

# **Analyzing Customer Reviews on Food Delivery Services Using Deep Learning and Explainable Artificial Intelligence (XAI)**

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Thesis submitted in fulfilment of the requirements for  
the degree of

**Master in Science (Research) in Computing Sciences**

under the supervision of Distinguished Professor Biswajeet  
Pradhan and Dr Nagesh Shukla

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November 2022

## CERTIFICATE OF ORIGINAL AUTHORSHIP

I, **Anirban Adak** declare that this thesis, is submitted in fulfilment of the requirements for the award of **Master of Science (Research) in Computing Sciences**, in the **Faculty of Engineering & Information Technology** at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

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## ACKNOWLEDGEMENT

I would like to express my sincere gratitude and respect to my esteemed principal supervisor, Distinguished Professor Biswajeet Pradhan and my co-supervisor Dr Nagesh Shukla. Their achievements in scientific world has been a continuous inspiration for me. Their continuous guidance throughout the research duration, all the way from assessing the research questions, defining research methodology, validating the experiments, critical reviews, and suggestions helped me immensely. Each review comment backed up by so much experience was always fascinating to see how it was changing the direction or flow of the research, and scientific papers that we published during my research period. Without their constant encouragement and supervision, this research would not have been possible.

I would like to extend my sincere gratitude to the candidature assessment panellists who patiently listened to my research and provided valuable feedback to shape up the research.

I am very grateful to the Centre for Advanced Modelling and Geospatial Information Systems, Faculty of Engineering and Information Technology, the University of Technology Sydney for offering research scholarships that have enabled me to accomplish this study.

I express my deep gratitude to my parents for their continuous encouragement and my wife for letting me spend as much time as possible on my study.

I also thank everyone whose name is not included here but have helped me directly or indirectly.

## LIST OF PAPERS/PUBLICATIONS

Following papers are produced as a part of the research:

- Adak, Anirban, Biswajeet Pradhan, and Nagesh Shukla. "Sentiment Analysis of Customer Reviews of Food Delivery Services Using Deep Learning and Explainable Artificial Intelligence: Systematic Review." *Foods 11*, no. 10 (2022): 1500 – **Published**
- Adak, Anirban, Biswajeet Pradhan, Nagesh Shukla, and Abdullah Alamri. 2022. "Unboxing Deep Learning Model of Food Delivery Service Reviews Using Explainable Artificial Intelligence (XAI) Technique", *Foods 11*, no. 14 (2022): 2019 – **Published**

**Note:** Thesis includes the contents from the papers published above.

## TABLE OF CONTENTS

<b>CERTIFICATE OF ORIGINAL AUTHORSHIP .....</b>	<b>i</b>
<b>ACKNOWLEDGEMENT .....</b>	<b>ii</b>
<b>LIST OF PAPERS/PUBLICATIONS .....</b>	<b>iii</b>
<b>LIST OF TABLES .....</b>	<b>vii</b>
<b>LIST OF FIGURES .....</b>	<b>viii</b>
<b>LIST OF ABBREVIATIONS .....</b>	<b>ix</b>
<b>ABSTRACT .....</b>	<b>x</b>
<b>1 INTRODUCTION .....</b>	<b>1</b>
1.1 General Introduction.....	1
1.2 Research Background.....	4
1.3 Research Gaps .....	5
1.4 Scope of Thesis .....	6
1.5 Motivation behind Research.....	7
1.6 Research Aim and Objectives .....	8
1.6.1 Objective 1 .....	9
1.6.2 Objective 2 .....	9
1.6.3 Objective 3 .....	9
1.7 Research Questions .....	10
1.7.1 Questions pertaining to objective 1 .....	10
1.7.2 Questions pertaining to objective 2.....	10
1.7.3 Questions pertaining to objective 3.....	10
1.8 Research Hypothesis .....	10
1.8.1 Hypothesis 1.....	10
1.8.2 Hypothesis 2.....	11
1.8.3 Hypothesis 3.....	11
1.8.4 Hypothesis 4.....	11
1.9 Novelty and Main Contribution .....	12
1.10 Thesis Organisation .....	14
<b>2 LITERATURE REVIEW .....</b>	<b>15</b>
2.1 Introduction .....	15

2.2	Literature Review Methodology .....	16
2.2.1	Aim and Research Questions .....	18
2.2.2	Search and Selection Process .....	18
2.3	Previous work on FDS using sentiment analysis .....	20
2.3.1	Traditional approaches on FDS using sentiment analysis.....	20
2.3.2	Machine learning approaches on FDS using sentiment analysis .....	21
2.3.3	Explainable AI techniques .....	26
2.3.4	Topic Categorization .....	33
2.4	Strength and limitations of models.....	35
2.5	Current research issues in food delivery services.....	37
2.6	Summary .....	37
<b>3</b>	<b>MATERIALS AND RESEARCH METHODOLOGY .....</b>	<b>39</b>
3.1	Introduction .....	39
3.2	Data Acquisition.....	39
3.2.1	Data scraping using ParseHub .....	39
3.2.2	Identify Data Attributes.....	41
3.2.3	Data Splitting .....	43
3.2.4	Data cleansing .....	43
3.3	RNN Architecture.....	43
3.4	Deep learning techniques .....	45
3.4.1	LSTM and Bi-LSTM .....	45
3.4.2	Bidirectional GRU .....	46
3.5	XAI Techniques .....	46
3.5.1	SHAP .....	46
3.5.2	LIME .....	47
3.6	LDA.....	48
3.6.1	Methods for finding the optimal number of topics in LDA.....	48
3.7	Overall Methodology .....	49
3.8	Implementation of the methodology .....	52
3.8.1	Objective 1 .....	52
3.8.2	Objective 2 .....	54
3.8.3	Objective 3 .....	55
3.8.4	Evaluation and performance metrics.....	56
3.9	Summary .....	58
<b>4</b>	<b>RESULTS AND DISCUSSION .....</b>	<b>60</b>

4.1	Introduction .....	60
4.2	Results of Objective 1 .....	60
4.2.1	Sentiment Analysis using simple and Hybrid DL models .....	60
4.2.2	Discussion .....	60
4.2.3	Validation.....	65
4.3	Results of Objective 2 .....	66
4.3.1	XAI explanation on LSTM model using SHAP and LIME.....	66
4.3.2	Discussion .....	66
4.3.3	Validation.....	69
4.4	Results of Objective 3 .....	69
4.4.1	Topic Categorization of negative and positive sentiments using LDA.....	69
4.4.2	Discussion .....	70
4.4.3	Validation.....	81
4.5	Summary .....	81
<b>5</b>	<b>CONCLUSIONS AND FUTURE WORK RECOMMENDATIONS.....</b>	<b>83</b>
5.1	General Conclusion .....	83
5.2	Conclusion of Objective 1 .....	83
5.3	Conclusion of Objective 2 .....	84
5.4	Conclusion of Objective 3 .....	85
5.5	Research Drawbacks and Limitations .....	86
5.6	Recommendations for Future Work .....	86
	<b>REFERENCES.....</b>	<b>87</b>

## LIST OF TABLES

Table 2.1. Search queries and results showing the number of papers. ....	19
Table 2.2. Literature classification.....	19
Table 2.3. Interpretability of methods used for sentiment analysis in FDS.....	27
Table 3.1. Different attributes of the dataset from ProductReview. ....	41
Table 3.2. Confusion Matrix .....	56
Table 4.1. Performance metrics - (a) LSTM; (b) Bi-LSTM; and (c) Bi-GRU-LSTM-CNN model.....	64
Table 4.2. Accuracy scores achieved in ML/DL models from recent papers. ....	65
Table 4.3. Word contribution for topic on (a) negative and (b) positive reviews.....	70
Table 4.4. Category Names derived from Keywords with weights .....	74
Table 4.5. Coherence score and perplexity for no. of topics.....	77
Table 4.6. Positive and Negative Categories extracted from customer reviews.....	81



## LIST OF FIGURES

Figure 1.1. High-level AI diagram.....	3
Figure 1.2. Solution framework for sentiment analysis in FDS.....	13
Figure 2.1. Literature review methodology.....	17
Figure 2.2. Classifications of techniques for Sentiment Analysis. ....	20
Figure 3.1. ProductReview website for Menulog (www.productreview.com.au) .....	40
Figure 3.2. Wordcloud of customer reviews from productreview site. ....	41
Figure 3.3. Negative and positive sentiment count. ....	43
Figure 3.4. Showing RNN architecture.....	44
Figure 3.5. LSTM architecture.....	46
Figure 3.6. Dependencies in LDA.....	48
Figure 3.7. Overall Methodology flow chart with DL model, XAI technique and LDA model adopted in this work. ....	51
Figure 3.8. Methodology flow chart with DL technique adopted in this work.....	52
Figure 3.9. Methodology flow chart with XAI technique adopted in this work.....	54
Figure 3.10. Methodology flow chart with LDA adopted in this work. ....	55
Figure 4.1. SHAP explanation on the positive customer review. ....	67
Figure 4.2. SHAP explanation on the negative customer review. ....	67
Figure 4.3. LIME explanation on the positive customer review detected by the LSTM model.....	68
Figure 4.4. LIME explanation on the negative customer review detected by the LSTM model.....	68
Figure 4.5. Coherence score vs no. of topics on (a) negative (b) positive reviews.....	76
Figure 4.6. (a) (b) (c) Topics with keywords for negative sentiments.....	79
Figure 4.7. (a) (b) Topics with keywords for positive sentiments. ....	80

## LIST OF ABBREVIATIONS

BERT	Bidirectional Encoder Representations from Transformers
Bi-GRU-LSTM-CNN	Embedded Bidirectional GRU LSTM CNN
Bi-LSTM	Bidirectional Long Short-Term Memory
CNN	Convolutional Neural Network
DL	Deep Learning
DT	Decision Trees
FDS	Food Delivery Services
LIME	Local Interpretable Model Agnostic Explanation
LDA	Latent Dirichlet Allocation
LSTM	Long short-term memory
ML	Machine Learning
NB	Nave Bayes
NN	Neural Networks
OA	Overall Accuracy
SHAP	Shapley Additive Explanations
SVM	Support Vector Machines
XAI	Explainable Artificial Intelligence

## **ABSTRACT**

Social media reviews and feedback are getting increasingly important for customers ordering food from a food delivery services in the last few years. This trend has become even more prominent since COVID-19 pandemic and government enforced lockdowns. During the Covid-19 crisis, customer's preferences in having food delivered to their doorstep instead of waiting in a restaurant has propelled the growth of food delivery services (FDS). As all restaurants go online and get onboarded to FDS, such as UberEATS, Menulog or Deliveroo, customer review on online platforms has become an important source of information about the company's performance. The FDS organisations would like to find complaints from customer feedback and use the data effectively to understand the areas for improvement to enhance customer satisfaction. The study aims to review the Machine Learning (ML) and Deep Learning (DL) models along with explainable artificial intelligence (XAI) method to predict customer sentiment in the FDS domain. This research aims to develop a robust end-to-end framework using AI/ML which can help to accurately predict customer sentiment in the first objective. The second objective presents the XAI technique implementation on the black box DL models. The explanations of the black box models as how they build the outcome will help build the trust in the system. The third objective groups the positive and negative sentiments in groups using topic categorization technique. The groups can be used for sending the customer complaints for process improvement and positive reviews for rewarding staff. Firstly, in the objective 1, customer review data was collected from Productreview website and was used for building simple Long short-term memory (LSTM), Bidirectional Long Short-Term Memory (Bi-LSTM) and hybrid Embedded Bidirectional GRU LSTM CNN (Bi-GRU-LSTM-CNN) DL models for performing sentiment analysis. The DL models were compared to pick the best classifier for FDS domain. The results showed LSTM model, Bi-LSTM model and Bi-GRU-LSTM-CNN model achieved accuracy of 96.07%, 95.85% and 96.33% respectively. Secondly, in the objective 2, XAI techniques such as Shapley Additive Explanations (SHAP) and Local Interpretable Model Agnostic (LIME) were used on the best DL model to provide explanation on the sentiment prediction. Both the techniques SHAP and LIME proved useful in explaining the model with features (words in case of sentences) which are contributing the prediction outcome.

Thirdly, in the objective 3, this study implemented topic categorization technique LDA on the positive and negative comments.

**Keywords:** sentiment analysis, food delivery services, deep learning, explainable artificial intelligence, lime, shapley