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. Features extracted from the patient's speech samples were tested using different models. The main classification models for effective use are Convolutional Neural Networks (CNN), Support Vector Machines (SVM) and Artificial Neural Networks (ANN). This has incredible potential to help doctors make diagnoses and expand medical services in areas where diagnosis is difficult.

Keywords:ArtificialNeuralNetwork(ANN),ConvolutionalNeuralNetwork(CNN),Parkinson'sDisease(PD),Support VectorMachine (SVM)

I. INTRODUCTION

Parkinson's Disease (PD) That Impacts The Nerve Cells In The Cerebrum That Make Dopamine ShowsSignsIncludingMuscleFirmness,Tremors,AndChangesInStepAndDiscourse.Parkinson'sDiseaseImpactsA Man's Voice, Influencing Them To Whisper Or Have Shivering In Talk. PD Is Only Second To Alzheimer'sDiseaseInNeurodegenerativeIllness.ItIsExpectedToIncreaseInTheComingYearsThereforeItIsNecessaryTo Develop Detection Systems For Practical Analysis And Timely Treatment. As The Signs Of PD HappenWell-Ordered And For The Most Part, The Elderly Observing The Sickness Using Estimations Of DysphoniaHas A Vital Part In Analysis. The Classification Algorithms From Machine Learning And Deep Learning AreUsed To Predict And Investigate The Parkinson's Disease. The Ideal Features From The Dataset Are Passed AsInput To The Models And The Prediction Results Are Obtained. The Prediction Performance Can Be ValidatedFromTheAccuracyObtainedThroughTheClassificationAlgorithm.TheDeterminationOfParkinson'sDiseaseHasProgressivelyEnhancedTheAccuracyParameterThroughTheVariousAlgorithms.

II. PARKINSON'SDISEASE

Parkinson'sIllnessIsAnIncessantDynamicNeurodegenerative,PortrayedByTheNearnessOfTranscendently 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, SpeechAnd Gulping Troubles), Are The Most Troublesome Difficulties The Treating Doctor Is Looked With WhenManaging Patients With A Long Span Of The Disease. In Expansion To The Motor Symptomatology Of PD[1],SomeNon-EngineManifestations,ForExample,Hyposmia,FastEyeDevelopments,RestConductIssue,IdentityChanges,TormentAndParesthesiasMightBePresentAndMayEvenShow BeforeTheMotorSymptoms[2].

Parkinson's Disease Is An Ubiquitous Issue, With An Unrefined Occurrence Rate Of 4.5– 19 For Every100 000 People For Each Year. As This Is An Unending Disorder With A Delayed Course, Pervasiveness IsSubstantially Higher Than Frequency. Raw Pervasiveness Fluctuate From 18 For Every 100 000 People In APopulace Study In Shanghai, China, To 328 For Each 100 000 In A Door-To-Door Study Of The Parsi PeopleGroupInMumbai,India.TheDominantPartOfStudiesAnnouncingGeneralRoughPervasiveness(Counting

GuysAndFemalesOverTheWholeAgeRun)FallInTheVicinityOf100And200ForEach100000Persons[3].

III. LITERATUREREVIEW

a. UsingMachineLearningAlgorithms

R. ArefiShirvan.EtAl[4] Proposed A System For Detect PD. The Data Classification Was Done UsingKnnMethod.SimplestMethodInGroupingTheSimilarityIsKNN.AmongClassificationMethodKNNIsUsedWheneverThe FactsForDataDistributionAreNotEnough[5].InThisMethodItHasTwoParts:A)DetermineK Close Neighbors, B) Determining Class Type Using These Close Neighbors. It Was Shown That A93.7% OfAccuracyPer4OptimizedFeatures, AnAccuracyOf94.8%Per7OptimizedFeaturesAnd 98.2%AccuracyFor9OptimizedFeaturesIsAchievedWhichIsARemarkableResultComparedToOtherStudies.InThisResearchData From [6] From UCI Repository Is Used. The Data Include 192 Voice Sample Recordings From 32 MaleAnd Female. Each Subject Has Had 6 Voice Signal Recordings. 23 People Suffer From PD And The Rest AreHealthy. People Were About 46-85 Years Old Themain Disadvantage Of The KNN algorithm Is That It Is ALazyLearner,I.E.Classification IsDoneByUsingTrainingDataAndFromTheTrainingDataItDoesn'tLearnAnything.

MohammadSIslam.EtAl[7]ConductedAComparativeAnalysisToDetectParkinson'sDiseaseUsingVarious Classifiers. Support Vector Machine (SVM), Feedforward Back-Propagation Based Artificial NeuralNetwork (FBANN) And Random Tree (RT) Classifiers Were Used And A Comparison Between Them Is MadeTo Differentiate BetweenPDAndHealthy Patients. TheStudy Has Utilized TheUCIMachineLearningRepository From [8],[9]. The Dataset Consists Of 195 Voice Samples From 31 Individuals Comprising Of BothMales And Females. From The Taken Subjects 23 Were Determined With PD And 8 Were Healthy. To ImproveThe Classification Accuracy With Minimal Error Rate A 10-Fold Cross Validation Which Was Repeated 100Times Has Been Implemented For All The Three Classifiers. The FBANN Classifier Has Achieved A 97.37%RecognitionAccuracyThusOutperformingTheOtherTwoClassifiers.

Dr.R.GeethaRamani.EtAl[10]HasProposedASystemToClassifyPDAndNon-PDPatientsByTheFollowing Methods Binary Logistic Regression, Linear Discriminant Analysis (LDA), Partial Least SquareRegression(PLS),Random Tree(RndTree)AndSupportVectorMachine(SVM).TheDatasetIsTheParkinson'sDiseaseDataAcquiredFromThe UCIRepository.TheTrainingDatasetComprisesOf197SamplesWith 22 Features Extracted From The Patients. Fisher Filtering Feature Selection Algorithm Was Found To BeAn Effective Feature Ranking System. The Rnd Tree Algorithm Achieved 100% Classification Accuracy WhileThe Lda, C4.5, Cs-Mc4 And K-Nn Yielded Accuracy Results Greater Than 90%.Among All, The C-PlsAlgorithmAchievedTheLeastAccuracyOf69.74%.

The Multi-Layer Perceptron (MLP) With Back-Propagation Learning Algorithm Is Used ByAnchanakhemphila Et Al. [11], Et Al To Effectively Classify And Diagnosis PD. The Study Has Utilized The UCIMachine Learning Repository's[8],[12] Parkinson's Disease Dataset. Experiments Were Done And InformationGain Was Calculated Using Weka 3.6.6 Tool. They Used Information Gain To filter Features And Hence NeedNot Be Taken From Patients. To Calculate Information Gain, The Input Must Be Discrete Numbers. BecauseContinuous Real Numbers Were Used In The Experiment, The Range Of Values Was Partitioned To ObtainDiscretization. The Accuracy Obtained In The Training Data Set Is 91.453% And The Validation Data Set Is80.769%ByUtilizingTheMainModel.

CarmenCamara.EtAl[13]ProposedANewMethodForStimulation,DetectionOfTremorIsBasedOnTheSubtypeOfTremorThePatientHas.ElectrophysiologyIsTheStudyOfElectricalActivityTheBody [14],[15]. Extracellular Physiology Is The Best Method To Detect The Neurons. Measure The ElectricalPotentialWithMicroelectrodes.TheSignalIsFilteredAndTheLfpSignalIsRepresented.TheDatasetDiagnosedWithTremor-DominantPD,AndWhoUnderwentSurgeryForTheImplantationOfANeurostimulator. 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 ShowedThe Existence Of Two Subgroups Of Patients Within The Group-1 Of Patients According To The ConsensusStatementOfTheMovementDisorder SocietyOnTremor[16].

ResulDas.EtAl[17]UsedVariousClassificationMethodsForIdentifyingPD.FourDifferentClassificationTechniquesWereImplementedAndAnalyzedAndThey Are Dmneural, NeuralNetworks, Regression,AndDecisionTreeRespectively.VariousEvaluationMethodsWereUsedForCalculating The Performance Of The Classifiers. After Evaluation From The Results, The Neural NetworksClassifier 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. TheAdjustable Parameters Of Each Classifier Were Tuned. For The Neural Networks Classifier,The BPNNAlgorithm Has Been Used In The Feed-Forward, Single Hidden Layer Neural Network. The Algorithm Used InTheStudyIsTheLevenberg–Marquardt(Lm)Algorithms.TheNeuralNetworkHas92.9%Accuracy.

David Gil A.EtAl[18] Proposed Methods Based On ANNs And SVMs To Aid The Specialist In TheDiagnosis Of PD. The Parkinson DatabaseIs Taken From The UCI Machine Learning Repository[8]. It WasUsed For Training And Testing Experiments. The SVM Produces Better Results Than The MLP. The SVMShows A High Accuracy Of Around 90%. Other Parameters That Reach Very High Accuracy Are "Sensitivity"And"NegativePredictiveValue"WithAccuracyValuesOf99.32%And97.06%Respectively.

C. OkanSaka.Et Al [19] Used Support Vector Machine For Building A Classification Model And ACross Validation Scheme That Is Called Leave-One-Individual-Out Is Used For Testing. This Scheme Fits WithThe Dataset Better Than The Traditional Bootstrapping Methods. Parkinson'sdataset Consists Of 195 VoiceSamples From 31 Individuals Comprising Of Both Males And Females. From The Taken Subjects 23 WereDeterminedWithPDAnd8WereHealthy.TheDatasetWasTakenFromUCIMachine-LearningRepository[8].TheyOptimizedThe SVMParametersAsSuggestedByTheWorkIn[20],[21]SoAsToBuildAnSVMModelCapable Of Achieving Their Reported Results Of 91% With Only 4 Features And 90% With A Greater SetConsistingOf10Features.

In This Paper IpsitaBhattacharya.Et Al [22] Used A Data Mining Tool, Weka, They Pre-Processed TheDataset On Which They Have Worked And Then Using One Of The Classification Methods I.E. Support VectorMachine Method (SVM), They Distinguished People With Parkinson'SDisease From The Healthy People.Appling Libsvm They Have Tried To Find The Best Possible Accuracy On Different Kernel Values For TheGivenDataset.TheyHaveDownloadedTheDatasetFrom[10],Where197VoiceRecordingSamplesAreThereOf 31 People From Which 23 Are Having The Parkinson Disease. On Changing The Split Ratio And RepeatingThe Test They Achieved Better Result. On The Random Split Of Dataset, They Concluded That The BestAccuracyAchievedWas65.2174%.

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 ForThis Project Has Been Taken Form The PD Data Set. It Is Also Observed That The Best Training Accuracy AndTestingAccuracyForLmAlgorithmOccurredAtHiddenUnitOf25AsComparedToOtherHiddenUnitsWith97.86 % For Training Phase And 92.96% For Testing Stage.Lm Performed Well With Classification AccuracyOf92.95%WhileScgObtained78.21%Accuracy.

UmaRaniK.EtAl[24]UsedTwoTypesOfANNForClassification,TheMultilayerPerceptron(MLP)Network And Radial Basis Function (RBF) Network. 112 Phonations Were Used To Train The Network And 24Phonations For Testing. The RBF Network Gave A Better Classification With 90.12% For Training Set And87.5%ForTestSetComparedToMLPWith86.66%ForTrainingSetAnd83.33%ForTestSet.

AthanasiosTsanas.Et Al [25] Adopted Four Algorithms For Feature Selection To Diagnose PD. TheyComputed132DysphoniaMeasuresFromSustainedVowels.Then,FourSubsetsOfTheseDysphoniaMeasuresW hich Are Parsimonious Are Selected Using The Feature Selection Algorithms.These Subsets Are Mapped ToA Binary Classification ResponseUsing TwoStatistical Classifiers:Random Forests AndSupportVectorMachines. The NCVS Database Comprises Of 263 Phonations From 43 Subjects (17 Females And 26 Males; 10Healthy Individuals And 33 PWP), An Extension Of The Database Used In [25] Is Used In The Paper. It Gives99%OverallClassificationAccuracyUsingJustTenDysphoniaFeatures.

b. UsingDeepLearningAlgorithms

Alex FridEt.Al [26] Have Proposed A Convolutional Neural Network (CNN) For Speech SignalProcessingUsingOne-DimensionForParkinson'sDisease.TheDatasetHasBeenAcquiredFrom[27],[28],[29]And [30]. During The Training Phase, The Entire Recording Is Processed And Windowing Is Applied FollowedBy A Decision Mechanism. The Binary Classification Between Healthy And Other Stages Of Parkinson'sDisease Results At The Window Level Indicates A Accuracy Of More Than 65% For All The Stages. The OtherBinary Classification At The Participant Level Indicates An Accuracy Of More Than 60% Between SubsequentStagesOfSeverityOfTheDisease.

Ali H. Al-Fatlawi .Et Al [31] Adopted A Deep Belief Network (DBN) Technique To Diagnose TheParkinson's Disease (PD). This Paper Uses Data Retrieved From A Parkinson's Data Set [32], [33] That AreCollected By Max Little Of The University Of Oxford, Who Developed A Tele-Monitoring Device To RecordThe Speech Signals. [34] Extracted Features Of The 195 Samples Of Voices That Have Been Recorded From 31People.In ThisPaper,DBNisUsedToClassify ThePDWhichComposesOf TwoStackedRestrictedBoltzmann machines (RBMs) And One Output Layer. Two Stages Of Learning Is Needed To Optimize TheNetworks'Parameters.TheFirstStageIsUnsupervisedLearningWhichUsesRBMsToOvercomeTheProblemTha t Can Cause Because Of The Random Value Of The Initial Weights. Next, Backpropagation Algorithm IsUsedAsASupervisedLearningForTheFineTuning.TheOverallTestingAccuracyOfTheProposedSystemIs94%W hichIsBetterThanOtherMethods.

Which Has A Stacked Auto Encoder And A Softmax Classifier. Multiple Simulations Are Performed Over TwoDatabasesToShowTheEffectivenessOfTheDeepNeuralNetworkClassifier.TheDNNIsComparedWithTheClassical 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 AreMeasured [36], [37]. The Dataset Contains Various Of Sound Samples And 1040 Samples For Training Set And168 Samples For Testing Set [38]. The Training And Testing Set Of Opd. The Results Show That The ClassifierOutperforms The Other Methods In Both Opd And PDs Databases. The Classification Of Various Techniques IsGivenInTable1.

ALGORITHMS

SupportVectorMachine

SupportVectorMachine(SVM)IsASupervisedLearningProcedureValuableWhenBothTheFeatures And Class Names Are Available In A Dataset. It Constructs A Model To Anticipate Classes For NewCases. The Two Types Of SVM Classifiers Are Linear SVM Classifier And Non-Linear SVM Classifier. In TheLinear Model The Data Points,Are Separated By HyperplaneAlso CalledAs Maximum-Margin Hyperplane(As Shown In Figure 1). The Essential Focus While Drawing The Hyper Plane Is To Expand The SeparationFrom The Hyper Plane To The Closest Data Points Of Either Class Known As Support Vectors. To SolvePartition Of Data Into Various Classes, Non-Linear SVM Classifier Is Utilized Employing The Kernels ToHyperplanes. The Information Focuses Are Plotted In A Higher Dimensional Space And Numerous Parts AndSomeStandard KernelsIncludePolynomialKernelAnd Radial BasisFunctionKernel.

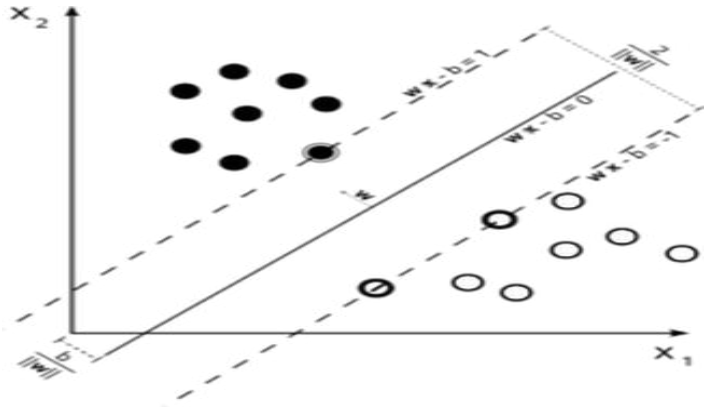

Figure1.SelectingThe SVMHyperplanes

ArtificialNeuralNetwork:

Animal Brains Consist Of Many Neurons. These Neurons Communicate With Each Other By SendingPulses 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 NeuronsCalled Artificial Neurons. These Neurons Communicate With Each Other Using Some Signals Which Are RealNumbers. Each Neuron Calculates Its Output By Using A Non-Linear Function On Its Inputs. Weights AreAssigned To Artificial Neurons And To The Connections Between Them. These Weights Are Revised ThroughA Process Called Learning. The ANN Are Designed So That The Neurons Are Distributed Over Several Layers.EachLayerProcessesItsInputUsingDifferentFunctionsAnd PassesTheOutputToTheNextLayer.

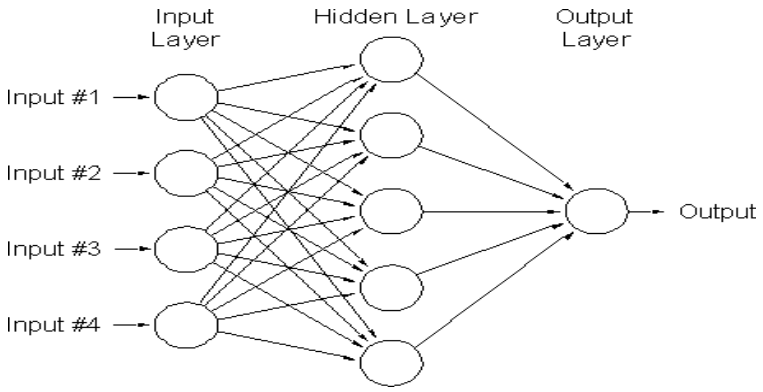

Figure2. ArtificialNeuralNetwork

convolutionalNeuralNetwork

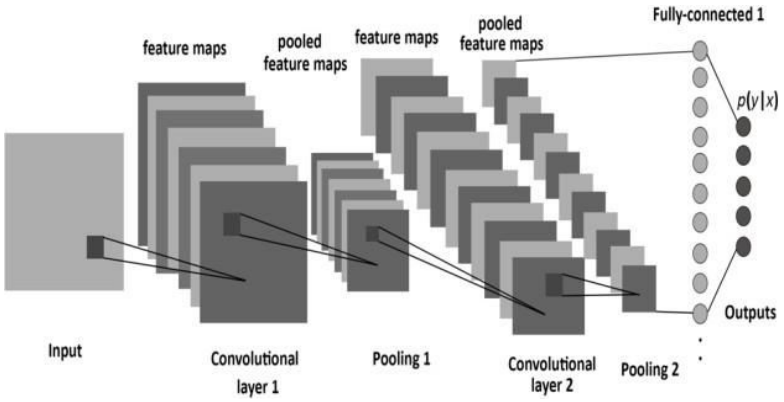

Figure3. ConvolutionalNeuralNetwork

A Convolutional Neural Network(CNN) Is A Type Of Deep, Feed Forward Artificial Neural Networks(AsShownInFigure3).ConvolutionalSystemsWereMotivatedByNaturalProceduresInThatTheCorrelating Pattern Between Neurons Takes After The Association Of The Animal Visual Cortex. A CNNComprises Of An Input Layer,An Output Layer, And Different Concealed Layers Like Convolutional Layers,PoolingLayers,FullyConnectedLayersAndNormalizationLayers.TheirActivationFunctionsCanBeComputed WithMatrixMultiplicationWhichIsFollowed ByABiasOffset.

TABLE1.ANALYSISOFTHETECHNIQUES

Title	Algorithm	Pros	Cons	Accuracy
1.VoiceAnalysisFor Detecting Parkinson'sDisease	KnnAlgorithm	• ThisMethodCanBeAppliedToTheDataFromAnyDistribution • SimpleMethod • EvenSamples Is LargeItCanBeClassified Perfectly	• It Is A LazyLearner • Test Stage IsExpensive.	94.3%
2.PerformanceComparison Of HeterogeousClassifiers For Detection OfParkinsonsDisease Using VoiceDisorder.	RandomTree(Rt)	• ItRuns Best On LargeDatabases. • Without VariableDeletion It Can HandleMoreData Variables.	• ItOverfitsForSome Datasets With Noisy Regression.	
	SupportVector Machine (SVM)	• ItNon-LinearDecisionBoundariesCanBeRepresented. • They AreVery RobustAgainstOverfitting.	• SVM's AreMemoryIntensiveOperation. • Presently RandomForests AreUsuallyPreferredOverSVM's.	
	Feedforward Back-Propagation BasedArtificialNeuralNetwork(Fbann)	• SimpleImplementation. • MathematicalFormulaCan Be Applied To AnyAlgorithm. • ComputingTimeIsReduced If The WeightsChosenAreSmallAtTheBeginning	• Slow AndInefficient • OutputsCanBeFuzzyOrNonNumeric	97.37%
3.ParkinsonDiseaseClassificationUsing Data MiningAlgorithms	BinaryLogisticRegression	• OutputsHave AGoodInterpretation, And TheAlgorithm. • It Can Be Modified ToAvoidOverfitting. • Logistic Models Can BeUpdatedEasilyUsing Sgd.	• LogisticRegressionTendsPerformLowInNon-LinearDecisionBoundaries. • They Are NotFlexibleEnough.	

	RandomTree (RndTree),	• It Runs Good On LargeDatabases. • Without VariableDeletion It Can HandleMoreData Variables.	• ItOverfitsNois ForyClassificatio n.	100%
	Knn	• ThisMethodCanBeAppliedToTheDataFromAny Distribution • SimpleMethod • EvenSamples Is LargeItCanBeClassified Perfectly	• It Is A LazyLearner • Test Stage IsExpensive.	90%
	PartialLeastSquareRegression (Pls)	• LinearRegressionIsStraightforwardTo Understand And Explain, And Thus CanBeRegularized ToAvoidOverfitting. • LinearModelsCanBeUpdated Using Sgd.	• LinearRegressionPerformsPoorInNon-LinearRelationships. • They Are NotFlexible. • TrickyAndTime-Consuming.	69.4%
	Support Vector Machine (SVM)	• ItNon-LinearDecision Boundaries Can Be Represented. • They Are Robust AgainstOverfitting.	• SVM's AreMemoryIntensive. • Presently RandomForests AreUsuallyPreferredOverSVM's.	
4.Parkinsons Disease Classification Using Neural Network And FeatureSelection	The Multi-Layer Perceptron (Mlp)With Back-Propagation Learning.	• SimpleImplementation. • MathematicalFormulaCan Be Applied To AnyAlgorithm. • ComputingTimeIsReduced If The WeightsChosenAreSmallAtTheBeginning.	• Slow AndInefficient. OutputsCanBeFuzzyOrNonNumeric	80.697%
5.RestingTremor Classification AndDetectionIn Parkinson's DiseasePatients				83.2%
6.AComparisonOf Multiple ClassificationMethods For Diagnosis Of ParkinsonDisease	NeuralNetworks	• Can Be Implemented InAnyApplication. • CanBeImplementedWithoutAnyProblem. • Neural Networks LearnsAnd Does Not Need ToBeReprogrammed.	• ItNeedsTrainingTo Operate. • RequiresHighProcessingTimeForLargeNeuralNetworks.	92.9%
	Regression	• LinearRegressionIsEasy ToUnderstand. • ItCanBeModifiedToAvoidOverfitting. • LlinearModelsCanBeUpdated UsingSgd.	• LinearRegressionPerformsPoorInNon-LinearRelationships. • They Are NotFlexible. • TrickyAndTime-Consuming.	
	DecisionTree	• DecisionTreesCanUnderstandNon-LinearData. • RobustSystem. • EnsemblesHaveHigerPerformance.	• Unconstrained,IndividualTreesAre Prone ToOverfitting. • ThisCanBeAlleviatedByUsingEnsembles.	
7.Diagnosing	SVM	• ItNon-LinearDecision	• SVM's Are	90%

Parkinson By Using Artificial		Boundaries Can Be	MemoryIntensive.	
NeuralNetworks AndSupportVect orMachines		Represented. • TheyAre RobustAgainstOverfitti ng.	• PresentlyRandomF orests AreUsuallyPreferr edOverSVM's	
8.Diagnosis OfPar kinson'sDisease From ContinuousSpeec h Using DeepConvolution alNetworksWitho utManualSelectio n OfFe atures	Convolutional NeuralNetwor k	• StagesOfParkinson'sDis easeAreClassified	• RequiresALotOfTr ainingDataAndGre aterComputational Costs	Mean Of 65%
9. Efficient Diagnosis SystemForParkin son'sDiseaseUsin g Deep Belief Network	Deep Belief Network	• ProvidesIncreasedAccur acyThanTheDeepNeural Network.		94%
10.DiagnosisOfT he Parkinson Disease By UsingDeep NeuralNe tworkClassifier	DeepNeuralNe tworkClassifie r	• Reduces Need ForFeatureEngineering.	• Difficult ToComprehendLe arning.	86%

IV. CONCLUSION

In Recent Years, The Field Of Speech Processing And Its Recognition Have Been Widely RecognizedFor Their Diverse Applications. Most Importantly Speech Processing Has Great Potential In The Detection,ClassificationAndDiagnosisOfParkinson'sDisease.SeveralMachineLearningAndDeepLearningAlgorithmsWereDiscussedInThisPaper,AfterAnalyzingManyClassifiersTheDeepBeliefNetwork(DBN)OutperformsAllOtherClassifiers.TheUseOfArtificialIntelligenceTechniquesInTheFieldOf Medicine,EspeciallyInTheEarlyDiagnosisOfParkinson'sDiseaseHasProvedToBeVeryEfficientAndEffective.

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