

## CONTENTS

<b>Aproval Page</b>	<b>ii</b>
<b>Declaration Page</b>	<b>iii</b>
<b>Acknowledgement Page</b>	<b>iv</b>
<b>Motto Page</b>	<b>v</b>
<b>PREFACE</b>	<b>vi</b>
<b>ABSTRACT</b>	<b>xiv</b>
<b>I Introduction</b>	<b>1</b>
1.1 Research Background . . . . .	1
1.2 Research Problems . . . . .	3
1.3 Research Scopes . . . . .	3
1.4 Research Objectives . . . . .	4
1.5 Research Benefit . . . . .	4
1.6 Research Methodology . . . . .	4
1.7 Writing Systematics . . . . .	6
<b>II Literature Review</b>	<b>8</b>
<b>III Basic Theory</b>	<b>22</b>
3.1 Mental Disorder . . . . .	22
3.2 Artificial Neural Network . . . . .	23
3.3 Convolutional Neural Network architecture . . . . .	24
3.3.1 Convolution Layer . . . . .	24
3.3.2 Pooling Layer . . . . .	25
3.3.3 Fully Connected Layer . . . . .	25
3.4 Stochastic Gradient Descent . . . . .	25
3.5 Adaptive Moment Optimization (Adam) . . . . .	27
3.6 Hyperparameter . . . . .	27
3.6.1 Activation function . . . . .	28
3.6.2 Learning Rate . . . . .	28



3.7	Transfer Learning . . . . .	29
3.7.1	VGGFace . . . . .	29
3.7.2	Resnet50 . . . . .	30
3.7.3	Inception-v3 . . . . .	33
3.8	Facial Landmarking . . . . .	33
3.9	Delaunay Triangulation and Face Averaging . . . . .	34
<b>IV</b>	<b>Research Methodology</b>	<b>35</b>
4.1	Research Description . . . . .	35
4.2	Research Apparatus (Development Environment) . . . . .	35
4.3	Dataset . . . . .	36
4.4	Research Phases . . . . .	36
4.4.1	Literature Study . . . . .	37
4.4.2	Data Acquisition . . . . .	38
4.4.3	Data Preprocessing . . . . .	39
4.4.4	Features in FCL . . . . .	44
4.4.5	CNN Pretrained model . . . . .	45
4.4.6	Model Training and Experimentation . . . . .	47
4.4.7	Evaluation . . . . .	49
<b>V</b>	<b>Implementation</b>	<b>51</b>
5.1	Main Program Flow . . . . .	51
5.2	Augmentation Process . . . . .	51
5.2.1	Dataset Class Initialization . . . . .	51
5.2.2	Resizing . . . . .	52
5.2.3	Horizontal Flip . . . . .	52
5.2.4	Photometric Augmentation . . . . .	53
5.2.5	Face Averaging . . . . .	54
5.3	CNN Models Transfer Learning Implementation . . . . .	57
5.3.1	Pretrained Models Implementation . . . . .	57
5.3.2	LIME Explainer Implementation . . . . .	59
<b>VI</b>	<b>Results and Discussions</b>	<b>60</b>
<b>VII</b>	<b>Conclusion</b>	<b>68</b>
7.0.1	Future Works . . . . .	68



<b>References</b>	<b>71</b>
<b>A Full Implementation</b>	<b>72</b>
<b>B Models Performance</b>	<b>81</b>

## LIST OF TABLES

2.1	Previous researches . . . . .	20
3.1	Architecture of VGGFace. (Parkhi et al., 2015) . . . . .	31
3.2	Comparison of different resnet model architectures. (He et al., 2016) . . . . .	32
4.1	Summary of dataset produced . . . . .	39
4.2	Custom VGGFace2 model architecture . . . . .	46
4.3	Custom InceptionV3 model architecture . . . . .	47
6.1	Average performance of models produced with epoch = 20 . . . . .	61
6.2	Average performance of models produced with epoch = 30 . . . . .	62
6.3	Average performance of models produced with epoch = 40 . . . . .	63
6.4	Results – Models Performances (20 epochs) . . . . .	65
6.5	Results – Models Performances (30 epochs) . . . . .	65
6.6	Results – Models Performances (40 epochs) . . . . .	65
6.7	Performance shown by adjusting the hyperparameters on the best models. . . . .	67

## LIST OF FIGURES

2.1	Sample stimuli used in the Ward and Scott (2018) experiment. . . . .	9
2.2	Appearance ratings of mental health, attractiveness, physical health, and masculinity against actual mental health conditions.(Ward and Scott, 2018) . . . . .	10
2.3	Different possible augmentation methods on facial images. (Wang et al., 2019) . . . . .	13
2.4	Landmarking and triangulation in facial features transfer. (Wang et al., 2019) . . . . .	14
2.5	General pipeline of FER. (Li and Deng, 2018) . . . . .	16
2.6	Flow of decision making using LIME. (Ribeiro et al., 2016) . . . . .	18
2.7	Demonstration of lime provided in [5] to explain features used to classify different objects in an image. (Ribero, Singh, Guestrin, 2016) . . . . .	19
3.1	Illustration of a basic ANN . . . . .	23
3.2	Illustration of a basic CNN architecture . . . . .	24
3.3	Basic intuition of gradient descent . . . . .	26
3.4	Architecture of a residual block. (He et al., 2016) . . . . .	30
3.5	InceptionV3 architecture. (Szegedy et al., 2015) . . . . .	33
4.1	Workflow of the research . . . . .	37
4.2	Composite facial images retrieved from Bangor University’s Ward and Scott (2018). High tendency of mental disorder (left) and Low tendency of mental disorder (right) . . . . .	38
4.3	Data Augmentation Flow . . . . .	39
4.4	Horizontal Flip on Resized Image sample . . . . .	40
4.5	Hue, Saturation, and Value illustration. (Wikimedia) . . . . .	41
4.6	Color replacement on the skin of the face . . . . .	42
4.7	Face Landmarking and Triangulation . . . . .	42
4.8	Composite image creation demonstration . . . . .	44
4.9	Illustration of the proposed model . . . . .	45
4.10	Illustration of the custom VGGFace2 model based on Resnet50 architecture . . . . .	46
4.11	Illustration of the custom InceptionV3 model . . . . .	47
4.12	k-fold process illustration. k = 4 . . . . .	48



- 6.1 Lime Explainer using InceptionV3 model on MSH2(left) and MSL8(right) 66
- 6.2 Lime Explainer using VGGFace2 model on MSH9(left) and MSL8(right) 67



## Listings

5.2.1 Augmentation.py __init__()	52
5.2.2 Augmentation.py resize()	52
5.2.3 Augmentation.py AugmentHFlip()	53
5.2.4 Augmentation.py AugmentColor()	53
5.2.5 Augmentation.py AugmentAverage()	54
5.2.6 Augmentation.py calcLandmark()	55
5.2.7 Augmentation.py faceAverage()	55
5.2.8 Augmentation.py morphTriangle()	56
5.3.9 pretrainedmodels.py train()	58
5.3.1(Lime.py explain()	59
1.0.1 main.py	72
1.0.2 Augmentation.py __init__()	72
1.0.3 Augmentation.py resize()	73
1.0.4 Augmentation.py AugmentHFlip()	74
1.0.5 Augmentation.py AugmentColor()	75
1.0.6 Augmentation.py calcLandmark()	76
1.0.7 Augmentation.py applyAffineTransform()	77
1.0.8 Augmentation.py AugmentAverage()	77
1.0.9 pretrainedmodels.py train()	78
1.0.1(Lime.py explain()	80