



Texas A&M University - Commerce
Department of Computer Science

Unmasking Deception through Advanced NLP Analysis (Bidirectional LSTM)

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Declaration

I, Najeebuddin Mohammed, of the Department of Computer Science, Texas A&M University - Commerce, confirm that this is my own work and figures, tables, equations, code snippets, artworks, and illustrations in this report are original and have not been taken from any other person's work, except where the works of others have been explicitly acknowledged, quoted, and referenced. I understand that if failing to do so will be considered a case of plagiarism. Plagiarism is a form of academic misconduct and will be penalised accordingly.

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Najeebuddin Mohammed
February 23, 2024

Abstract

The proliferation of misinformation, particularly in the form of fake news, has become a significant challenge in today's digital age. This research project aims to leverage Natural Language Processing (NLP) techniques and machine learning algorithms to detect and combat the spread of deceptive content in online news articles. By analyzing linguistic patterns and employing sentiment analysis, the study seeks to develop a robust framework for accurately identifying fake news articles. The research objectives include analyzing and preprocessing a corpus of news articles, developing a Long Short-Term Memory (LSTM) model for binary categorization, and evaluating the effectiveness of NLP techniques in detecting fake news sources. Through this investigation, the project aims to contribute to the development of reliable mechanisms for combating misinformation and promoting information integrity in online platforms.

Keywords: fake news detection, natural language processing (NLP), machine learning, classifier comparison, text analysis

Acknowledgements

An acknowledgements section is optional. You may like to acknowledge the support and help of your supervisor(s), friends, or any other person(s), department(s), institute(s), etc. If you have been provided specific facility from department/school acknowledged so.

Contents

1	Introduction	1
1.1	Background	1
1.2	Problem statement	1
1.3	Aims and objectives	1
1.4	Solution approach	2
1.5	Summary of contributions and achievements	2
2	Literature Review	3
2.1	Evaluation of Existing Scholarship on Fake News Detection	4
2.2	Summary	4
3	Methodology	5
4	Results	7
4.1	A section	7
4.2	Example of a Table in \LaTeX	8
4.3	Example of captions style	8
4.4	Summary	8
5	Discussion and Analysis	9
5.1	A section	9
5.2	Significance of the findings	9
5.3	Limitations	9
5.4	Summary	9
6	Conclusions and Future Work	10
6.1	Conclusions	10
6.2	Future work	10
7	Reflection	11
	Appendices	13
A	An Appendix Chapter (Optional)	13
B	An Appendix Chapter (Optional)	14

List of Figures

3.1	Fake News Categories	6
3.2	Fake News - word Cloud	6

List of Tables

4.1	Example of a table in \LaTeX	8
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List of Abbreviations

SMPCS School of Mathematical, Physical and Computational Sciences

Chapter 1

Introduction

1.1 Background

The pervasive dissemination of misinformation in online articles presents a critical challenge in today's information landscape. This project delves into the intersection of Natural Language Processing (NLP) and machine learning to address this issue. Motivated by the increasing impact of fake news on public perception and decision-making, the project seeks to contribute to the development of robust mechanisms for detecting and mitigating the spread of deceptive content.

1.2 Problem statement

Despite advancements in fake news detection techniques, accurately identifying deceptive content in online articles remains a significant challenge. Traditional machine learning approaches often struggle to capture the nuanced linguistic patterns and contextual information present in text data, leading to suboptimal performance in distinguishing between real and fake news articles. Therefore, there is a need to explore more sophisticated methods, such as LSTM networks, to improve the accuracy and effectiveness of fake news detection. The dataset utilized in this research, referred to as the ISOT Fake News Dataset (2018)

1.3 Aims and objectives

Aims: To enhance the precision of fake news detection within a corpus of news articles in Dataset (2018) using LSTM networks.

Objectives:

1. Evaluate the effectiveness of LSTM networks in discerning distinctive linguistic patterns associated with fake news sources within the defined news article corpus.(Dataset, 2018)
2. Investigate the impact of LSTM-based models on improving the accuracy of fake news detection compared to traditional machine learning approaches.
3. Explore techniques for optimizing LSTM architectures, including hyperparameter tuning and model regularization, to achieve better performance in fake news classification tasks.

1.4 Solution approach

The solution approach involves leveraging LSTM networks as the primary technique for fake news detection in online articles. The methodology includes the following steps:

1. Preprocessing and tokenization of the fake news corpus to prepare the text data for LSTM modeling.
2. Designing and training LSTM-based deep learning models for binary classification of news articles into real or fake categories.
3. Fine-tuning the LSTM architectures and experimenting with different configurations to optimize model performance.
4. Evaluating the trained LSTM models using standard evaluation metrics and comparing their performance against baseline models and traditional machine learning algorithms.
5. Analyzing the results to assess the effectiveness of LSTM networks in addressing the fake news detection problem and identifying areas for further improvement.

1.5 Summary of contributions and achievements

Chapter 2

Literature Review

The realm of social media, encompassing forums, social networking, microblogging, social bookmarking, and wikis (*Using Social Media*, n.d., Gil, 2019), significantly influences the dynamics of information dissemination. However, the unintentional factors contributing to the rise of fake news, as evidenced by incidents like the Nepal Earthquake case (Tandoc Jr et al., 2017, Radianti et al., 2016), underline the intricacies of navigating the digital information landscape. In 2020, the global health sector encountered a substantial surge in fake news, prompting the World Health Organization (WHO) to declare an 'infodemic' during the COVID-19 outbreak. This infodemic involved a flood of both authentic and false information, including a noteworthy volume of misinformation.

In response to the challenges of identifying and combating fake news, several research initiatives have proposed innovative solutions. Sahoo and Gupta (2021) introduced an automatic fake news identification technique tailored for the Chrome environment, providing a means to detect fake news on Facebook. This approach leverages various features associated with a Facebook account, coupled with news content features, utilizing deep learning to analyze account characteristics.

FakeNewsNet, presented by Shu et al. (2020), serves as a valuable repository of fake news data. This resource provides datasets with diverse features, spatiotemporal information, and social context, facilitating research in the domain of fake news. Evaluation indicates that user engagements can contribute to fake news detection in addition to news articles, highlighting the multifaceted nature of information dissemination.

Kumar et al. (2020) proposed a CNN and bidirectional LSTM ensembled network for identifying original and false news instances. Utilizing various advanced approaches, such as Long Short Term Memories LSTMs, Convolutional Neural Networks CNNs, attention mechanisms, and ensemble methods, the study collected news instances from sources like PolitiFact. The CNN and bidirectional LSTM ensembled network, incorporating an attention mechanism, demonstrated superior accuracy, emphasizing the significance of model complexity in addressing the fake news identification challenge.

Natural Language Processing (NLP) emerges as a pivotal tool in tackling fake news. Choudhary and Arora (2021) proposed a linguistic model, employing handcrafted linguistic features for fake news detection. The model, driven by language-specific features, demonstrated a remarkable 86% accuracy in detecting and categorizing fake messages. Additionally, Abdullah et al. (2020) adopted a multimodal approach, combining Convolutional Neural Network (CNN) and

Long Short-Term Memory (LSTM), achieving significant performance in classifying fake news articles based on source, history, and linguistic cues.

Furthermore, Aslam et al. (2021) introduced an ensemble-based deep learning model for classifying news as fake or real using the LIAR dataset. Employing a combination of Bi-LSTM-GRU- dense and dense deep learning models, the study achieved notable accuracy, recall, precision, and F-score. Despite these advancements, ongoing research aims to enhance the robustness of these models, emphasizing the need for continual improvement and exploration of diverse datasets in fake news detection.

2.1 Evaluation of Existing Scholarship on Fake News Detection

The comprehensive examination of the literature reveals a multifaceted landscape in the realm of fake news identification. Researchers employ diverse strategies, ranging from linguistic models to multimodal approaches, emphasizing the need for a holistic understanding that incorporates both content and social context. Key findings underscore the significance of model complexity, with advanced architectures like the CNN bidirectional LSTM ensembled network exhibiting notable success. Natural Language Processing (NLP) emerges as a critical tool in deciphering news content, demonstrated by linguistic models and the utilization of NLP techniques for textual attribute analysis. Despite considerable progress, there remains a persistent call for improvement, urging researchers to explore feature richness, latent semantic features, and diverse datasets. The global impact of infodemics, particularly highlighted during the COVID-19 outbreak, underscores the urgency in developing robust fake news detection systems. In essence, the literature review illuminates the dynamic and evolving nature of fake news research, emphasizing innovation and adaptability in response to the challenges presented in the digital information age.

2.2 Summary

In summary, this literature review provides a comprehensive exploration of the current state of research in the field of fake news detection. The chapter commences by delineating the landscape of social media and its role in the dissemination of misinformation. It delves into the inadvertent factors contributing to the emergence of fake news, exemplifying instances such as the Nepal Earthquake case. The review accentuates the gravity of the 'infodemic,' particularly evident during the COVID-19 outbreak, necessitating advanced detection mechanisms. Several notable research endeavors are scrutinized, including Sahoo and Gupta (2021) automatic fake news identification technique, Shu et al. (2020) repository, and Kumar et al. (2020) CNN+bidirectional LSTM ensembled network. The significance of Natural Language Processing (NLP) in understanding and detecting fake news is highlighted through studies like Choudhary and Arora (2021) linguistic model. The literature underscores the need for continuous innovation, feature exploration, and adaptation to address the evolving challenges posed by the rampant spread of fake news. This synthesis of existing knowledge provides a robust foundation for the ensuing research endeavors aimed at enhancing the efficacy of fake news detection systems.

Chapter 3

Methodology

Data Collection and Preprocessing

The dataset utilized in this research, referred to as the ISOT Fake News Dataset (2018), encompasses articles categorized as either authentic or fabricated news. The data gathering process involved several key steps: authentic news articles were procured through web crawling from Reuters.com, a renowned news platform acclaimed for its credibility, while fabricated news articles were sourced from multiple untrustworthy outlets identified by Politifact, a prominent fact-checking entity, and Wikipedia. To maintain uniformity, articles were predominantly collected within the timeframe of 2016 to 2017. The dataset comprises two CSV files: "True.csv" containing over 12,600 articles sourced from Reuters.com and "Fake.csv" containing a similar number of articles from diverse fake news sources. Each article within the dataset includes essential information such as the title, text, type (real or fake), and publication date.

Exploratory Data Analysis (EDA)

We performed Exploratory Data Analysis (EDA) on the preprocessed dataset to gain insights into the distribution of real and fake news articles, as well as the distribution of news articles across different subjects. The following figures were generated to visualize the dataset:

Chapter 4

Results

The results chapter tells a reader about your findings based on the methodology you have used to solve the investigated problem. For example:

- If your project aims to develop a software/web application, the results may be the developed software/system/performance of the system, etc., obtained using a relevant methodological approach in software engineering.
- If your project aims to implement an algorithm for its analysis, the results may be the performance of the algorithm obtained using a relevant experiment design.
- If your project aims to solve some problems/research questions over a collected dataset, the results may be the findings obtained using the applied tools/algorithms/etc.

Arrange your results and findings in a logical sequence.

4.1 A section

...

4.2 Example of a Table in \LaTeX

Table 4.1 is an example of a table created using the package \LaTeX “booktabs.” do check the link: wikibooks.org/wiki/LaTeX/Tables for more details. A table should be clean and readable. Unnecessary horizontal lines and vertical lines in tables make them unreadable and messy. The example in Table 4.1 uses a minimum number of liens (only necessary ones). Make sure that the top rule and bottom rule (top and bottom horizontal lines) of a table are present.

Table 4.1: Example of a table in \LaTeX

Bike		
Type	Color	Price (£)
Electric	black	700
Hybrid	blue	500
Road	blue	300
Mountain	red	300
Folding	black	500

4.3 Example of captions style

- The **caption of a Figure (artwork)** goes **below** the artwork (Figure/Graphics/illustration). See example artwork in Figure ??.
- The **caption of a Table** goes **above** the table. See the example in Table 4.1.
- The **caption of an Algorithm** goes **above** the algorithm. See the example in Algorithm ??.
- The **caption of a Listing** goes **below** the Listing (Code snippet). See example listing in Listing ??.

4.4 Summary

Write a summary of this chapter.

Chapter 5

Discussion and Analysis

Depending on the type of project you are doing, this chapter can be merged with “Results” Chapter as “ Results and Discussion” as suggested by your supervisor.

In the case of software development and the standalone applications, describe the significance of the obtained results/performance of the system.

5.1 A section

Discussion and analysis chapter evaluates and analyses the results. It interprets the obtained results.

5.2 Significance of the findings

In this chapter, you should also try to discuss the significance of the results and key findings, in order to enhance the reader’s understanding of the investigated problem

5.3 Limitations

Discuss the key limitations and potential implications or improvements of the findings.

5.4 Summary

Write a summary of this chapter.

Chapter 6

Conclusions and Future Work

6.1 Conclusions

Typically a conclusions chapter first summarizes the investigated problem and its aims and objectives. It summarizes the critical/significant/major findings/results about the aims and objectives that have been obtained by applying the key methods/implementations/experiment set-ups. A conclusions chapter draws a picture/outline of your project's central and the most significant contributions and achievements.

A good conclusions summary could be approximately 300–500 words long, but this is just a recommendation.

A conclusions chapter followed by an abstract is the last things you write in your project report.

6.2 Future work

This section should refer to Chapter 4 where the author has reflected their criticality about their own solution. The future work is then sensibly proposed in this section.

Guidance on writing future work: While working on a project, you gain experience and learn the potential of your project and its future works. Discuss the future work of the project in technical terms. This has to be based on what has not been yet achieved in comparison to what you had initially planned and what you have learned from the project. Describe to a reader what future work(s) can be started from the things you have completed. This includes identifying what has not been achieved and what could be achieved.

A good future work summary could be approximately 300–500 words long, but this is just a recommendation.

Chapter 7

Reflection

Write a short paragraph on the substantial learning experience. This can include your decision-making approach in problem-solving.

Some hints: You obviously learned how to use different programming languages, write reports in \LaTeX and use other technical tools. In this section, we are more interested in what you thought about the experience. Take some time to think and reflect on your individual project as an experience, rather than just a list of technical skills and knowledge. You may describe things you have learned from the research approach and strategy, the process of identifying and solving a problem, the process research inquiry, and the understanding of the impact of the project on your learning experience and future work.

Also think in terms of:

- what knowledge and skills you have developed
- what challenges you faced, but was not able to overcome
- what you could do this project differently if the same or similar problem would come
- rationalize the divisions from your initial planned aims and objectives.

A good reflective summary could be approximately 300–500 words long, but this is just a recommendation.

Note: The next chapter is “**References**,” which will be automatically generated if you are using BibTeX referencing method. This template uses BibTeX referencing. Also, note that there is difference between “References” and “Bibliography.” The list of “References” strictly only contain the list of articles, paper, and content you have cited (i.e., refereed) in the report. Whereas Bibliography is a list that contains the list of articles, paper, and content you have cited in the report plus the list of articles, paper, and content you have read in order to gain knowledge from. We recommend to use only the list of “References.”

References

- Abdullah, A., Awan, M., Shehzad, M. and Ashraf, M. (2020), 'Fake news classification bimodal using convolutional neural network and long short-term memory', *Int. J. Emerg. Technol. Learn* **11**, 209–212.
- Aslam, N., Ullah Khan, I., Alotaibi, F. S., Aldaej, L. A. and Aldubaikil, A. K. (2021), 'Fake detect: A deep learning ensemble model for fake news detection', *complexity* **2021**, 1–8.
- Choudhary, A. and Arora, A. (2021), 'Linguistic feature based learning model for fake news detection and classification', *Expert Systems with Applications* **169**, 114171.
- Dataset, I. F. N. (2018), 'Fake news'.
URL: <https://www.kaggle.com/datasets/emineyetm/fake-news-detection-datasets>
- Gil, P. (2019), 'What exactly is twitter?'.
URL: <https://www.lifewire.com/what-exactly-is-twitter-2483331>
- Kumar, S., Asthana, R., Upadhyay, S., Upreti, N. and Akbar, M. (2020), 'Fake news detection using deep learning models: A novel approach', **31**(2), e3767. e3767 ETT-19-0216.R1.
URL: <https://onlinelibrary.wiley.com/doi/abs/10.1002/ett.3767>
- Radianti, J. et al. (2016), An overview of public concerns during the recovery period after a major earthquake: Nepal twitter analysis, in 'HICSS '16 Proceedings of the 2016 49th Hawaii International Conference on System Sciences (HICSS)', IEEE, pp. 136–145.
- Sahoo, S. R. and Gupta, B. B. (2021), 'Multiple features based approach for automatic fake news detection on social networks using deep learning', *Applied Soft Computing* **100**, 106983.
- Shu, K., Mahudeswaran, D., Wang, S., Lee, D. and Liu, H. (2020), 'Fakenewsnet: A data repository with news content, social context, and spatiotemporal information for studying fake news on social media', *Big data* **8**(3), 171–188.
- Tandoc Jr, E. C. et al. (2017), 'Defining fake news: A typology of scholarly definitions', *Digital Journalism* pp. 1–17.
- Using Social Media* (n.d.), <https://esrc.ukri.org/research/impact-toolkit/social-media/using-social-media>. Economic and Social Research Council.

Appendix A

An Appendix Chapter (Optional)

Some lengthy tables, codes, raw data, length proofs, etc. which are **very important but not essential part** of the project report goes into an Appendix. An appendix is something a reader would consult if he/she needs extra information and a more comprehensive understating of the report. Also, note that you should use one appendix for one idea.

An appendix is optional. If you feel you do not need to include an appendix in your report, avoid including it. Sometime including irrelevant and unnecessary materials in the Appendices may unreasonably increase the total number of pages in your report and distract the reader.

Appendix B

An Appendix Chapter (Optional)

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