

Artificial Neural Network Prediction Model for Anxiety and Depression of an Individual on the Impact of COVID-19 Lockdown in Ethiopia

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ABSTRACT:- COVID-19 Lockdown causes different health problems in the society of Ethiopia. Among these problems mental health problem such as anxiety, depression, panic and fear are common. This research aimed to redesign a neural network model of an anxiety and depression based on Hospital Anxiety and Depression Score (HADS) measurement techniques. We collected 713 data from different individuals including students, working and non-working male and female age group from 16 to 55 using online survey. In order to online survey, we prepared 7 questions using HADS standard for anxiety and depression. Each of these questions has four answer scores from 0 to 3. We generate neural network model on the basis of participant response and HADS measurement technique in order to classify the level of Anxiety and Depression. The level of anxiety and depression can be normal, mild, moderate and severe. The model was tested and its specificity was 0.997940975 for anxiety and 0.996577687 for depression. We achieved the sensitivity value for anxiety is 0.926666667 and for depression is 0.945205479. We compared the model accuracy manually using HADS technique. We found the Average Percentage Value (APV) 0.017379846 and 0.018365 for anxiety and depression respectively. This study can further designed to recommend some advices on what an individual may do or what kind of measurements they must do in each level of Anxiety and depression.

Keywords:- Anxiety, Depression, COVID-19, Artificial Neural Network, Hospital Anxiety and Depression Scale.

I. INTRODUCTION

COVID-19 is an illness which stands for corona virus disease that caused by a virus that can spread from person to person. As World Health Organization (WHO) reported that the COVID-19 was first identified in China, Wuhan city and spread throughout the world. In 2021 more than 80,000,000 cases reported [1]. According to the new survey done by WHO, the COVID-19 pandemic has disordered mental health service demand is increasing in the society which is 93% of countries worldwide. From depression and anxiety alone approximately 1 trillion united states dollar economic productivity is lost in each year worldwide [2]. In Ethiopia, more than 26 million students were distorted during the COVID -19 pandemic and it is reported in news a number of

students and people affected by depression and anxiety and commit suicide in the pandemic [3]

Depression is a disorder that affects how you feel, behave and the way how you think. Depression is a bad mood that causes sadness and loss of interest and it can lead to different physical and emotional problems. Someone who affected by depression may not able to perform his day to day activities, and occasionally he/she may feel as if life isn't worth living [4]. Nowadays depression is foremost contributor to the worldwide burden of disease and it affects people in any societies through the world. In 2012, depression is estimated to affect 350 million people [5]. Environmental factors, personality, genetics and biochemistry are some of the factors of depression [6]. According to oxford dictionary anxiety is a strong desire or concern to do something or for something to happen and it is also defined as a feeling of worry, nervousness, or unease about something with an uncertain outcome [7]. There is different classification of anxiety and there are different risk factors of anxiety among this stress due to an illness, stress buildup, Trauma, other mental health disorder and drugs or alcohol [8]. Feeling faint or dizzy, dry mouth, sweating, apprehension and worry, restlessness, distress and fear are some of the symptoms of an anxiety attack [9]. The causes of both anxiety and depression are multifactorial, including biological, economic, social, environmental and cultural. Diagnosis of it is made by psychiatrists or psychologists according to Diagnostic and Statistical Manual of Mental Disorders (DSM)-5 [10] or International Classification of Diseases (ICD) 10 [11].

Machine-learning approaches is better than traditional statistical prediction models on recognizing multipart contours and patterns in data, and preventing hypothetically imprecise model specifications [12]. Machine learning and data mining methods is used in health centers to diagnose complex diagnosis based on the patient's history and this can be used for making logical decisions. Diagnosis of anxiety disorders is a very complex and challenging task. Thus using machine learning, an anxiety can be diagnosis with the high accuracy [13]. Artificial Neural Networks (ANNs) are densely interconnected and adaptive processing units, with an inherent ability for learning from experience and discovering new knowledge [14]. Hospital anxiety and depression score (HADS) is a measurement tool for clinical practice and research. It was designed to measure anxiety and depression in general patients in health centers [15]. It is

simple and easy to use calculate the level of anxiety and depression of an individual's[16].

Different authors conduct a research on machine learning model for prediction of anxiety and depression. Lana G. Tennenhousea and *et al.* [17] did a study on machine-learning models for depression and anxiety in individuals with immune-mediated inflammatory disease. They used Patient-reorted out-come measures (PROMs) to predict anxiety and depression of an individual with immune-mediated inflammatory disease (IMID) using machine learning. They collected 637 data to train the machine, logistic regression (LR), neural network (NN), and random forest (RF) technique was used. However, their model was designed anxiety and depression caused by deregulation of the immune system.

Anu priyaa and *et al.* designed a model that predicting anxiety, depression and stress in modern life using machine

Anxiety

- I feel tense or 'wound up'?
- I get a sort of frightened feeling as if something awful is about to happen?
- Worrying thoughts go through my mind?
- I can sit at ease and feel relaxed?
- I get a sort of frightened feeling like 'butterflies' in the stomach?
- I feel restless as I have to be on the move?
- I get sudden feelings of panic?

Depression

- I still enjoy the things I used to enjoy?
- I can laugh and see the funny side of things?
- I feel cheerful?
- I feel as if I am slowed down?
- I have lost interest in my appearance?
- I look forward with enjoyment to things?
- I can enjoy a good book or radio or TV program?

The expected answer and score point for each question in the questioner for Anxiety and depression is shown below in Table 1[18].

Table 1. Anxiety and depression questioner answer and score.

Anxiety		Depression	
Answer	Score	Answer	Score
Very definitely and quite badly	3	Not at all	0
Yes, but not too badly	2	Sometimes	1
A little, but it doesn't worry me	1	Very often	2
Not at all	0	Nearly all the time	3

The collected data for Anxiety and depression score level of individual was categorized as normal, mild, severe and moderate using HADS technique [18]. The four categories such as normal, mild, severe and moderate are coded using decimal numbers as 1, 2, 3 and 4 respectively and these used for training in the neural network. In Figure 1 the questioner collected from each person is coded from *p1-Ans* to *p1607-Ans* and the questions are coded horizontally with their respective answer score vertically.

	B	C	D	E	F	G	H	I		B	C	D	E	F	G	H	I
3		Anxi- q1	Anxi- q2	Anxi- q3	Anxi- q4	Anxi- q5	Anxi- q6	Anxi- q7	3		Depr- q1	Depr- q2	Depr- q3	Depr- q4	Depr- q5	Depr- q6	Depr- q7
4	p1-Ans	3	0	3	3	0	0	3	4	p1-Ans	2	3	2	1	1	3	3
5	p2-Ans	1	3	2	0	2	1	3	5	p2-Ans	1	2	2	3	1	2	1
6	p3-Ans	0	2	1	1	0	3	0	6	p3-Ans	0	2	1	2	1	2	3
7	p4-Ans	1	1	3	0	1	2	1	7	p4-Ans	1	3	3	3	0	2	2
8	p5-Ans	3	3	3	0	2	2	1	8	p5-Ans	0	2	0	2	1	2	2
9	p6-Ans	2	1	1	2	3	1	1	9	p6-Ans	1	0	2	0	3	0	2
10	p7-Ans	0	3	1	1	1	3	1	10	p7-Ans	2	2	1	3	1	1	1
11	p8-Ans	3	3	2	1	2	1	1	11	p8-Ans	3	1	2	3	3	0	1
12	p9-Ans	3	1	1	1	2	1	3	12	p9-Ans	1	1	0	2	2	3	2
13	p10-Ans	0	0	3	0	0	0	0	13	p10-Ans	0	1	0	1	1	2	1
14	p11-Ans	0	3	2	0	0	3	2	14	p11-Ans	2	1	3	2	3	0	0
15	p12-Ans	0	3	1	1	3	3	3	15	p12-Ans	3	3	0	1	2	0	3
16	p13-Ans	2	2	0	2	1	2	2	16	p13-Ans	0	0	0	0	0	1	1
17	p14-Ans	3	2	2	3	0	2	2	17	p14-Ans	3	2	1	3	0	0	2
18	p15-Ans	3	0	3	3	1	3	0	18	p15-Ans	0	3	3	3	1	3	3
19	p16-Ans	2	2	0	3	1	1	1	19	p16-Ans	2	1	1	2	2	3	3
20	p17-Ans	0	1	3	3	3	3	0	20	p17-Ans	2	3	1	2	0	0	1
21	p18-Ans	3	1	0	0	1	2	2	21	p18-Ans	0	2	3	2	1	3	0
									22	p19-Ans	3	2	1	0	1	1	0
									23	p20-Ans	2	0	1	1	1	3	0

(a) Anxiety

(b) Depression

Figure 1: Anxiety and Depression collected questioner answer of an individual

2.2 Experiment

MatLab programming language was used to train and test the model generated. It is a High-level language for technical computing and interactive environment used to perform computationally intensive tasks faster than other traditional programming languages like c and c++ [19]. The network is created to recognize the Pattern using feedforward networks that can be trained to classify inputs (each score/answer of the questions shown in Figure 1) according to target classes (anxiety and depression class calculated using HADS). With the help of pattern network 20 hidden layers are used as shown in neural network design Figure 2 below.

2.3 Dividing Data

In multilayer networks training, the 712 data is divided into three subsets as training, validation and testing sets. In the first subset, among all data 70% is used for training, which is used for computing the gradient and updating the network weights and biases. The second subset is the validation set and here we used 15% of all data. The third subset is testing and similarly with the validation 15% of all data is used.

2.4 Training Neural Network

The multilayer feed forward network can be trained for function approximation pattern recognition [20]. In implementing the training there are two modes such as incremental mode and batch mode. In incremental mode, the gradient is calculated and the weights are updated after every single input is applied to the network. In batch mode, before the weights are updated all the inputs in the training set are applied to the network. In using the Neural Network Toolbox software, batch training is significantly faster and produces smaller errors than incremental training in most problems [21].

The Scaled Conjugate Gradient algorithm is used by default by pattern recognition. The network is trained using Scaled conjugate gradient back propagation algorithm using the input, target and the created network parameters. There are 7 inputs and 1 output for both anxiety and depression training as shown in Figure 2 below. The training was stopped at epoch 54, it takes 0.22 seconds long, with the performance 0.664, at 1.29 performance gradient and with 6 validation performance.

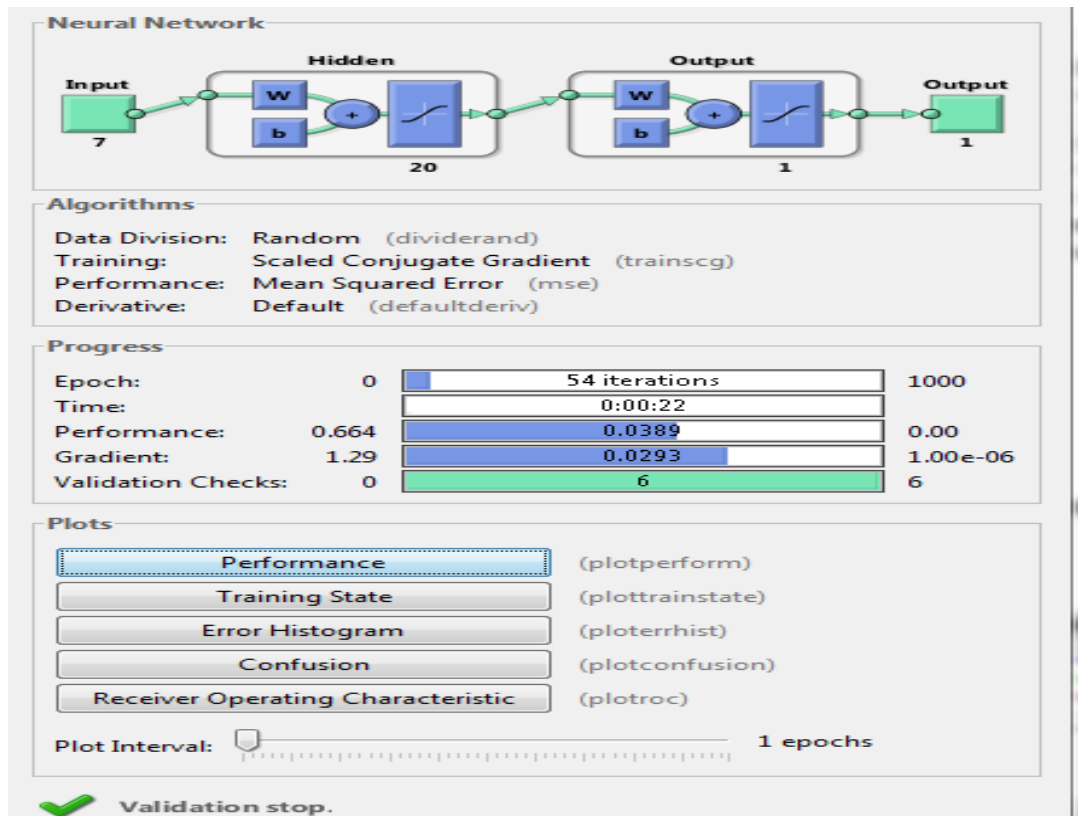


Figure 2: The design of Artificial Neural Network

2.5 Training performance validation and testing

The training performance shows the final mean square error is small at epoch 54 as shown in Figure 3. In the figure the validation and test set error have similar characteristics and it achieves the best validation performance 0.049968 at iteration 48 and no significant over fitting occurred at iteration 48.

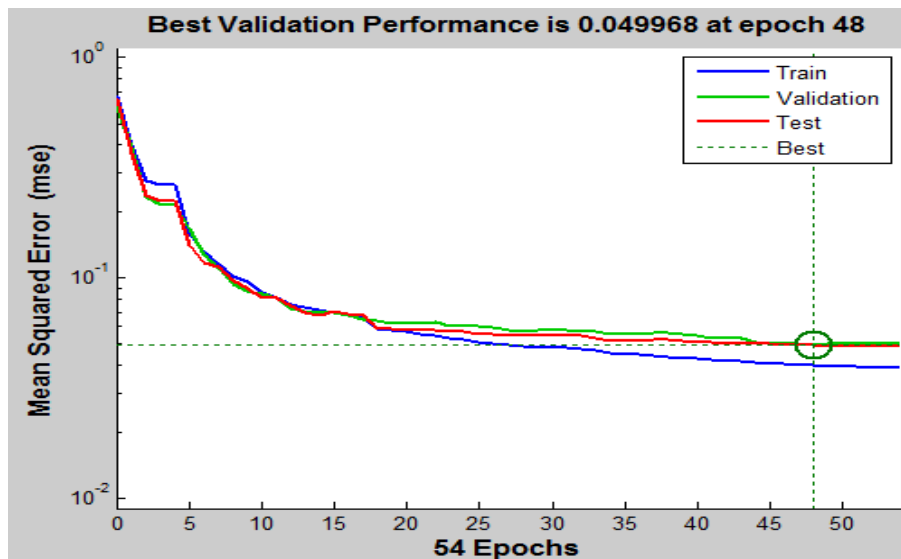


Figure 3. Training performance validation and testing

III. RESULTS AND DISCUSSIONS

The accuracy result of the model is compared with the manually calculated value by hospital anxiety and depression score. The anxiety and depression error rate measured in absolute percentage value (APV) of 0.017379846 and 0.018365 respectively. Moreover the sensitivity is calculated for anxiety and depression using APV as 0.926666667 and 0.945205479 respectively, the specificity of the anxiety and depression is 0.997940975 and 0.996577687 respectively.

Table 2: Result of the designed model of an anxiety and depression

		True Class(Anxiety and depression) using HADS						
		Class	Precision	Sensitivity	Specificity	F1-score	Accuracy	Error Rate
Predicted class using ANN	Anxiety	Normal	0.995271868	0.976798144	0.994630872	0.985948	0.985065	0.014934661
		Mild	0.916363636	0.984375	0.95481336	0.949153	0.964706	0.035294118
		Moderate	0.968023256	0.982300885	0.991324921	0.97511	0.989421	0.010578718
		Severe	0.978873239	0.926666667	0.997940975	0.952055	0.991288	0.008711886
	APV		0.964633	0.967535174	0.984677532	0.9655665	0.98262	0.017379846
	Depression	Normal	0.985176739	0.998843931	0.982479784	0.991963	0.991288	0.008711886
		Mild	0.964705882	0.917910448	0.981052632	0.940727	0.958277	0.041722746
		Moderate	0.957831325	0.969512195	0.989053948	0.963636	0.985065	0.014934661
		Severe	0.965034965	0.945205479	0.996577687	0.955017	0.99191	0.008089608
	APV		0.968187	0.957868	0.987291	0.962836	0.981635	0.018365

IV. CONCLUSION

In this study, our main finding shows neural network model for prediction of anxiety and depression caused by COVID -19 lockdown in Ethiopia was designed and gives us a good result. During the model generation we collected 713 data using online survey in Ethiopia and in answering the questioner employed, unemployed, student, female male and age between 16 up to 55 was participated. Based on the standard HADS, 7 question used form both anxiety and depression. In the experiment, feedforward neural network was used and it achieves a best accuracy of 0.049968 at iteration 54. The overall result of specificity and sensitivity in detection of Anxiety was 0.997940975 and 0.926666667 respectively and the overall specificity and sensitivity result of depression was 0.996577687 and 0.945205479 respectively. The result of the neural network model was compared with the ground truth value calculated manually using HADS and the average percentage error of the model in anxiety and depression detection is 0.017379846 and 0.018365 respectively. In the future we will further consider attributes like age, income level and gender in generating the model.

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