

Application of Propositional Logic in Detecting Fake News: A Case Study of Indonesian Social Media

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With the increasing number of social media users, the issue of spreading hoaxes and fake news through these platforms has become a significant concern. Unlike news web portals, where texts or narratives undergo professional procedures before being published, social media allows anyone to upload their writings. This naturally increases the risk of hoaxes or fake news being disseminated on its channels. One notable characteristic of fake news on social media is the frequent use of provocative language. Detecting posts containing fake news using propositional logic in this context offers an interpretative solution, particularly suitable for small datasets, such as texts with specific linguistic complexity. This study uses a dataset of fake news from Indonesian social media to evaluate a detection algorithm based on propositional logic rules. The detection system reads words in the uploaded text and matches them with potentially hoax-related or clickbait words. The main findings highlight the effectiveness of this approach in recognizing patterns of fake news written on social media, with practical implications for developing transparent and easily adoptable automatic detection systems in specific languages.

Keywords: fake news detection, propositional logic, social media analysis, text classification.

I. INTRODUCTION

The spread of fake news or hoaxes is a prevalent phenomenon among Indonesian society, particularly in today's digital era. Social media platforms like Facebook, Twitter, and WhatsApp, which allow users to exchange text-based media, have become primary channels for disseminating information—both valid and false. Fake news often exploits societal emotions to spread more rapidly, such as fear, anger, or sympathy. In Indonesia, the impact of fake news is not limited to public opinion but also causes social tensions, financial losses, and even threats to political stability.

One instance of fake news widely circulated on social media platforms like Facebook, Twitter, and WhatsApp in 2021 disrupted netizens significantly. It involved a narrative claiming that the COVID-19 vaccine contained the heavy metal ethylmercury, a deadly biological weapon. Although this claim seemed absurd, many Indonesians believed and worried about it. As a result, vaccination targets in some regions slowed. This issue was highlighted by Nisa et al., who reported a significant influence of vaccine-related hoaxes on decisions to receive the COVID-19 vaccine, with a significant effect size of 14.9%.^[2] Such hoaxes also triggered divisions in society between those supporting and opposing vaccination, frequently visible in

lengthy debates within comment sections of related content

Another example involved a fake news item on WhatsApp, claiming that earthquakes in several regions would escalate through the Ring of Fire fault line, targeting Indonesia. This information, allegedly from the Indonesian Meteorological, Climatological, and Geophysical Agency (BMKG), was shared via WhatsApp and later posted by a Twitter user. It caused public anxiety, particularly among the elderly, who are more prone to believing such information. This incident illustrates how fake news can impact public psychology and lead to unnecessary chaos. It underscores the tendency of society to accept information without filtering or seeking further verification..^[3]

Detecting and classifying fake news is not a simple task. Fake news is often designed to appear credible, closely mimicking authentic writing styles, incorporating images, or using data taken out of context. In the Indonesian language, challenges arise from the diverse sentence structures and techniques writers use to obscure facts. An automatic detection system must understand context, perform semantic analysis, and identify patterns indicative of potential fake news.

Social media platforms also present technical challenges in detection. For example, the message encryption feature in applications like WhatsApp complicates direct access for content analysis. Additionally, social media algorithms tend to amplify content with high engagement, including fake news, further complicating efforts to disseminate clarifications.

This study focuses on applying propositional logic to detect fake news, leveraging this branch of discrete mathematics in real-world applications. Propositional logic can be implemented on small datasets, making it a practical solution for developers with limited resources. The study uses a local dataset to ensure relevance to Indonesian society and evaluates the effectiveness of rule-based detection systems in recognizing patterns of fake news specific to Indonesian social media.

II. LITERATURE REVIEW

A. SOCIAL MEDIA ANALYSIS

Social media has become one of the primary sources of information for the Indonesian public, with 167 million active users recorded in January 2023, representing 60.4% of the total population..^[4] Platforms like Facebook, Twitter, Instagram, and WhatsApp are widely used not only for sharing personal

experiences but also for disseminating news and current information. This high level of activity makes social media a vulnerable ecosystem for the spread of fake news (hoaxes).^[5]

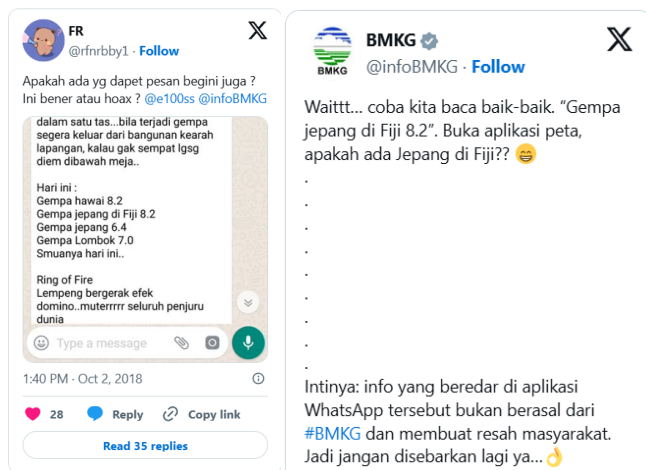


Fig. 2.1 A Twitter post questioning the validity of news spread on WhatsApp, directly addressed by BMKG
Source :

<https://www.tribunnews.com/section/2018/10/03/bmkg-tegaskan-informasi-gempa-89-sr-di-jakarta-adalah-hoax>

In Indonesia, social media has several characteristics that influence the pattern of news dissemination, including information spreading within minutes through WhatsApp's forwarding feature or Twitter's retweet function. Many users tend to share information without verifying its source or accuracy. Additionally, the language used often mixes formal Indonesian with slang, colloquialisms, or regional languages, making text analysis more complex.

For example, news about COVID-19 vaccines allegedly causing harmful side effects once went viral in WhatsApp groups, complete with emotional narratives and edited images. Although this news was debunked by health authorities, its impact remained significant, as many people were influenced to delay or refuse vaccination.^[6]

Research shows that fake news tends to attract more attention because it often uses sensational headlines and provocative images. The dissemination pattern is generally:

1. Exponential spread, fake news often spreads within specific social circles, where one individual shares the news with multiple groups or friends, who then continue the distribution chain.
2. Use of anonymous accounts or bots, a large amount of fake news originates from accounts specifically designed to disseminate massive amounts of information, often with the intent of influencing political opinions or inciting social tension.

Challenges in analyzing Indonesian social media content include:

1. Large data volume, thousands of new posts are created on social media every second, requiring high computational capacity to process the data in real-time..

2. Unverified data sources, the prevalence of anonymous accounts or bot-created accounts makes it more difficult to verify the source of information..

A social media analysis-based approach is essential for understanding the dynamics of fake news dissemination. This study employs a proposition logic-based approach to provide a more targeted solution to the challenges within Indonesia's social media ecosystem.

B. PROPOSITIONAL LOGIC

Propositional logic is a branch of discrete mathematical logic that focuses on the relationships between propositions, which have truth values: either true (True) or false (False). This logic is based on the relationships between statements or sentences. Only sentences with a definitive truth value, either true or false, are considered.^[1] In the context of fake news detection, propositional logic is employed to develop systems capable of analyzing and detecting specific patterns in text based on inference rules. The primary elements of propositional logic include propositions, logical operators, and inference rules. A proposition is a statement or sentence with a truth value, such as "This news is a hoax."

Propositional logic involves the use of logical operators that connect propositions in fake news detection systems. These operators include:

1. Conjunction AND (\wedge)

This operator is true only if both connected propositions are true.

$$p \wedge q = \text{True} \text{ jika } p = \text{True} \text{ dan } q = \text{True} \dots [1]$$

Conversely, if either proposition is false, the result is false.

2. Disjunction OR (\vee)

This operator is true if at least one or both connected propositions are true.

$$p \vee q = \text{True} \text{ jika } p = \text{True} \text{ atau } q = \text{True} \dots [1]$$

It is false only if both propositions are false.

3. Negation NOT (\neg)

This operator reverses the truth value of a proposition.

$$\text{Jika } p = \text{True}, \text{ maka } \neg p = \text{False} \dots [1]$$

In other words, if a proposition is true, the result is false, and vice versa.

4. Exclusive Disjunction (\oplus)

This operator is true if one proposition is true but not both.

$$p \oplus q = \text{True}, \text{ jika}$$

1. $p = \text{True}$ dan $q = \text{False}$
2. $p = \text{False}$ dan $q = \text{True}$.. [1]

These are the four operators in propositional logic.

Tabel Kebenaran

p	q	$p \wedge q$	p	q	$p \vee q$	p	$\sim p$	p	q	$p \oplus q$
T	T	T	T	T	T	T	F	T	T	F
T	F	F	T	F	T	F	T	T	F	T
F	T	F	F	T	T	F	F	T	T	T
F	F	F	F	F	F	F	F	F	F	F

Fig. 2.2 Truth table for the 4 propositional operations

Source :

<https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/01-Logika-2024.pdf>

In fake news detection systems, propositional logic enables the creation of rules based on keywords, such as: "If a news article contains words like 'viral' or 'mencengangkan' or 'tidak disangka' then the article likely contains elements of clickbait."

However, there are challenges in applying propositional logic for text analysis, particularly in the context of the Indonesian language. One major challenge is the complexity of Indonesian language structures and the use of informal language on social media, which often complicates the application of logic rules based on formal grammar. Additionally, grammatical ambiguity poses another obstacle, where a proposition may have different meanings depending on the context of the sentence.

C. FAKE NEWS DETECTION

Fake news detection is a significant challenge in the digital era, particularly with the increasing volume of information spread through social media. Fake news often exhibits distinct characteristics, such as the use of curiosity-provoking or emotionally charged language or sensational headlines.

Previous studies have made valuable contributions to understanding the traits of fake news. Shu et al. (2020) identified fake news using textual features, such as keywords, grammatical patterns, and sentiment analysis.^[7] Furthermore, the distribution patterns of fake news on social media often indicate the involvement of bot accounts or accounts affiliated with certain political interests. Fake news tends to spread more rapidly, especially on social media platforms.

Methods for detecting fake news can be categorized into three main approaches. Rule-based systems leverage the matching of sensational keywords or fact-checking against existing databases. On the other hand, machine learning algorithms, such as Decision Trees, Random Forest, or Gradient Boosting, are used to identify patterns in historical data. A more advanced approach involves deep learning, where algorithms like Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) can analyze news content more deeply and identify complex patterns.^[8]

Despite advancements, research on fake news detection still faces several challenges. One major issue is the lack of representation of the Indonesian language in research datasets. Most studies focus on English-language news, resulting in relatively lower accuracy for detecting fake news in Indonesian. Additionally, the distinction between clickbait and fake news is often unclear. Clickbait, which aims to grab readers' attention, requires deeper analysis to determine whether the information presented is genuinely misleading or merely intended to attract

website visits.

Social media platforms like Facebook, Instagram, Twitter, and WhatsApp are the primary channels for fake news dissemination in Indonesia. For example, during the early stages of the COVID-19 pandemic, fake news about vaccination side effects spread widely through WhatsApp, creating public distrust in vaccination programs. To counter such dissemination, detection systems need to account for local cultural contexts and the rapid spread of information on these platforms. Fake information is often tailored to local norms and beliefs to enhance its credibility among the public.

The types of hoaxes circulating on the internet are numerous. Social and political hoaxes rank highest. This is common due to competing political interests, where parties spread biases through the most popular medium, social media.

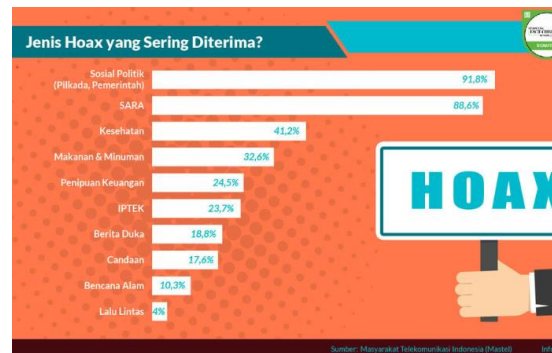


Fig 2.3 Research Findings on the Most Common Types of Hoaxes

Source : <https://tirto.id/hoaks-dan-bahaya-rendahnya-kepercayaan-terhadap-media-cKAX>

The detection of potentially fake news using this propositional logic method is expected to complement existing approaches. Moreover, improving public digital literacy is essential to enable individuals to independently identify and avoid fake news. Such a holistic approach is anticipated to reduce the impact of fake news on Indonesian society..

III. IMPLEMENTATION

A. Environment and Technologies Used

The implementation utilizes the Python programming language, supported by several libraries for text analysis. The development environment comprises Python 3.x running on a Windows operating system with Visual Studio Code as the code editor. Libraries such as textblob for sentiment analysis and re for pattern-based text processing are used. Additionally, a propositional logic-based approach is applied to facilitate structured analysis.

B. Implementation Approach

The approach to detecting fake news focuses on using propositional logic and feature weighting based on significance. It begins with categorizing keywords into groups such as "clickbait," "emotional language," "urgency," and "hoax indicators." Each category reflects characteristics commonly found in fake news. The system analyzes text using a point-based logic system where each feature is assigned a specific

weight, representing its contribution to detecting fake news.

The analysis steps include:

1. Contradiction Detection
Identifying conflicts between sentences in the text.
2. Source Verification
Searching for references or quoted sources to indicate validity.
3. Emotional Analysis
Measuring the extent of emotional language usage.
4. Clickbait and Urgency Indicators
Identifying phrases that prompt readers to act or share information immediately
5. Sentiment Analysis
Using sentiment analysis models to detect strong negative tendencies in the text.

Sentiment analysis identifies strong negative sentiments often associated with fake news. This is measured using the polarity provided by the textblob library.

After completing the analysis, an overall score is calculated by summing the weights of detected features. This score is used to classify the text into three categories:

- Potentially fake news, if the score falls below a certain threshold.
- Likely valid news, if the score exceeds a certain threshold.
- Requires further verification, if the score lies between the two thresholds.

This approach ensures the system relies on multiple indicators rather than a single feature.

C. Program Implementation

The program classifies news with potential misinformation based on words found in the content and headlines. Research on classified fake news reveals several words likely to spread misinformation. These keywords are further categorized into types: clickbait, emotional, urgency, and hoax keywords. The implementation involves a point-based system to score and classify the text.

```
from textblob import TextBlob
import re

class FakeNewsDetector:
    def __init__(self):
        # Dictionary kata kunci yang sering muncul di berita palsu
        self.keyword_dict = {
            'clickbait': ['viral', 'mengejutkan', 'tidak disangka', 'masih ingat'],
            'emotional': ['mencengangkan', 'menggemparkan', 'heboh', 'mengharukan', 'panik'],
            'urgency': ['sebarakan', 'share', 'bagikan segera', 'breaking news'],
            'hoax_keywords': ['tidak benar', 'palsu', 'hoax', 'konspirasi']
        }

        # Logika berbasis poin
        self.logic_rules = [
            ('if_contradictory', -0.2),
            ('has_source', 0.3),
            ('emotional_language', -0.1),
            ('clickbait', -0.1),
            ('urgency', -0.1),
            ('hoax_indicators', -0.2)
        ]
```

Fig. 3.1 The initialization of the fake news detection system

Source :

https://github.com/salmaanhaniiif/FraudDetection_IndonesianNewsInSoemed

Using the defined characteristics, classification employs propositional logic and a point-based system. Propositions determine the factuality, while scoring validates the news.

```
def analyze_text(self, text, hoax, urgency, emotional, clickbait, sentiment_negatif, kontradiksi):
    # Analisis utama teks
    score = 0.5 # Score awal 0.5 dianggap netral

    # Memeriksa kontradiksi dalam teks
    sentences = text.split('.')
    contradictions = 0

    for i in range(len(sentences)):
        for j in range(i + 1, len(sentences)):
            words1 = set(sentences[i].lower().split())
            words2 = set(sentences[j].lower().split())
            if len(words1 & words2) > 0 and len(words1.symmetric_difference(words2)) > 5:
                contradictions += 1

    if contradictions > 0:
        score += self.logic_rules[0][1]
        kontradiksi = True

    # Memeriksa kutipan sumber
    source_patterns = [
        r'menurut\s+(\w+)',
        r'berdasarkan\s+(\w+)',
        r'dikutip\s+dari\s+(\w+)',
        r'sumber\s+(\w+)'
    ]

    if any(re.search(pattern, text.lower()) for pattern in source_patterns):
        score += self.logic_rules[1][1]

    # Cek penggunaan bahasa emosional
    emotional_count = sum(word in self.keyword_dict['emotional'] for word in text.lower().split())
    if emotional_count > 0: # Kurang dari 2 pun cukup untuk deteksi
        score += self.logic_rules[2][1]
        emotional = True

    # Cek clickbait
    clickbait_count = sum(word in self.keyword_dict['clickbait'] for word in text.lower().split())
    if clickbait_count > 0:
        score += self.logic_rules[3][1]
        clickbait = True

    # Cek urgensi
    urgency_count = sum(word in self.keyword_dict['urgency'] for word in text.lower().split())
    if urgency_count > 0:
        score += self.logic_rules[4][1]
        urgency = True

    # Cek indikasi hoax
    hoax_count = sum(word in self.keyword_dict['hoax_keywords'] for word in text.lower().split())
    if hoax_count > 0:
        score += self.logic_rules[5][1]
        hoax = True

    # Analisis sentimen tambahan
    sentiment = TextBlob(text).sentiment.polarity
    if sentiment < -0.5:
        sentiment_negatif = True

    return max(0, min(1, score)), hoax, urgency, emotional, clickbait, sentiment_negatif, kontradiksi
# Normalize score between 0 and 1
```

Fig 3.2 The implementation of the analyze_text function for fake news detection

Source :

https://github.com/salmaanhaniiif/FraudDetection_IndonesianNewsInSoemed

The analyze_text function returns facts derived from its arguments. The subsequent classify function initializes facts required for detection, calls analyze_text to obtain facts from the text, and finally classifies the news based on the truth values of the facts. Initially, classification relied on AND operations for fact propositions. However, inefficiencies in this approach led to a switch to simpler branching operations.


```

def classify(self, text):
    # Inisialisasi logika proposisi berbasis boolean
    hoax = False
    urgency = False
    emotional = False
    clickbait = False
    kontradiksi = False
    sentiment_negatif = False

    detected_features = []

    score, hoax, urgency, emotional, clickbait, kontradiksi, sentiment_negatif = self.analyze_t

# Contoh implementasi dengan operasi AND proposisi
# if hoax and urgency and emotional and clickbait: #kondisional dengan operasi AND
#     detected_features.append("indikator hoax, urgency, bahasa emosional, clickbait")
# elif hoax and urgency and emotional: #kondisional dengan operasi AND
#     detected_features.append("indikator hoax, urgency, bahasa emosional")

# Karena terlalu banyak dan tidak efektif, maka diaplikasikan dengan operasi percabangan biasa
if hoax:
    detected_features.append("indikator hoax")
if clickbait:
    detected_features.append("clickbait")
if urgency:
    detected_features.append("urgency")
if emotional:
    detected_features.append("bahasa emosional")
if sentiment_negatif < -0.5:
    detected_features.append("sentimen negatif")

if detected_features:
    feature_message = ", ".join(detected_features)
else:
    feature_message = "tidak ada karakteristik mencurigakan"

if score < 0.4:
    return f"Kemungkinan Berita Palsu dengan fitur: {feature_message}", score
elif score > 0.6:
    return f"Kemungkinan Berita Valid dengan fitur: {feature_message}", score
else:
    return f"Perlu Verifikasi Lebih Lanjut dengan fitur: {feature_message}", score

```

Fig. 3.3 Final implementation of the classify function for fake news detection.

Source :

https://github.com/salmaanhaniif/FraudDetection_IndonesianNewsInSocmed

D. Results of Code Implementation for Detected Fake News

Fake news samples were scraped from websites uploading fake news shared on social media. Testing was conducted on several retrieved texts.

```

# Contoh teks berita palsu yang tersebar di sosial media untuk pengujian
text1 = ""Gaji Presiden RI mencengangkan dikabarkan bakal mengalami kenaikan. bagikan segera sebelum terlambat!""
text2 = ""DIBUKA LOWONGAN PETUGAS HAJI INDONESIA, SEGERA DAFTARKAN DIRI ANDA PENDAFTARAN TERBATAS !!""
text3 = ""Penemuan mengejutkan di Hutan HujanAmazon! Tengkorak Raksasa dengan leher terpanjang di dunia, ""
text4 = ""SIAP-SIAP! Pemegang Kartu KIS BPJS Kesehatan Bakal Terima 3 Bansos Pada Oktober 2024. Untuk menjamin kesehatan masyarakat kategori miskin, pemegang Kartu Indonesia Sehat (KIS) BPJS Kesehatan dipastikan menerima sejumlah bansos penting dari pemerintah. Untuk mendapatkan bantuan klik daftar""
text5 = ""BANSOS PKH 2024 Bantuan Sosial uang tunai Akhirnya sudah ada informasi jelas hari ini, ada bantuan bansos yang mau dapat bantuan bansos silahkan daftar link 📌📌📌 https://xxbansos2024.pdjhc.store/""
text6 = "Ma'ruf amin: kalau Jokowi terpilih lagi 3 periode ibu-ibu cukup bayar pakai kartu"
text7 = ""Mulai besok dan seterusnya ada peraturan komunikasi baru. Setelah dilantiknya Badan Siber & Sandi Nasional (BSSN), oleh Bpk Jokowi, Presiden NKRI: .Semua panggilan dicatat. .Semua rekaman panggilan telepon tersimpan. .WhatsApp dipantau, .Twitter dipantau, .Facebook dipantau, Semua...media sosial.... dan forum dimonitor, Informasikan kepada mereka yang tidak tahu. Perangkat Anda terhubung ke sistem pelayanan. Berhati-hatilah mengirimkan pesan yg tidak perlu. Beritahu anak-anak Anda, Kerabat dan teman tentang berita ini Jangan teruskan tulisan atau video dll, Polisi telah mengeluarkan pemberitahuan yang disebut .. Kejahatan Cargo ... dan tindakan akan dilakukan ... bila perlu hapus saja. Menulis atau meneruskan pesan apapun pada setiap perdebatan politik dan agama Informasikan berita ini kepada orang lain agar selalu waspada. Ini sangat serius, perlu diketahui semua kelompok dan anggota /individu.""

```

Fig. 3.4 Text samples indicative of fake news

Source :

https://github.com/salmaanhaniif/FraudDetection_IndonesianNewsInSocmed

Here is the implementation of code application :

```

# Inisialisasi objek FakeNewsDetector
detector = FakeNewsDetector()
hasil1 = detector.classify(text1)
print(hasil1[0])
hasil2 = detector.classify(text2)
print(hasil2[0])
hasil3 = detector.classify(text3)
print(hasil3[0])
hasil4 = detector.classify(text4)
print(hasil4[0])
hasil5 = detector.classify(text5)
print(hasil5[0])
hasil6 = detector.classify(text6)
print(hasil6[0])
hasil7 = detector.classify(text7)
print(hasil7[0])

```

Fig. 3.5 The testing implementation code

Source :

https://github.com/salmaanhaniif/FraudDetection_IndonesianNewsInSocmed

And here is the result :

```

[Running] python -u "c:\Users\saman\Documents\Code\Makalah\Matdis\frauddetection.py"
Kemungkinan Berita Palsu dengan fitur: urgency, bahasa emosional
Perlu Verifikasi Lebih Lanjut dengan fitur: urgency
Perlu Verifikasi Lebih Lanjut dengan fitur: clickbait
Kemungkinan Berita Palsu dengan fitur: indikator phishing
Perlu Verifikasi Lebih Lanjut dengan fitur: indikator phishing
Kemungkinan Berita Palsu dengan fitur: indikator hoax
Kemungkinan Berita Palsu dengan fitur: urgency

```

Fig. 3.6 The test results

Source :

https://github.com/salmaanhaniif/FraudDetection_IndonesianNewsInSocmed

IV. CONCLUSION

This study discusses the application of propositional logic as an interpretative approach to detecting fake news on Indonesian social media. This approach is based on the linguistic characteristics of fake news circulating on Indonesian social media. The designed system is capable of identifying word patterns that indicate hoaxes, phishing, urgency, emotional content, and clickbait. A scoring system for each indication also classifies the likelihood of falsehood for each piece of news. Using a dataset of fake news from Indonesian-language social media, the system was evaluated to determine its effectiveness in recognizing the characteristics of fake news.

The evaluation results indicate that this propositional logic-based approach is effective in detecting fake news circulating on social media, particularly for small datasets with specific linguistic characteristics. This approach offers several advantages, including transparency, which provides easy interpretation of the results, low computational requirements for its algorithm, and suitability for specific linguistic contexts.

However, the language-based classification program also has the potential for errors in its detection process. Non-fake news with a writing style similar to fake news may also be classified as fake by this program. Furthermore, there is room for further development, including integration with machine learning algorithms to enhance detection capabilities that are more relevant beyond linguistic information. Additionally, exploring other characteristics of the Indonesian language, such as dialect variations and writing styles, could provide additional benefits in improving the system's accuracy.

Overall, this study demonstrates that the application of propositional logic can be a relevant solution to addressing the challenge of fake news dissemination on social media while offering a strong foundation for future research and the development of rule-based detection systems.

V. RECOMMENDATIONS

This study was conducted and written based on a language-based approach to detecting fake news commonly found on Indonesian social media. Naturally, this propositional logic-based detection method differs from other detection systems that use machine learning, deep learning, or similar algorithms, which recognize specific patterns in identifying fake news. This program focuses on detecting classified keywords. Therefore, the program has the potential to misclassify genuine news with writing styles resembling fake news as false information. This study aims to contribute to reducing the risks associated with the spread of fake news. The program can be used in conjunction with other fake news detection systems to complement and refine detection mechanisms, particularly from a linguistic perspective.

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DECLARATION

I hereby declare that this paper is my original work, not an adaptation or translation of another person's paper, and not a case of plagiarism.

Bandung, 31 Desember 2024



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