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ANN for Parkinson's Disease Prediction

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***Abstract**: Parkinson's Disease (PD) is a long-term degenerative disorder of the central nervous system that mainly affects the motor system. The symptoms generally come on slowly over time. Early in the disease, the most obvious are shaking, rigidity, slowness of movement, and difficulty with walking. Doctors do not know what causes it and finds difficulty in early diagnosing the presence of Parkinson's disease. An artificial neural network system with back propagation algorithm is presented in this paper for helping doctors in identifying PD. Previous research with regards to predict the presence of the PD has shown accuracy rates up to 93% [1]; however, accuracy of prediction for small classes is reduced. The proposed design of the neural network system causes a significant increase of robustness. It is also has shown that networks recognition rates reached 100%.*

Keywords: Parkinson's disease, Artificial Neural Network, Prediction

1. INTRODUCTION

Parkinson's disease is a lasting worsening syndrome of the central nervous system that mostly smidgeons the motor system [1].The symptoms normally come on gradually over time[1]. In the early stage of the disease, the most obvious are shaking, inflexibility, leisureliness of movement, and trouble with walking [1]. Thinking and behavioral problems might similarly happen [2]. Dementia turns out to be common in the progressive stages of the disease [2]. Depression and anxiety are also common, happening in more than a third of people with PD [2]. Other symptoms comprise sensory, sleep, and emotional difficulties [1]. The crucial motor symptoms are together called "parkinsonism" or a "parkinsonian syndrome" [3].

The cause of Parkinson's disease is normally unknown, but believed to include mutually genetic and environmental factors [3]. Those with a family member pretentious are further likely to acquire the disease themselves [3]. There is also a bigger risk in people exposed to specific pesticides and amongst those who have had previous head damages, while there is a abridged risk in tobacco smokers and those who consume coffee or tea [3]. The motor symptoms of the disease outcome from the death of cells in the substantia nigra, a region of the midbrain[1]. This results in not sufficiently dopamine in these areas[1]. The reason for this cell death is not understood, but includes the build-up of proteinsinto Lewy bodies in the neurons [3]. Diagnosis of distinctive cases is mostly based on symptoms, with examinations such as neuroimaging being used to exclude other diseases[1].

There is no treatment for Parkinson's disease, with treatment directed at improving symptoms [1]. Initial treatment is naturally with the antiparkinson medication levodopa (L-DOPA), with dopamine agonists being used once levodopa becomes less effective [2]. As the disease growth and neurons continue to be lost, these medications turn out to be less in effect while at the same time they create a difficulty marked by instinctive writhing movements [2].Diet and some forms of rehabilitation have exposed some efficiency at refining symptoms [5]. Surgery to place microelectrodes for deep brain stimulation has been used to decrease motor symptoms in severe cases where drugs are ineffective[1]. Indication for treatments for the non-movement-related symptoms of PD, such as sleep disturbances and emotional problems, is less robust [3].

In 2015, PD pretentious 6.2 million people and caused in about 117,400 deaths worldwide [4]. Parkinson's disease naturally occurs in people over the age of 60, of which about 1% are affected [1]. Males are more frequently affected than females at a ratio of around three to two [3]. When PD is seen in people before the age of fifty, it is so-called young-onset PD [6]. The normal life expectancy after diagnosis is between seven and fourteen years [2].The disease is called after the English doctor James Parkinson, who published the first detailed description in An Essay on the Shaking Palsy, in 1817 [7]. Public consciousness campaigns consist of World Parkinson's Day (on the birthday of James Parkinson, 11 April) and the use of a red tulip as the symbol of the disease [8]. People with Parkinson's who have improved the public's awareness of the condition include actor Michael J. Fox, Olympic cyclist Davis Phinney, and late professional boxer Muhammad Ali [9].

2. THE ARTIFICIAL NEURAL NETWORKS

Artificial neural networks (ANN) or connectionist systems are computing systems vaguely enthused by the biological neural networks that constitute human brains [10]. The neural network is a framework for many different machine learning algorithms to work together and process compound inputs [11]. This type of a system learns to do tasks by examples, normally without being programmed with any task-explicit rules. For example, in image recognition, it may learns to recognize images that contain dogs by considering example images that have been manually labeled as "dog" or "no dog" and using the outputs to recognize dogs in

other images. It does this without any previous knowledge about dogs, for example, that they have tails and dog-like faces. Instead, they automatically produce recognizing characteristics from the learned material that it processes.

An ANN is established on a group of connected nodes called artificial neurons, which roughly model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transfer a signal from one artificial neuron to another. An artificial neuron that gets a signal can do some work on it and then signal further artificial neurons linked to it.

In ANN implementations, the signal at a connection among artificial neurons is a actual number, and the output of each artificial neuron is calculated by a certain non-linear function of the summation of its inputs. The connections among artificial neurons are named 'edges'. Artificial neurons and edges characteristically have a weight that fine-tunes as learning continues. The weight may upsurges or declines the strength of the signal at a connection. Artificial neurons usually have a threshold such that the signal is only referred if the collective signal crosses that threshold. Naturally, artificial neurons are grouped into layers. Layers can perform different types of transformations on the inputs they receive. Signals travel from the input layer (first layer), to the output layer (last layer), perhaps after traversing the layers several times.

The initial goal of the ANN method was to crack problems in the same way a human brain would. But, over time, consideration moved to performing explicit tasks, leading to aberrations from biology. Artificial neural networks have been used on a range of tasks, counting machine translation, computer vision, social network filtering, speech recognition, playing video games, and medical diagnosis.

A main trigger for improved interest in neural networks and learning was Werbos's (1975) back-propagation algorithm that efficiently solved the XOR problem by making the training of multi-layer networks possible and effective. Backpropagation dispersed the error term back up through the layers, by adjusting the weights at each node [12].

In the 1980s, parallel distributed processing turn out to be popular under the name connectionism. Rumelhart and McClelland in 1986 clearly described the use of connectionism to mimic neural processes [13].

Support vector machines and other, much modest methods such as linear classifiers slowly overtook neural networks in machine learning fame. But, using neural networks transmuted some domains, such as the prediction of protein structures [14].

In 1992, max-pooling was presented to help with least shift invariance and tolerance to deformation to aid in 3D object recognition [15]. In 2010, Backpropagation training through max-pooling was accelerated by GPUs and shown to perform better than other pooling variants [16].

The vanishing gradient problem affects many-layered feedforward networks that use backpropagation and also Recurrent Artificial Neural Networks (RANNs) [17]. As errors spread from layer to layer, they shrink exponentially with the number of layers, obstructing the tuning of neuron weights that is based on those errors, mainly affecting deep networks.

To solve this problem, Schmidhuber embraced a multi-level hierarchy of networks (1992) pre-trained one level at any time by unsupervised learning and adjusted by backpropagation [18]. Behnke (2003) depend on only on the sign of the gradient (Rprop)[19] on problems such as image rebuilding and face localization.

Hinton et al. (2006) proposed learning a high-level representation using successive layers of binary or real-valued latent variables with a controlled Boltzmann machine [19] to model each layer. Once adequately many layers have been learned, the deep architecture may be used as a reproductive model by reproducing the data when sampling down the model (an "ancestral pass") from the top level feature activations [20]. In 2012, Ng and Dean shaped a network that learned to identify higher-level concepts, such as dogs, only from viewing unlabeled images taken from YouTube videos [21].

Former challenges in training deep neural networks were positively addressed with methods such as unsupervised pre training, while existing computing power increased through the use of GPUs and distributed computing. Neural networks were set up on a large scale, mostly in image and visual recognition problems. This became known as "deep learning".

3. METHODOLOGY:

3.1 The dataset of Parkinson's disease

The data used in this research is a voice recording originally done at University of Oxford by M.A. Little [2]. Furthermore, a detailed presentation was made on the specificities of the recording equipment as well as in what environment the experiment was carried out. The data consists of 195 recordings extracted from 31 people whom 23 are suffering from Parkinson's disease. The time since first diagnosis of Parkinson's disease was done 0 to 28 years ago and the age of the subjects ranged from 46 to 85 years and a total of 6 vocal sounds were recorded from each subject.

3.2 The Input Variables

The input variables selected are those which can easily be obtained from previous research. The input variables are as in Little et. al [22] where the exact computations of each measurement is described.

Table 1: the input variables

1	MDVP:Flo(Hz)	Average vocal fundamental frequency
2	MDVP:Jitter(%)	measures of variation in fundamental frequency
3	MDVP: Jitter(Abs)	measures of variation in fundamental frequency
4	MDVP: RAP	measures of variation in fundamental frequency
5	MDVP: PPQ	measures of variation in fundamental frequency
6	Jitter: DDP	Several measures of variation in fundamental frequency
7	MDVP: Shimmer	Several measures of variation in amplitude
8	MDVP: Shimmer(dB)	Several measures of variation in amplitude
9	Shimmer:APQ3	Several measures of variation in amplitude
10	Shimmer:APQ5	Several measures of variation in amplitude
11	MDVP:APQ	Several measures of variation in amplitude
12	Shimmer: DDA	Several measures of variation in amplitude
13	NHR	first measures of ratio of noise to tonal components in the voice
14	HNR	second measures of ratio of noise to tonal components in the voice
15	RPDE	First nonlinear dynamical complexity measure
16	DFA	Signal fractal scaling exponent
17	spread1	First nonlinear measure of fundamental frequency variation
18	spread2	Second nonlinear measure of fundamental frequency variation
19	D2	Second nonlinear dynamical complexity measure
21	PPE	Third nonlinear measure of fundamental frequency variation

3.3 The output Variable

Table 2 shows the output variable and its meaning.

Table 2: The output variable

S.n.	Variable	meaning
1	Status	Health status of the subject (1) - Parkinson's, (0) - healthy

3.4 Evaluation and analysis

We have 195 samples in the dataset. We divide it into 170 training sample and 25 validating sample then we imported the dataset in Just Neural Network (JNN) environment (as shown in Figure 1). We then trained, validated the ANN model (as seen in Figure 2). We found the most important attributes contributing to the ANN model as shown in Figure 3. The detail of ANN model is shown in Figure 4. The accuracy of the ANN model was 100%.

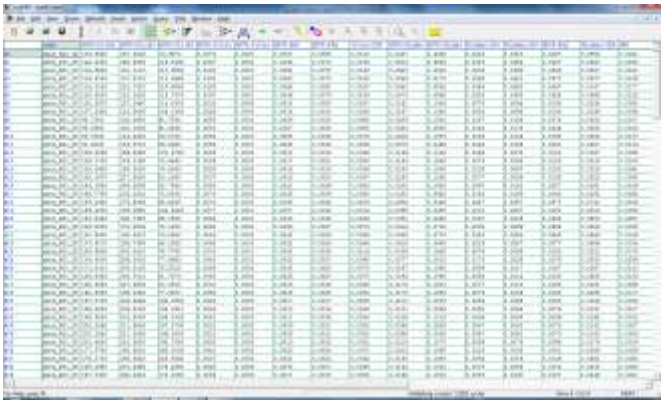

Figure 1: Imported the data set in JNN environment

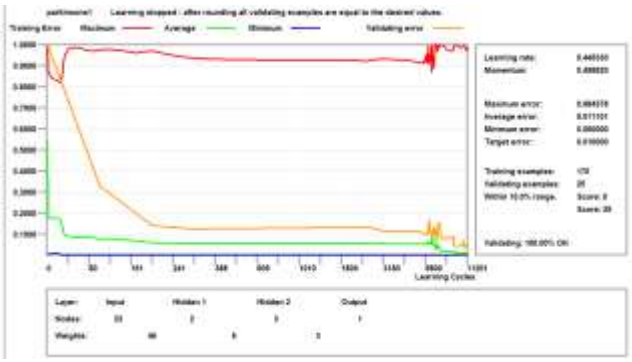

Figure 2: Training and validating of the ANN model in JNN environment

parkinsons1 11201 cycles. Target error 0.0100 Average training error 0.011101

The first 23 of 23 Inputs in descending order.

Column	Input Name	Importance
22	PPE	26.3195
17	RPDE	24.2531
19	spread1	24.0959
20	spread2	22.2432
12	Shimmer:APQ5	22.1033
1	MDVP:Fo(Hz)	20.4615
18	DFA	19.7158
0	name	16.5601
2	MDVP:Fhi(Hz)	15.1029
16	HNR	11.3190
21	D2	11.2267
7	MDVP:PPQ	11.1821
4	MDVP:Jitter(%)	9.9519
5	MDVP:Jitter(Abs)	9.8071
13	MDVP:APQ	9.1635
15	NHR	6.0074
11	Shimmer:APQ3	5.1437
14	Shimmer:DDA	5.1209
8	Jitter:DDP	4.6969
6	MDVP:RAP	4.6792
9	MDVP:Shimmer	4.0461
10	MDVP:Shimmer(dB)	3.2278
3	MDVP:Flo(Hz)	0.5247

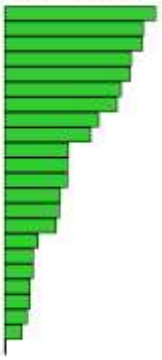

Figure 3: Most important attributes of the ANN model

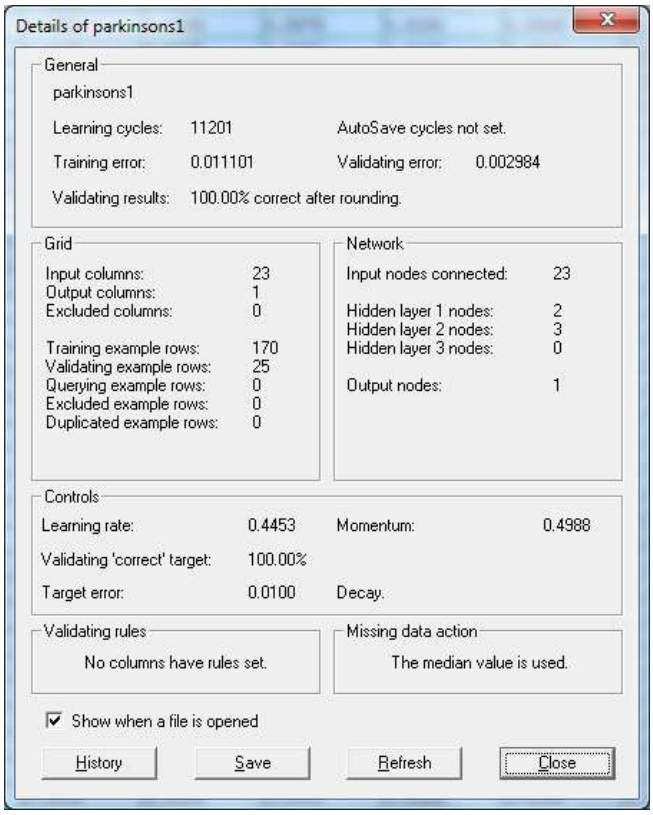

Figure 4: Details of the ANN model

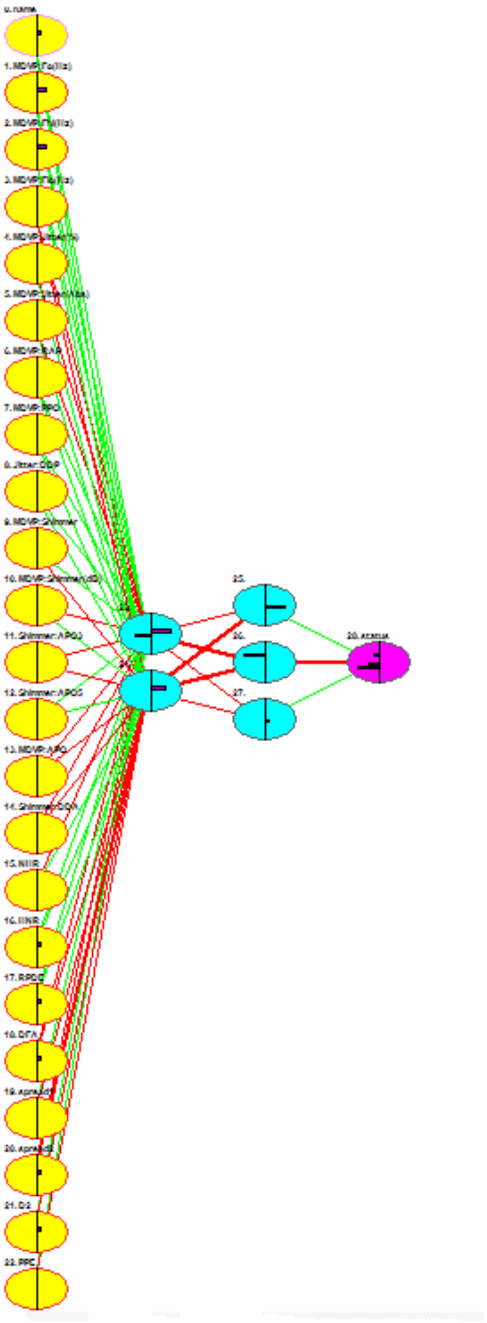

Figure 5: Architecture of the ANN model

4. CONCLUSION

Parkinson's disease is a long-term degenerative disorder of the central nervous system that mainly affects the motor system. The symptoms generally come on slowly over time. An ANN model was presented for Parkinson's disease prediction to help specialist in the field. The accuracy we got is 100%.

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