



Contents

APPROVAL PAGE	i
PLAGIARISM STATEMENT	i
MOTTO	ii
DEDICATION	iv
FOREWORDS	v
TABLE OF CONTENTS	x
LIST OF TABLES	xi
LIST OF FIGURES	xii
ACRONYMS	xiii
GLOSSARY	xvi
ABSTRAK	xix
ABSTRACT	xx
1 Introduction	1
1.1 Background	1
1.2 Research Problem	3
1.3 Problem Statement	4
1.4 Research Scope	5
1.5 Research Objectives	5
1.6 Research Advantages	6
2 Literature Review	7
2.1 Preface	7
2.2 Data Augmentation	8
2.3 Feature Extraction	8
2.4 Modelling and Classification	11



2.5	Neural Network Architectures	12
2.6	Research Comparison	15
3	Theory	17
3.1	Corpus	17
3.1.1	Speech corpus	18
3.2	Language / Dialect Identification	18
3.3	Mel Filter Bank	19
3.4	Mel Frequency Cepstral Coefficients	20
3.5	Model	22
3.5.1	Model training	22
3.5.2	Model validation	22
3.6	Neural Network	23
3.6.1	Multi-layer perceptrons	24
3.6.2	Recurrent Neural Network	25
3.6.3	Convolutional Neural Network	25
3.7	Short-time Fourier Transform	28
4	Research Methodology	31
4.1	Research Description	31
4.2	Tools and Materials	31
4.2.1	Tools	31
4.2.2	Dataset	32
4.3	Research Phases	36
4.3.1	Literature study	36
4.3.2	Dataset and features collection	37
4.3.3	Model structural design	38
4.3.4	Model training and validation	39
4.3.5	Model comparison	40
4.3.6	Evaluation	40
4.3.7	Final report	44
5	Implementation	45
5.1	Dataset	45
5.2	Feature Extraction	46
5.2.1	Wave file loading	46
5.2.2	Frequency spectrogram	47
5.2.3	Mel-scale spectrogram	48
5.2.4	Mel Frequency Cepstral Coefficients	49
5.3	Feature Preprocessing	49
5.3.1	Pre-emphasis	50
5.3.2	Low/High-pass filters	50
5.3.3	Voice activity detection	51
5.3.4	Segment splitting	52
5.3.5	Cepstral mean-variance normalisation	53



5.4	Model Conception and Training	54
5.4.1	Model architectures	54
5.4.2	Model training	61
6	Results and Discussion	64
6.1	Model Performances	64
6.1.1	Mel-scale spectrogram	64
6.1.2	Mel frequency cepstral coefficients	66
6.1.3	Frequency spectrogram	68
6.2	Per-dialect Performances	71
6.2.1	Mel-scale spectrogram	72
6.2.2	Frequency spectrogram	75
6.2.3	Mel frequency cepstral coefficients	78
6.3	Performance Metrics Comparison	80
6.3.1	Accuracy	80
6.3.2	Precision	80
6.3.3	Recall	81
6.3.4	F-score	81
6.4	Discussion	82
7	Conclusion and Future Works	85
7.1	Conclusion	85
7.2	Future Works	86