information about the user was accessed, stored, or examined. In the preparation stage, all of the data were made anonymous, and the study respects all ethical rules for public web data. There were no people in this study.

## Data Availability

JoNewsFake dataset DOI: 10.5281/zenodo.17797681.

## References

- Abdelaal, H. M., Elmahdy, A. N., Halawa, A. A., & Youness, H. A. (2018). Improve the automatic classification accuracy for Arabic tweets using ensemble methods. *Journal of Electrical Systems and Information Technology*, 5(3), 363–370. <https://doi.org/10.1016/j.jesit.2018.03.001>
- Ahmed, N. A., Shehab, M. A., Al-Ayyoub, M., & Hmeidi, I. (2015). Scalable multi-label Arabic text classification. *2015 6th International Conference on Information and Communication Systems (ICICS)*, 64–69. <https://doi.org/10.1109/iacs.2015.7103229>
- Al-Ahmad, B., Al-Zoubi, A. M., Abu Khurma, R., & Aljarah, I. (2021). An Evolutionary Fake News Detection Method for COVID-19 Pandemic Information. *Symmetry*, 13(6), 1091. <https://doi.org/10.3390/sym13061091>
- Al-Ayyoub, M., Nuseir, A., Kanaan, G., & Al-Shalabi, R. (2016). Hierarchical Classifiers for Multi-Way Sentiment Analysis of Arabic Reviews. *International Journal of Advanced Computer Science and Applications*, 7(2), 69. <https://doi.org/10.14569/ijacsa.2016.070269>
- Alazab, M., Awajan, A., Alazab, A., Khreisat, A., Alhyari, A., & Saadeh, R. (2022). Fake-News Detection System Using Machine Learning Algorithms for Arabic-Language. *Journal of Theoretical and Applied Information Technology*, 100(17), 5056–5069.
- Alhindi, T., Alabdulkarim, A., Alshehri, A., Abdul-Mageed, M., & Nakov, P. (2021). AraStance: A Multi-Country and Multi-Domain Dataset of Arabic Stance Detection for Fact Checking. *Proceedings of the Fourth Workshop on NLP for Internet Freedom: Censorship, Disinformation, and Propaganda*, 57–65. <https://doi.org/10.18653/v1/2021.nlp4if-1.9>
- Al-Jalabneh, A. A., Safori, A. O., & Shlool, H. (2023). Covid-19 and Misinformation Prevalence: A Content Analysis of Fake News Stories Spread in Jordan. *The Implementation of Smart Technologies for Business Success and Sustainability*, 535–545. [https://doi.org/10.1007/978-3-031-10212-7\\_44](https://doi.org/10.1007/978-3-031-10212-7_44)
- Aljedani, N., Alotaibi, R., & Taileb, M. (2020). Multi-Label Arabic Text Classification: An Overview. *International Journal of Advanced Computer Science and Applications*, 11(10), 694–706. <https://doi.org/10.14569/ijacsa.2020.0111086>
- Alkudah, N. M., Idris, N. B., Mahmoud Abushariah, M. A.-A., & Sabri, A. Q. M. (2026). An empirical comparison of ensemble and deep learning models for multi-level Arabic fake news detection using the JoNewsFake dataset. *PeerJ Computer Science*, 12, e3510. <https://doi.org/10.7717/peerj-cs.3510>
- Almarashy, A. H. J., Feizi-Derakhshi, M.-R., & Salehpour, P. (2023). Enhancing Fake News Detection by Multi-Feature Classification. *IEEE Access*, 11, 139601–139613. <https://doi.org/10.1109/access.2023.3339621>
- Al-Salemi, B., Ayob, M., Kendall, G., & Noah, S. A. M. (2019). Multi-label Arabic text categorization: A benchmark and baseline comparison of multi-label learning algorithms. *Information Processing and Management*, 56(1), 212–227. <https://doi.org/10.1016/j.ipm.2018.09.008>
- Al-Taie, M. Z. (2025). Comparative Study of Machine Learning Approaches for Detecting Fake News in Arabic Text. *IETI Transactions on Data Analysis and Forecasting (ITDAF)*, 3(1), 18–31. <https://doi.org/10.3991/itdaf.v3i1.53575>
- Al-Zahrani, L., & Al-Yahya, M. (2024). Pre-Trained Language Model Ensemble for Arabic Fake News Detection. *Mathematics*, 12(18), 2941. <https://doi.org/10.3390/math12182941>
- Amer, E., Kwak, K.-S., & El-Sappagh, S. (2022). Context-Based Fake News Detection Model Relying on Deep Learning Models. *Electronics*, 11(8), 1255. <https://doi.org/10.3390/electronics11081255>
- Awajan, A., Alazab, M., Khurma, R. A., Alsaadeh, R., Wedyan, M., & Abraham, A. (2022). Fake News Detection and Prevention Using Artificial Intelligence Techniques: A Review of a Decade of Research. *Journal of Theoretical and Applied Information Technology*, 100(21), 7139–7152.
- Bsoul, M. A., Qusef, A., & Abu-Soud, S. (2022). Building an Optimal Dataset for Arabic Fake News Detection. *Procedia Computer Science*, 201, 665–672. <https://doi.org/10.1016/j.procs.2022.03.088>
- Çetiner, H. (2024). Fake News Detection and Classification with Recurrent Neural Network Based Deep Learning Approaches. *Osmaniye Korkut Ata Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 7(3), 973–993. <https://doi.org/10.47495/okufbed.1199738>
- David, J., & Micheal, L. (2025). *Leveraging NLP and Gradient Boosting in a Multi-Class Setting*.
- Einea, O., Elnagar, A., & Al Debsi, R. (2019). SANAD: Single-label Arabic News Articles Dataset for automatic text categorization. *Data in Brief*, 25, 104076. <https://doi.org/10.1016/j.dib.2019.104076>
- Essa, E., Omar, K., & Alqahtani, A. (2023). Fake news detection based on a hybrid BERT and LightGBM models. *Complex and Intelligent Systems*, 9(6), 6581–6592. <https://doi.org/10.1007/s40747-023-01098-0>
- Guo, C., Cao, J., Zhang, X., Shu, K., & Yu, M. (2019). Exploiting Emotions for Fake News Detection on Social Media. *ArXiv Preprint*.
- Himdi, H., Weir, G., Assiri, F., & Al-Barhamtoshy, H. (2022). Arabic Fake News Detection Based on Textual Analysis. *Arabian Journal for Science and Engineering*, 47(8), 10453–10469. <https://doi.org/10.1007/s13369-021-06449-y>

- Hocini, A., & Smaili, K. (2025). Detecting Fake News: Exploring Key Features in Multilingual Arabic Dialect Corpus. *Arabic Language Processing: From Theory to Practice*, 236–248.  
[https://doi.org/10.1007/978-3-031-80438-0\\_18](https://doi.org/10.1007/978-3-031-80438-0_18)
- Huang, K.-H., McKeown, K., Nakov, P., Choi, Y., & Ji, H. (2023). Faking Fake News for Real Fake News Detection: Propaganda-Loaded Training Data Generation. *Proceedings of the 61st Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers)*, 14571–14589.  
<https://doi.org/10.18653/v1/2023.acl-long.815>
- Jardaneh, G., Abdelhaq, H., Buzz, M., & Johnson, D. (2019). Classifying Arabic Tweets Based on Credibility Using Content and User Features. *2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology (JEEIT)*, 596–601.  
<https://doi.org/10.1109/jeeit.2019.8717386>
- Lazer, D. M. J., Baum, M. A., Benkler, Y., Berinsky, A. J., Greenhill, K. M., Menczer, F., Metzger, M. J., Nyhan, B., Pennycook, G., Rothschild, D., Schudson, M., Sloman, S. A., Sunstein, C. R., Thorson, E. A., Watts, D. J., & Zittrain, J. L. (2018). The science of fake news. *Science*, 359(6380), 1094–1096.  
<https://doi.org/10.1126/science.aao2998>
- Lee, G. Y., Alzamil, L., Doskenov, B., & Termehchy, A. (2021). A Survey on Data Cleaning Methods for Improved Machine Learning Model Performance. *ArXiv*.
- Markov, I., Ljubešić, N., Fišer, D., & Daelemans, W. (2023). Exploring Stylometric and Emotion-Based Features for Multilingual Cross-Domain Hate Speech Detection. *Published in Lecture Notes in Computer Science*, 149–159.
- Molina, M. D., Sundar, S. S., Le, T., & Lee, D. (2019). “Fake News” Is Not Simply False Information: A Concept Explication and Taxonomy of Online Content. *American Behavioral Scientist*, 65(2), 180–212.  
<https://doi.org/10.1177/0002764219878224>
- Narra, M., Umer, M., Sadiq, S., Eshmawi, A. A., Karamti, H., Mohamed, A., & Ashraf, I. (2022). Selective Feature Sets Based Fake News Detection for COVID-19 to Manage Infodemic. *IEEE Access*, 10, 98724–98736.  
<https://doi.org/10.1109/access.2022.3206963>
- Nasir, J. A., Khan, O. S., & Varlamis, I. (2021). Fake news detection: A hybrid CNN-RNN based deep learning approach. *International Journal of Information Management Data Insights*, 1(1), 100007.  
<https://doi.org/10.1016/j.jjime.2020.100007>
- Nassif, A. B., Elnagar, A., Elgendy, O., & Afadar, Y. (2022). Arabic fake news detection based on deep contextualized embedding models. *Neural Computing and Applications*, 34(18), 16019–16032.  
<https://doi.org/10.1007/s00521-022-07206-4>
- Patil, D. R. (2022). Fake News Detection Using Majority Voting Technique. *ArXiv*.
- Pradeep, P., & Krishnamoorthy, S. (2019). The MOM of context-aware systems: A survey. *Computer Communications*, 137, 44–69.  
<https://doi.org/10.1016/j.comcom.2019.02.002>
- Sabbeh, S. F., & Baatwah, S. Y. (2018). Arabic News Credibility on Twitter: An Enhanced Model Using Hybrid Features. *Journal of Theoretical and Applied Information Technology*, 96(8).
- Samih, Y., Mubarak, H., Abdelali, A., Attia, M., Eldesouki, M., & Darwish, K. (2019). QC-GO Submission for MADAR Shared Task: Arabic Fine-Grained Dialect Identification. *Proceedings of the Fourth Arabic Natural Language Processing Workshop*, 290–294.  
<https://doi.org/10.18653/v1/w19-4639>
- Wotaifi, T. A., & Dhannoon, B. N. (2023). An Effective Hybrid Deep Neural Network for Arabic Fake News Detection. *Baghdad Science Journal*, 20(4), 20.  
<https://doi.org/10.21123/bsj.2023.7427>