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Parkinson's Disease Detection And Classification Using Machine Learning And Deep Learning Algorithms– A Survey

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Abstract: *Parkinson's Disease Is A Neurodegenerative Ailment Which Influences Dopamine-Creating Neurons In Substantia Nigra, A Section Of The Brain. This Progressively Causes The Patients To Experience Issues In Talking, Strolling Or Finishing Other Basic Functions. The Recognition, Checking And Analysis Of Parkinson's Disease Have Been Enormously Affected By Speech Processing And Artificial Intelligence Strategies. Machine Learning And Deep Learning Algorithms Have Been Utilized Generally In The Determination Of Parkinson's Disease. Different Techniques That Are Utilized As A Part Of The Discovery, Grouping And Diagnosis Of Parkinson's Disease Have Been Contemplated In This Paper. The Features Extracted From The Voice Samples Of Patients Are Tested Utilizing Different Classification Models. The Significant Classification Models That Are Effectively Utilized Are Convolutional Neural Network (CNN), Support Vector Machine (SVM) And Artificial Neural Network (ANN). This Has Incredible Potential In Assisting The Doctors Amid Examination And Expanding The Medicinal Services Offices In The Territories Where Powerful Diagnosis Is Troublesome.*
Keywords:*Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Parkinson's Disease(PD), Support Vector Machine (SVM)*

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I. INTRODUCTION

Parkinson's Disease (PD) That Impacts The Nerve Cells In The Cerebrum That Make Dopamine Shows Signs Including Muscle Firmness, Tremors, And Changes In Step And Discourse. Parkinson's Disease Impacts A Man's Voice, Influencing Them To Whisper Or Have Shivering In Talk. PD Is Only Second To Alzheimer's Disease In Neurodegenerative Illness. It Is Expected To Increase In The Coming Years Therefore It Is Necessary To Develop Detection Systems For Practical Analysis And Timely Treatment. As The Signs Of PD Happen Well-Ordered And For The Most Part, The Elderly Observing The Sickness Using Estimations Of Dysphonia Has A Vital Part In Analysis. The Classification Algorithms From Machine Learning And Deep Learning Are Used To Predict And Investigate The Parkinson's Disease. The Ideal Features From The Dataset Are Passed As Input To The Models And The Prediction Results Are Obtained. The Prediction Performance Can Be Validated From The Accuracy Obtained Through The Classification Algorithm. The Determination Of Parkinson's Disease Has Progressively Enhanced The Accuracy Parameter Through The Various Algorithms.

II. PARKINSON'S DISEASE

Parkinson's Illness Is An Incessant Dynamic Neurodegenerative, Portrayed By The Nearness Of Transcendently Motor Symptomatology (Bradykinesia, Rest Tremor, Inflexibility, And Postural Aggravations). It Is Likewise Connected With A Decent Variety Of Non-Motor Side Effects, Which, Together With Late-Beginning Motor Indications, (For Example, Postural Precariousness And Falls, Solidifying Of Step, Speech And Gulping Troubles), Are The Most Troublesome Difficulties The Treating Doctor Is Looked With When Managing Patients With A Long Span Of The Disease. In Expansion To The Motor Symptomatology Of PD[1], Some Non-Engine Manifestations, For Example, Hyposmia, Fast Eye Developments, Rest Conduct Issue, Identity Changes, Torment And Paresthesias Might Be Present And May Even Show Before The Motor Symptoms[2].

Parkinson's Disease Is An Ubiquitous Issue, With An Unrefined Occurrence Rate Of 4.5– 19 For Every 100 000 People For Each Year. As This Is An Unending Disorder With A Delayed Course, Pervasiveness Is Substantially Higher Than Frequency. Raw Pervasiveness Fluctuate From 18 For Every 100 000 People In A Populace Study In Shanghai, China, To 328 For Each 100 000 In A Door-To-Door Study Of The Parsi People Group In Mumbai, India. The Dominant Part Of Studies Announcing General Rough Pervasiveness (Counting

Guys And Females Over The Whole Age Run) Fall In The Vicinity Of 100 And 200 For Each 100 000 Persons[3].

III. LITERATURE REVIEW

a. Using Machine Learning Algorithms

R. Arefi Shirvan.Et Al[4] Proposed A System For Detect PD. The Data Classification Was Done Using Knn Method. Simplest Method In Grouping The Similarity Is KNN. Among Classification Method KNN Is Used Whenever The Facts For Data Distribution Are Not Enough [5]. In This Method It Has Two Parts: A) Determine K Close Neighbors, B) Determining Class Type Using These Close Neighbors. It Was Shown That A 93.7% Of Accuracy Per 4 Optimized Features, An Accuracy Of 94.8% Per 7 Optimized Features And 98.2% Accuracy For 9 Optimized Features Is Achieved Which Is A Remarkable Result Compared To Other Studies. In This Research Data From [6] From UCI Repository Is Used. The Data Include 192 Voice Sample Recordings From 32 Male And Female. Each Subject Has Had 6 Voice Signal Recordings. 23 People Suffer From PD And The Rest Are Healthy. People Were About 46-85 Years Old Themain Disadvantage Of The KNN algorithm Is That It Is A Lazy Learner, I.E. Classification Is Done By Using Training Data And From The Training Data It Doesn't Learn Anything.

Mohammad S Islam.Et Al [7] Conducted A Comparative Analysis To Detect Parkinson's Disease Using Various Classifiers. Support Vector Machine (SVM), Feedforward Back-Propagation Based Artificial Neural Network (FBANN) And Random Tree (RT) Classifiers Were Used And A Comparison Between Them Is Made To Differentiate Between PD And Healthy Patients. The Study Has Utilized The UCI Machine Learning Repository From [8],[9]. The Dataset Consists Of 195 Voice Samples From 31 Individuals Comprising Of Both Males And Females. From The Taken Subjects 23 Were Determined With PD And 8 Were Healthy. To Improve The Classification Accuracy With Minimal Error Rate A 10-Fold Cross Validation Which Was Repeated 100 Times Has Been Implemented For All The Three Classifiers. The FBANN Classifier Has Achieved A 97.37% Recognition Accuracy Thus Outperforming The Other Two Classifiers.

Dr. R. Geetha Ramani.Et Al [10] Has Proposed A System To Classify PD And Non-PD Patients By The Following Methods Binary Logistic Regression, Linear Discriminant Analysis (LDA), Partial Least Square Regression (PLS) , Random Tree (Rnd Tree) And Support Vector Machine (SVM). The Dataset Is The Parkinson's Disease Data Acquired From The UCI Repository. The Training Dataset Comprises Of 197 Samples With 22 Features Extracted From The Patients. Fisher Filtering Feature Selection Algorithm Was Found To Be An Effective Feature Ranking System. The Rnd Tree Algorithm Achieved 100% Classification Accuracy While The Lda, C4.5, Cs-Mc4 And K-Nn Yielded Accuracy Results Greater Than 90%. Among All, The C-Pls Algorithm Achieved The Least Accuracy Of 69.74%.

The Multi-Layer Perceptron (MLP) With Back-Propagation Learning Algorithm Is Used By Anchana khemphila Et Al. [11], Et Al To Effectively Classify And Diagnosis PD. The Study Has Utilized The UCI Machine Learning Repository's[8],[12] Parkinson's Disease Dataset. Experiments Were Done And Information Gain Was Calculated Using Weka 3.6.6 Tool. They Used Information Gain To filter Features And Hence Need Not Be Taken From Patients. To Calculate Information Gain, The Input Must Be Discrete Numbers. Because Continuous Real Numbers Were Used In The Experiment, The Range Of Values Was Partitioned To Obtain Discretization. The Accuracy Obtained In The Training Data Set Is 91.453% And The Validation Data Set Is 80.769% By Utilizing The Main Model.

Carmen Camara.Et Al [13] Proposed A New Method For Stimulation, Detection Of Tremor Is Based On The Subtype Of Tremor The Patient Has. Electrophysiology Is The Study Of Electrical Activity The Body [14],[15]. Extracellular Physiology Is The Best Method To Detect The Neurons. Measure The Electrical Potential With Microelectrodes. The Signal Is Filtered And The Lfp Signal Is Represented. The Dataset Diagnosed With Tremor-Dominant PD, And Who Underwent Surgery For The Implantation Of A Neurostimulator. Clustering And Detection Are Combined In The Proposed System. Back Propagation Multi-Layer Perceptron Is The Training Algorithm Used. From Their Experimentation And As A Result They Showed The Existence Of Two Subgroups Of Patients Within The Group-1 Of Patients According To The Consensus Statement Of The Movement Disorder Society On Tremor [16].

Resul Das .Et Al [17] Used Various Classification Methods For Identifying PD. Four Different Classification Techniques Were Implemented And Analyzed And They Are Dmneural, Neural Networks, Regression, And Decision Tree Respectively . Various Evaluation Methods Were Used For Calculating The Performance Of The Classifiers. After Evaluation From The Results, The Neural Networks Classifier Yielded The Best Results. The Input Dataset Was Randomly Partitioned Into Train And Test Dataset. 65% Of The Input Dataset Was Used For Training And The Rest Of The Data-Set Was Used For Testing. The Adjustable Parameters Of Each Classifier Were Tuned. For The Neural Networks Classifier, The BPNN Algorithm Has Been Used In The Feed-Forward, Single Hidden Layer Neural Network. The Algorithm Used In The Study Is The Levenberg– Marquardt (Lm) Algorithms. The Neural Network Has 92.9% Accuracy.

David Gil A.Et Al[18] Proposed Methods Based On ANNs And SVMs To Aid The Specialist In The Diagnosis Of PD. The Parkinson Database Is Taken From The UCI Machine Learning Repository[8]. It Was Used For Training And Testing Experiments. The SVM Produces Better Results Than The MLP. The SVM Shows A High Accuracy Of Around 90%. Other Parameters That Reach Very High Accuracy Are "Sensitivity" And "Negative Predictive Value" With Accuracy Values Of 99.32% And 97.06% Respectively.

C. Okan Saka.Et Al [19] Used Support Vector Machine For Building A Classification Model And A Cross Validation Scheme That Is Called Leave-One-Individual-Out Is Used For Testing. This Scheme Fits With The Dataset Better Than The Traditional Bootstrapping Methods. Parkinson'sdataset Consists Of 195 Voice Samples From 31 Individuals Comprising Of Both Males And Females. From The Taken Subjects 23 Were Determined With PD And 8 Were Healthy. The Dataset Was Taken From UCI Machine-Learning Repository [8]. They Optimized The SVM Parameters As Suggested By The Work In [20], [21] So As To Build An SVM Model Capable Of Achieving Their Reported Results Of 91% With Only 4 Features And 90% With A Greater Set Consisting Of 10 Features.

In This Paper Ipsita Bhattacharya.Et Al [22] Used A Data Mining Tool, Weka, They Pre-Processed The Dataset On Which They Have Worked And Then Using One Of The Classification Methods I.E. Support Vector Machine Method (SVM), They Distinguished People With Parkinson'S Disease From The Healthy People. Appling Libsvm They Have Tried To Find The Best Possible Accuracy On Different Kernel Values For The Given Dataset. They Have Downloaded The Dataset From [10], Where 197 Voice Recording Samples Are There Of 31 People From Which 23 Are Having The Parkinson Disease. On Changing The Split Ratio And Repeating The Test They Achieved Better Result. On The Random Split Of Dataset, They Concluded That The Best Accuracy Achieved Was 65.2174%.

Zahari Abu Bakar.Et Al [23] Conducted Analysis Based On Two Algorithms. They Are Levenberg-Marquardt (Lm) And Scg Of Multilayer Perceptrons (MLPs) Neural Network In Detecting PD. The Dataset For This Project Has Been Taken Form The PD Data Set. It Is Also Observed That The Best Training Accuracy And Testing Accuracy For Lm Algorithm Occurred At Hidden Unit Of 25 As Compared To Other Hidden Units With 97.86% For Training Phase And 92.96% For Testing Stage. Lm Performed Well With Classification Accuracy Of 92.95% While Scg Obtained 78.21% Accuracy.

Uma Rani K.Et Al [24] Used Two Types Of ANN For Classification, The Multilayer Perceptron (MLP) Network And Radial Basis Function (RBF) Network. 112 Phonations Were Used To Train The Network And 24 Phonations For Testing. The RBF Network Gave A Better Classification With 90.12% For Training Set And 87.5% For Test Set Compared To MLP With 86.66% For Training Set And 83.33% For Test Set.

Athanasios Tsanas.Et Al [25] Adopted Four Algorithms For Feature Selection To Diagnose PD. They Computed 132 Dysphonia Measures From Sustained Vowels. Then, Four Subsets Of These Dysphonia Measures Which Are Parsimonious Are Selected Using The Feature Selection Algorithms. These Subsets Are Mapped To A Binary Classification Response Using Two Statistical Classifiers: Random Forests And Support Vector Machines. The NCVS Database Comprises Of 263 Phonations From 43 Subjects (17 Females And 26 Males; 10 Healthy Individuals And 33 PWP), An Extension Of The Database Used In [25] Is Used In The Paper. It Gives 99% Overall Classification Accuracy Using Just Ten Dysphonia Features.

b. Using Deep Learning Algorithms

Alex Frid Et.Al [26] Have Proposed A Convolutional Neural Network (CNN) For Speech Signal Processing Using One-Dimension For Parkinson's Disease. The Dataset Has Been Acquired From [27], [28], [29] And [30]. During The Training Phase, The Entire Recording Is Processed And Windowing Is Applied Followed By A Decision Mechanism. The Binary Classification Between Healthy And Other Stages Of Parkinson's Disease Results At The Window Level Indicates A Accuracy Of More Than 65% For All The Stages. The Other Binary Classification At The Participant Level Indicates An Accuracy Of More Than 60% Between Subsequent Stages Of Severity Of The Disease.

Ali H. Al-Fatlawi .Et Al [31] Adopted A Deep Belief Network (DBN) Technique To Diagnose The Parkinson's Disease (PD). This Paper Uses Data Retrieved From A Parkinson's Data Set [32], [33] That Are Collected By Max Little Of The University Of Oxford, Who Developed A Tele-Monitoring Device To Record The Speech Signals. [34] Extracted Features Of The 195 Samples Of Voices That Have Been Recorded From 31 People. In This Paper, DBN is Used To Classify The PD Which Composes Of Two Stacked Restricted Boltzmann machines (RBMs) And One Output Layer. Two Stages Of Learning Is Needed To Optimize The Networks' Parameters. The First Stage Is Unsupervised Learning Which Uses RBMs To Overcome The Problem That Can Cause Because Of The Random Value Of The Initial Weights. Next, Backpropagation Algorithm Is Used As A Supervised Learning For The Fine Tuning. The Overall Testing Accuracy Of The Proposed System Is 94% Which Is Better Than Other Methods.

Abdullah Caliskan.Et Al [35] Proposed A System For A Parkinson Disease Detection Using The Speech Modifications, Which Is The Secondary Symptom For PD. This System Uses Deep Neural Network Classifier,

Which Has A Stacked Auto Encoder And A Softmax Classifier. Multiple Simulations Are Performed Over Two Databases To Show The Effectiveness Of The Deep Neural Network Classifier. The DNN Is Compared With The Classical Methods Like The SVM, Nb And Dt Classifiers Over Oxford Parkinson's Disease Detection (Opd)" And "Parkinson Speech Dataset(Psd)" Dataset. From 31 Patients 195 Samples Are Taken Where 23 Traits Are Measured [36], [37]. The Dataset Contains Various Of Sound Samples And 1040 Samples For Training Set And 168 Samples For Testing Set [38]. The Training And Testing Set Of Opd. The Results Show That The Classifier Outperforms The Other Methods In Both Opd And PDs Databases. The Classification Of Various Techniques Is Given In Table 1.

ALGORITHMS

4.1 Support Vector Machine

Support Vector Machine(SVM) Is A Supervised Learning Procedure Valuable When Both The Features And Class Names Are Available In A Dataset. It Constructs A Model To Anticipate Classes For New Cases. The Two Types Of SVM Classifiers Are Linear SVM Classifier And Non-Linear SVM Classifier. In The Linear Model The Data Points, Are Separated By Hyperplane Also Called As Maximum-Margin Hyperplane (As Shown In Figure 1). The Essential Focus While Drawing The Hyper Plane Is To Expand The Separation From The Hyper Plane To The Closest Data Points Of Either Class Known As Support Vectors. To Solve Partition Of Data Into Various Classes, Non-Linear SVM Classifier Is Utilized Employing The Kernels To Hyperplanes. The Information Focuses Are Plotted In A Higher Dimensional Space And Numerous Parts And Some Standard Kernels Include Polynomial Kernel And Radial Basis Function Kernel.

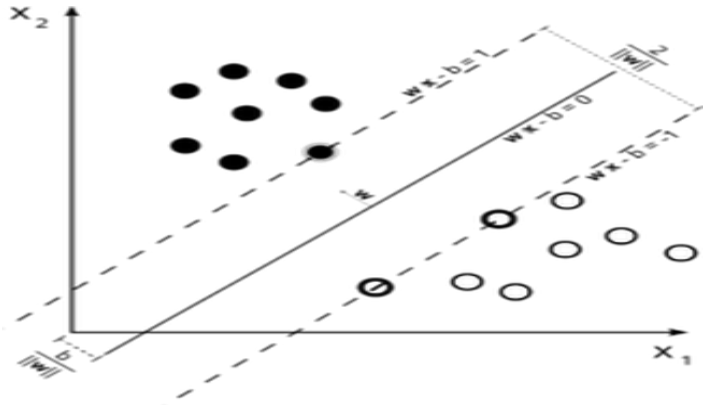

Figure 1.Selecting The SVM Hyperplanes

4.2 Artificial Neural Network:

Animal Brains Consist Of Many Neurons. These Neurons Communicate With Each Other By Sending Pulses From One Neuron To Another. This System Is Applied For Computing In Artificial Neural Networks (ANNs)(As Shown In Figure 2). ANN Is Formed By A Set Of Nodes That Functions Like Biological Neurons Called Artificial Neurons. These Neurons Communicate With Each Other Using Some Signals Which Are Real Numbers. Each Neuron Calculates Its Output By Using A Non-Linear Function On Its Inputs. Weights Are Assigned To Artificial Neurons And To The Connections Between Them. These Weights Are Revised Through A Process Called Learning. The ANN Are Designed So That The Neurons Are Distributed Over Several Layers. Each Layer Processes Its Input Using Different Functions And Passes The Output To The Next Layer.

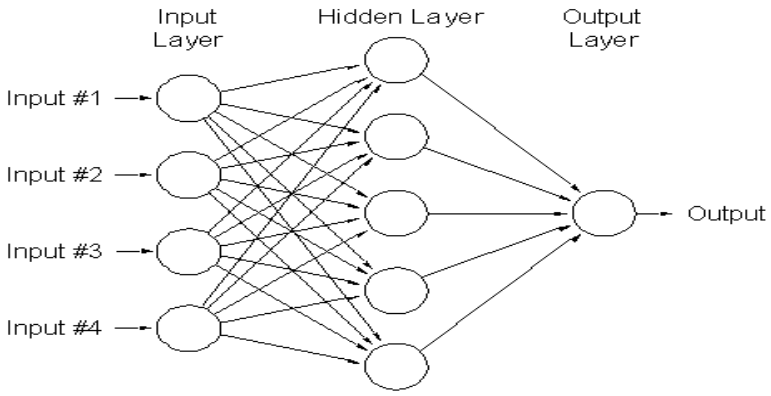

Figure 2. Artificial Neural Network

4.3convolutional Neural Network

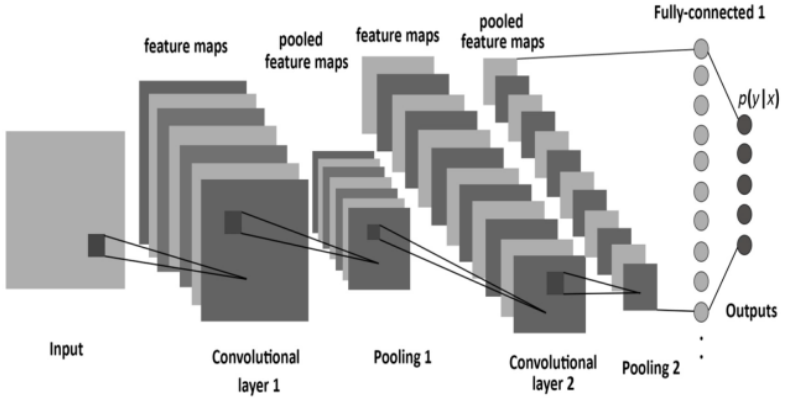

Figure 3. Convolutional Neural Network

A Convolutional Neural Network(CNN) Is A Type Of Deep, Feed Forward Artificial Neural Networks (As Shown In Figure 3). Convolutional Systems Were Motivated By Natural Procedures In That The Correlating Pattern Between Neurons Takes After The Association Of The Animal Visual Cortex. A CNN Comprises Of An Input Layer,An Output Layer, And Different Concealed Layers Like Convolutional Layers, Pooling Layers, Fully Connected Layers And Normalization Layers. Their Activation Functions Can Be Computed With Matrix Multiplication Which Is Followed By A Bias Offset.

TABLE 1. ANALYSIS OF THE TECHNIQUES

Title	Algorithm	Pros	Cons	Accuracy
1.Voice Analysis For Detecting Parkinson's Disease	Knn Algorithm	• This Method Can Be Applied To The Data From Any Distribution • Simple Method • Even Samples Is Large It Can Be Classified Perfectly	• It Is A Lazy Learner • Test Stage Is Expensive.	94.3%
2.Performance Comparison Of Heterogeous Classifiers For Detection Of Parkinsons Disease Using Voice Disorder.	Random Tree (Rt)	• It Runs Best On Large Databases. • Without Variable Deletion It Can Handle More Data Variables.	• It Overfits For Some Datasets With Noisy Regression.	
	Support Vector Machine (SVM)	• It Non-Linear Decision Boundaries Can Be Represented. • They Are Very Robust Against Overfitting.	• SVM's Are Memory Intensive Operation. • Presently Random Forests Are Usually Preferred Over SVM's.	
	Feedforward Back-Propagation Based Artificial Neural Network (Fbann)	• Simple Implementation. • Mathematical Formula Can Be Applied To Any Algorithm. • Computing Time Is Reduced If The Weights Chosen Are Small At The Beginning	• Slow And Inefficient • Outputs Can Be Fuzzy Or Non Numeric	97.37%
3.Parkinson Disease Classification Using Data Mining Algorithms	Binary Logistic Regression	• Outputs Have A Good Interpretation, And The Algorithm. • It Can Be Modified To Avoid Overfitting. • Logistic Models Can Be Updated Easily Using Sgd.	• Logistic Regression Tends Perform Low In Non-Linear Decision Boundaries. • They Are Not Flexible Enough.	

	Random Tree (Rnd Tree),	• It Runs Good On Large Databases. • Without Variable Deletion It Can Handle More Data Variables.	• It Overfits For Noisy Classification.	100%
	Knn	• This Method Can Be Applied To The Data From Any Distribution • Simple Method • Even Samples Is Large It Can Be Classified Perfectly	• It Is A Lazy Learner • Test Stage Is Expensive.	90%
	Partial Least Square Regression (Pls)	• Linear Regression Is Straightforward To Understand And Explain, And Thus Can Be Regularized To Avoid Overfitting. • Linear Models Can Be Updated Using Sgd.	• Linear Regression Performs Poor In Non-Linear Relationships. • They Are Not Flexible . • Tricky And Time-Consuming.	69.4%
	Support Vector Machine (SVM)	• It Non-Linear Decision Boundaries Can Be Represented. • They Are Robust Against Overfitting.	• SVM's Are Memory Intensive. • Presently Random Forests Are Usually Preferred Over SVM's.	
4.Parkinsons Disease Classification Using Neural Network And Feature Selection	The Multi-Layer Perceptron (Mlp)With Back-Propagation Learning.	• Simple Implementation. • Mathematical Formula Can Be Applied To Any Algorithm. • Computing Time Is Reduced If The Weights Chosen Are Small At The Beginning.	• Slow And Inefficient. Outputs Can Be Fuzzy Or Non Numeric	80.697%
5.Resting Tremor Classification And Detection In Parkinson's Disease Patients				83.2%
6.A Comparison Of Multiple Classification Methods For Diagnosis Of Parkinson Disease	Neural Networks	• Can Be Implemented In Any Application. • Can Be Implemented Without Any Problem. • Neural Networks Learns And Does Not Need To Be Reprogrammed.	• It Needs Training To Operate. • Requires High Processing Time For Large Neural Networks.	92.9%
	Regression	• Linear Regression Is Easy To Understand. • It Can Be Modified To Avoid Overfitting. • Llinear Models Can Be Updated Using Sgd.	• Linear Regression Performs Poor In Non-Linear Relationships. • They Are Not Flexible . • Tricky And Time-Consuming.	
	Decision Tree	• Decision Trees Can Understand Non-Linear Data. • Robust System. • Ensembles Have Higer Performance.	• Unconstrained, Individual Trees Are Prone To Overfitting. • This Can Be Alleviated By Using Ensembles.	
7.Diagnosing Parkinson By Using Artificial	SVM	• It Non-Linear Decision Boundaries Can Be	• SVM's Are Memory Intensive.	90%

Neural Networks And Support Vector Machines		Represented. • They Are Robust Against Overfitting.	• Presently Random Forests Are Usually Preferred Over SVM's	
8.Diagnosis Of Parkinson's Disease From Continuous Speech Using Deep Convolutional Networks Without Manual Selection Of Features	Convolutional Neural Network	• Stages Of Parkinson's Disease Are Classified	• Requires A Lot Of Training Data And Greater Computational Costs	Mean Of 65%
9. Efficient Diagnosis System For Parkinson's Disease Using Deep Belief Network	Deep Belief Network	• Provides Increased Accuracy Than The Deep Neural Network.		94%
10. Diagnosis Of The Parkinson Disease By Using Deep Neural Network Classifier	Deep Neural Network Classifier	• Reduces Need For Feature Engineering.	• Difficult To Comprehend Learning.	86%

IV. CONCLUSION

In Recent Years, The Field Of Speech Processing And Its Recognition Have Been Widely Recognized For Their Diverse Applications. Most Importantly Speech Processing Has Great Potential In The Detection, Classification And Diagnosis Of Parkinson's Disease. Several Machine Learning And Deep Learning Algorithms Were Discussed In This Paper, After Analyzing Many Classifiers The Deep Belief Network (DBN) Outperforms All Other Classifiers. The Use Of Artificial Intelligence Techniques In The Field Of Medicine, Especially In The Early Diagnosis Of Parkinson's Disease Has Proved To Be Very Efficient And Effective.

REFERENCES

[1] New England Journal Of Medicine, 2005, 353:1021–1027.

[2] Chaudhuri Kr, Yates L, Martinez-Martin P. The Non-Motor Symptom Complex Of Parkinson's Disease: A Comprehensive Assessment Is Essential. Current Neurology And Neuroscience Reports 2005, 5:275–283.

[3] Marras C, Tanner Cm. Epidemiology Of Parkinson's Disease. In: Watts Rl, Koller Wc, Eds. Movement Disorders, Neurologic Principles And Practice, 2nd Ed. New York, Mcgraw Hill, 2004:177–196.

[4] P. Devijver, Andj. Kittler, "Pattern Recognition: Astatistical Approach," Prentice Hall, 1982.

[5] A. Little, P. E. Mcsharry, E. J. Hunter, J. Spielman, L. O. Ramig, "Suitability Of Dysphonia Measurements For Telemonitoring Of Parkinson's Disease," Ieee Transactions On Biomedical Engineering, Vol. 56, Pp. 1015-1022, 2006.

[6] Mohammad S Islam ; Imtiaz Parvez ; Hai Deng ; Parijat Goswami," Performance Comparison Of Heterogeneous Classifiers For Detection Of Parkinson's Disease Using Voice Disorder (Dysphonia)", International Conference On Informatics, Electronics & Vision (Iciev), Page(S):1 - 7

[7] Center For Machine Learning And Intelligent Systems,Website:Http://Archive.Ics.UCI.Edu/Ml/Datasets/Parkinsons, 2008.

[8] A. Asuncion And D.Newman "UCI Machine Learning Repository(2009) Website: Http://Www.Ics.UCI.Edu/Mlearn/Mlrepository.Html

[9] M.A.Little, P.E. Mcsharry, E.J.Hunter, J.Spielmanand L.O.Ramig "Suitability Of Dysphonia Measurements For Telemonitoring Of Parkinson's Disease" Ieee Transactions On Biomedical Engineering,2009.

[10] Dr. Geetha R Ramani, G Sivagami,"Parkinson Disease Classification Using Data Mining Algorithms", International Journal Of Computer Applications 32(9):17-22, October 2011.

[11] Anchana Khemphila, Veera Boonjing, "Parkinsons Disease Classification Using Neural Network And Feature Selection", World Academy Of Science, Engineering And Technology International Journal Of Mathematical And Computational Sciences Vol:6, No:4, 2012.

[12] A. Asuncion And D.J. Newman. UCI Machine Learning Repository, 2007. Url Http://Www.Ics.UCI.Edu/~Mlearn/Mlrepository.Html.

[13] Carmen Camara, Pedro Isasi, Kevin Warwick, Virginie Ruiz, Tipu Aziz, John Stein, Eduard Bakštein, "Resting Tremor Classification And Detection In Parkinson's Disease Patients", Biomedical Signal Processing And Control, Volume 16, February 2015, Pages 88-97

[14] B.J. Harrison, C. Pantelis, Local Field Potencials. Encyclopedia Of Psychophar-Macology, Springer, Berlin/Heidelberg, 2010.

[15] Q. Gaucher, J.M. Edeline, B. Gourevitch, How Different Are The Local Field Poten-Tials And Spiking Activities Insight From Multi-Electrodes Arrays, J. Physiol. Paris 106 (3) (2012) 93–103.

[16] G. Deuschl, P. Bain, M. Brin, Consensus Statement Of The Movement Disordersociety On Tremor, Mov. Disord. 13 (S3) (1998) 2–23.

[17] Resuldas, "A Comparison Of Multiple Classification Methods For Diagnosis Of Parkinson Disease", Expert Systems With Applications, Volume 37, Issue 2, March 2010, Pages 1568-1572

[18] David Gil, Magnus Johnsson, " Diagnosing Parkinson By Using Artificial Neural Networks And Support Vector Machines", In Global Journal Of Computer Science And Technology, 2009, 9(4). P.63-71

[19] Sakar Co, Kursun O, "Telediagnosis Of Parkinson's Disease Using Measurements Of Dysphonia", Journal Of Medical Systems, August 2010, Volume 34, Issue 4, Pp 591–599

[20] Little, M. A., Mcsharry, P. E., Hunter, E. J., Ramig, L. O., Suitability Of Dysphonia Measurements For Telemonitoring Of Parkinson's Disease. Ieee Trans. Biomed. Eng. 2009. Doi:10.1109/Tbme.2008.2005954.

[21] Learning Repository, U.C.I.: Http://Archive.Ics.UCI.Edu/Ml/, June 2008.

[22] Ipsita Bhattacharya, M. P. S. Bhatia, "SVM Classification To Distinguish Parkinson Disease Patients", Proceedings Of The 1st Amrita Acm-W Celebration On Women In Computing In India, 2010.

[23] Zahari Abu Bakar, Nooritawati Md Tahir, Ihsan M Yassin, "Classification Of Parkinson's Disease Based On Multilayer Perceptrons Neural Network', Ieee Colloquium In Signal Processing And Its Applications (Cspa), 2010.

[24] Uma Rani K And Mallikarjun S. Holi, 'Analysis Of Speech Characteristics Of Neurologicaldiseases And Their Classification', Proceedings Of Ieee International Conference On Computing Communication &Networking Technologies (Icccnt), 2012 Coambator, India, Pp 1-6

[25] A. Tsanas, M.A. Little, P.E. Mcsharry, J. Spielman, L.O. Ramig, "Novel Speech Signal Processing Algorithms For High-Accuracy Classification Of Parkinson's Disease", Ieee Transactions On Biomedical Engineering, Vol. 59, No. 5, Pp. 1264-1271, 2012.

[26] Alex Frid, Ariel Kantor, Dimitri Svechin, Larry M. Manevitz, Diagnosis Of Parkinson's Disease From Continuous Speech Using Deep Convolutional Networks Without Manual Selection Of Features, 2016 Icsee International Conference On The Science Of Electrical Engineering.

[27] S. Sapir, L. O. Ramig, J. L. Spielman, And C. Fox, "Formant Centralization Ratio (Fcr): A Proposal For A New Acoustic Measure Of Dysarthric Speech," J. Speech Lang. Hear. Res. Jslhr, Vol. 53, No. 1, P.114, Feb. 2010

[28] H. Hazan, D. Hilu, L. Manevitz, L. O. Ramig, And S. Sapir, "Early Diagnosis Of Parkinson's Disease Via Machine Learning On Speech Data," In 2012 Ieee 27th Convention Of Electrical Electronics Engineers In Israel (Ieeei), 2012, Pp. 1–4.

[29] A. Frid, H. Hazan, D. Hilu, L. Manevitz, L. O. Ramig, And S. Sapir, "Computational Diagnosis Of Parkinson's Disease Directly From Natural Speech Using Machine Learning Techniques," In 2014 Ieee International Conference On Software Science, Technology And Engineering (Swste), 2014, Pp. 50–53.

[30] R. Arefi Shirvan, E. Tahami, "Voice Analysis For Detecting Parkinson's Disease Using Genetic Algorithm And Knn Classification Method",2011 18th Iranian Conference Of Biomedical Engineering (Icbme), 2011, Page(S):278 - 283

[31] Ah Al-Fatlawi, Mh Jabardi, Sh Ling, "Efficient Diagnosis System For Parkinson's Disease Using Deep Belief Network", 2016 Ieee Congress On Evolutionary Computation (Cec), 2016.

[32] G. E. Hinton And R. R. Salakhutdinov, "Reducing The Dimensionality Of Data With Neural Networks," Science, Vol. 313, Pp. 504-507, 2006.

[33] G. E. Hinton, "Training Products Of Experts By Minimizing Contrastive Divergence," Neural Computation, Vol. 14, Pp. 1771-1800, 2002.

[34] M. A. Little, P. E. Mcsharry, E. J. Hunter, J. Spielman, And L.O. Ramig, "Suitability Of Dysphonia Measurements For Telemonitoring Of Parkinson Disease," Ieee Transactions On Biomedical Engineering, , Vol. 56, Pp. 1015-1022, 2009.

[35] Abdullah Caliskan, Hasan Badem, A. Başturk, M.E. Yüksel, "Diagnosis Of The Parkinson Disease By Using Deep Neural Network Classifier", Journal Of Electrical And Electronics Engineering, 2017(2):3311-3318

[36] Lichman, M. UCI Machine Learning Repository [Http://Archive.Ics.UCI.Edu/Ml]. Irvine, Ca: University Of California, School Of Information And Computer Science, 2013.

[37] M. A. Little, P. E. Mcsharry, S. J. Roberts, D. Costello, I. M. Moroz, "Exploiting Nonlinear Recurrence And Fractal Scaling Properties For Voice Disorder Detection", Biomed. Eng., Vol. 6, No. 23, 2007.

[38] B. E. Sakar, M. E. Isenkul, C. O. Sakar, A. Sertbas, F. Gurgen, S. Delil, H. Apaydin, O. Kursun, "Collection And Analysis Of A Parkinson Speech Dataset With Multiple Types Of Sound Recordings", Ieee Journal Of Biomedical And Health Informatics, Vol. 17, No. 4, Pp. 828-834, July 2013.

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