

Machine Learning based Health Care in Neurology

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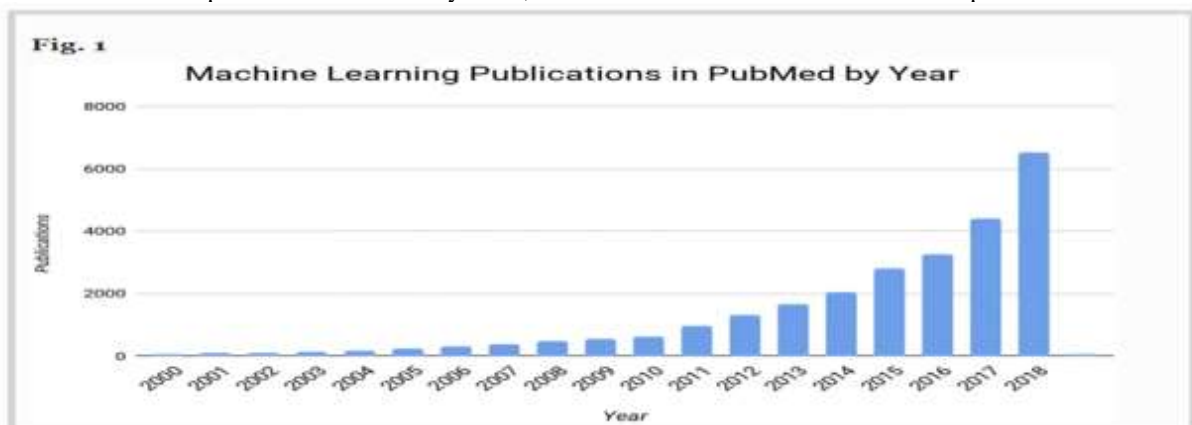
Abstract: Application of Machine Learning Algorithms has increased many folds within 8-10. Due to the availability of Huge data and variety of data form which is Big Data in real sense Machine learning Algorithms can give the best solution In his paper we have Experimented using Parkinson data of MIT[9,10] and compared the Accuracy of Prediction using K-NN, Decision Tree and Random Forest achieving good Result with Random Forest. Future scope of he work moves towards finding the accuracy on multimodal data of Parkinson.

Keywords: Neurological Diseases, Machine Learning, KNN, Decision Tree, Random Forest, Tremor, Typing Pattern etc.

I. INTRODUCTION

There is a huge list of Neurological Diseases ranging from Alzheimer, Parkinson, Depression to Epilepsy, to many more [1]. The Neurological diseases can broadly be categorized as Communicable and Non communicable. The percentage of non-communicable neurological disorders in India has almost doubled from 4.0% in 1990 to 8.2% in 2019, whereas the no of communicable neurological disorders decreased from 4.1% in 1990 to 1.1% (0.9–1.5) in 2019.[7]

Our effort in this paper is to do dive deep into the Exploration of Problem related to Neurological diseases and how it has been handled by the Machine Learning Community. In this paper we have taken up Parkinson Disease because it has one of the most prevalent Diseases in Neurological Domain [1,2]. We can see that the Machine Learning Community is very enthusiastically participating & exploring the Application of ML in all disease especially the Neurological Diseases. The Application of AI / ML in Health care can prove to be a Disruptive Technology strong enough to replace the Human Physician in time to come or be an essential companion of a Human Physician, The same can be inferred from the Graph Shown



Below:

Figure 1: Incresing trend of Reserrch trends in medical Domain using ML

This graph efficiently shows the persistent progressive Interest of ML community in Medical domain. Similarly by zooming into similar observation we conclude that there has been multifold jump into AI/ML based exploration in Neurological field[2,3].

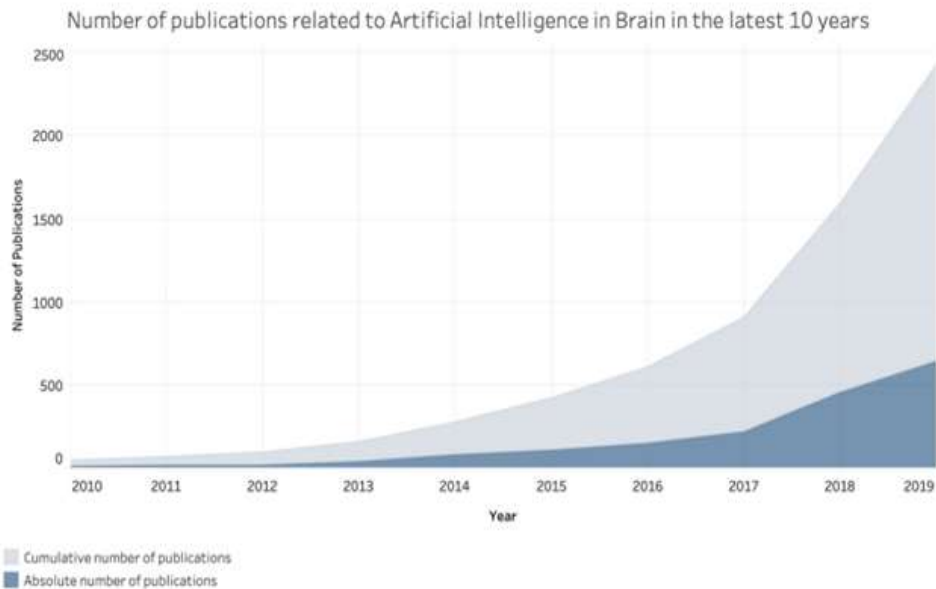


Figure 2.[2]: Increasing trend in Interest of AI Fraternity towards Neurological Deiseses

Thus the above graph explain the reason behind our exploration in this area of AI/ML based Nero Care.

In the Following paragraph we have tried to highlight the reasons behind such successful application of AI & ML behind the Medical Industry in the field of Tele Medicine.

Since ML learns from data and healthcare industry has lot of data from various Resources in various file formats that helps the Machine Learning Algorithm to learn well from various sources & forms of data to produce a good detection and Prediction model. [2.3.4]

- Machine Learning Algorithms can draw rich inferences for prediction from huge volume of data available in Medical domain.
- AI and Machine Learning is good idea to apply when we want to Automate Repetitive Job , such as analyzing tests, X-Rays, CT scans or data entry;
- Its universally known facts that AI systems can help to reduce Human especially in the medical field where there is large Human resources involved ranging from Lab Technicians , Nurses to Physicians.
- An intelligent telemedicine system based on super powerful Machine Learning Algorithm can help develop precise doses of Medications.

Thus we conclude that AI can provide digital consultations and health monitoring services — to the extent of complimenting and or replacing Human Physician.

From the Diagram shown below we can conclude that Parkinson Disease and Alzemier is one of the few most Common Disease among Neurological Diseases.[4]

Pathology (diagnosis)

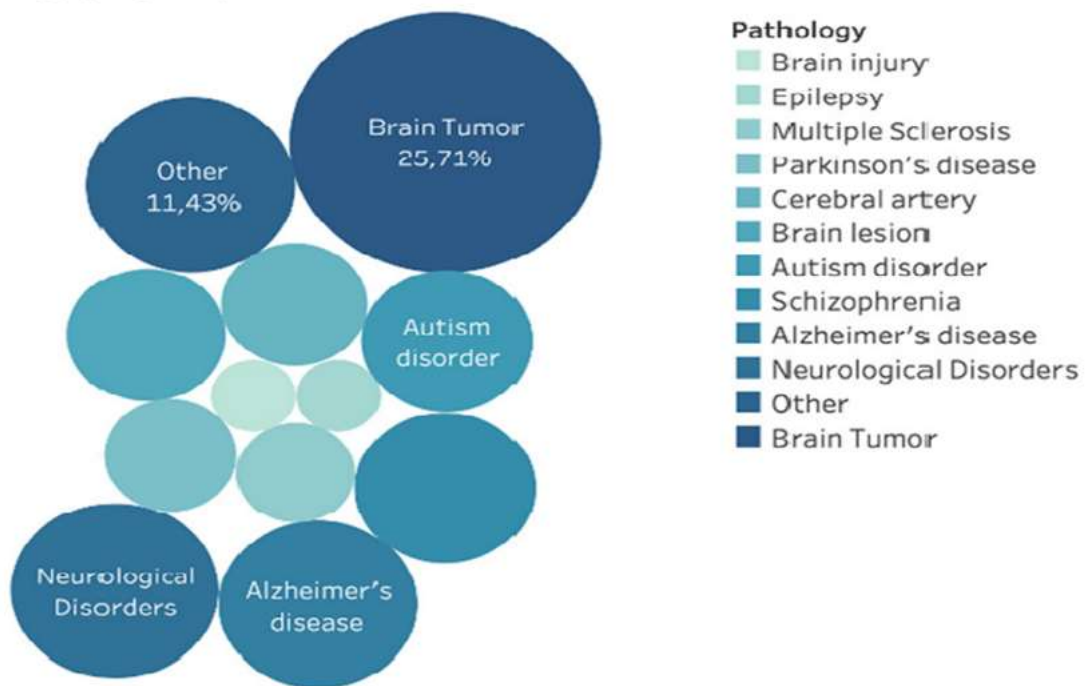


Figure 3 [1]: Various Neurological Diseases

“In India in 2019, an estimated 771 000 (95% UI 635 000–919 000) people had Parkinson’s disease, and an estimated 45 300 (95% UI 38 600–52 800) deaths were due to Parkinson’s disease”[5]. Alzheimer is more Prevalent in Female than Male while Parkinson Dominates in Male than Female.

We believe that a Multi model data gives more precise result and better result prediction than a uni -modal data, we explored to find that most of the sources of various forms of data are from

MRI(Images), PET(Images), CT Scan(Images) [6] as shown in Diagram below in Figure 4

Type of Data (diagnosis)

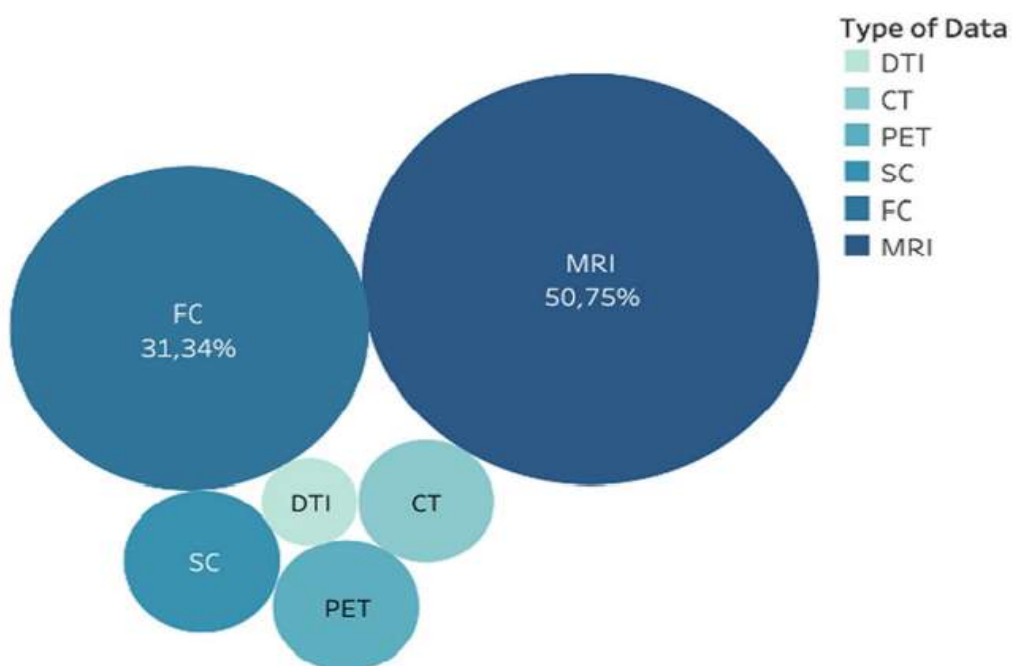


Figure [4].: Sources of Multiple form of Image Data of PD.

We explored that true form of Multi Modal experiment can be done using that EEG(GraphData), Bio Markers(wav form of data from Voice) , Tremor data(In form of frequency Spectrum) and Handwriting data (in the form of various features like pressure, velocity acceleration , jerks and strokes while writing) .

These facts are motivating enough and convincing enough for us to Drill down deep into this area for further exploration

Moving on with the same concern we Drilled down towards Neurological Diseases with Special Emphasis on Parkinson Disease.. Parkinson Diseases are one of the Most Dominant Diseases in Nero.

II. INTRODUCTION TO PERKINSONS DISEASES

Parkinson Disease (PD) is a non-Communicable Nero disease. It is the result of Disorder of Central Nervous system due to Damage of Nerve cell in the Brain Causing Dopamine Level to Drop in Brain leading to Various symptoms of Parkinson. It is a neuron degenerative disease occurring due to drying up of a Neuron fluid Called Dopamine. It occurs in various phases, starting from Striking Features like Tremor in Stage 1, Muscle stiffness in Stage to 2, Loss of Balance / Decreased Reflexes in Stage 3 , In stage 4: Movement may Requires Assistive Device while stage 5: May need wheelchair & are not able to stand.

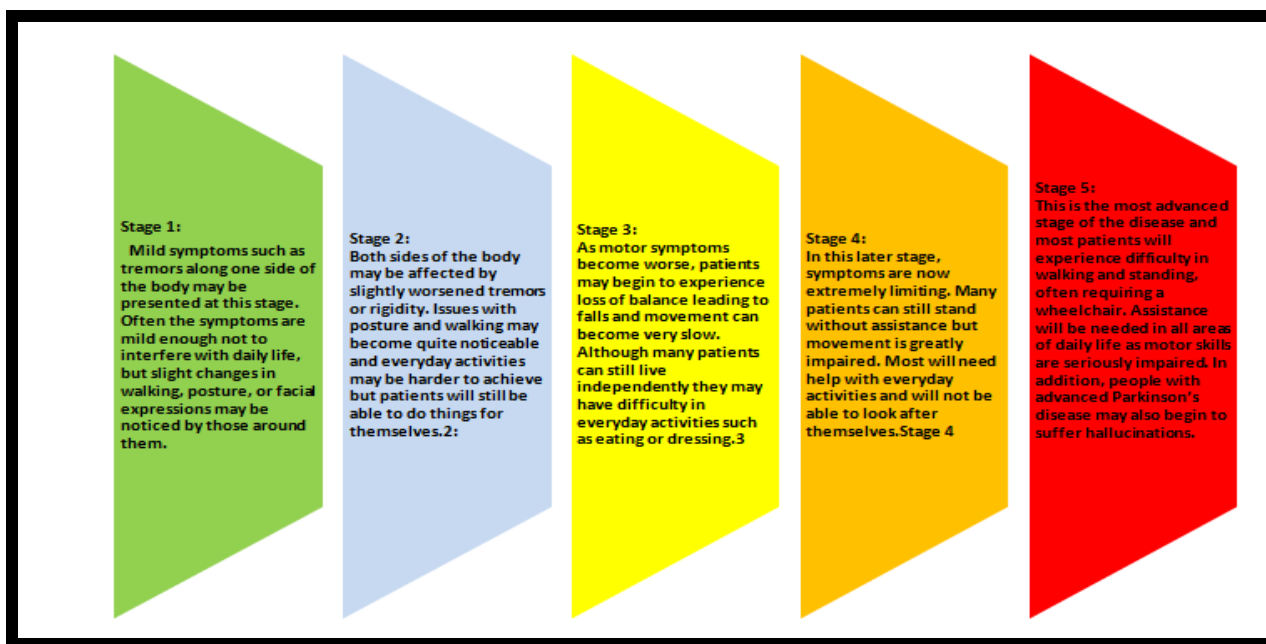


Figure 5: Stage wise Progression of Parkinson Disease along with Basic symptoms.

Males show more severity than Females in India for Parkinson Diseases [Ref 5] . Broadly speaking Symptoms of the Disease can be Motor or Non Motor symptoms. Most common **Motor symptoms**[7,9] can be:

- 1) Freezing
- 2) Slowness of movement
- 3) Tremor
- 4) Rigidity
- 5) Bradykinesia
- 6) Tremor
- 7) Falls and dizziness
- 8) Muscle cramps and dystonia

Most common Non - Motor Symptoms[7,8,9] can be:

1. Pain Cramp

2. Constipation
3. Pain.
4. Fatigue.
5. Low blood pressure.
6. EDS(Excessive Day Time Sleepiness)
7. Restless legs.
8. Bladder and bowel problems.
9. Skin and sweating.
10. Sleep.
11. Eating, swallowing and saliva control.

The above list indicates that there is going to be various sources of digital and non digital format through which we can collect data for Training our Machine Learning Algorithms . Various Input format for Machine Learning Techniques can be broadly divided into as Invasive or Non Invasive Data source.

Input format for machine Learning technique used can be :

Invasive:

Non Invasive

- 1) Image from CT SXCAN
 - 2) REP(Rapid Eye Movement)
 - 3) EEG
 - 4) FMRI
 - 5) Wav File
 - 6) Hand Writing
 - 7) Tremor/ Shaking
 - 8) Sick Bay, CNS Monitor Device
- Gait Analysis

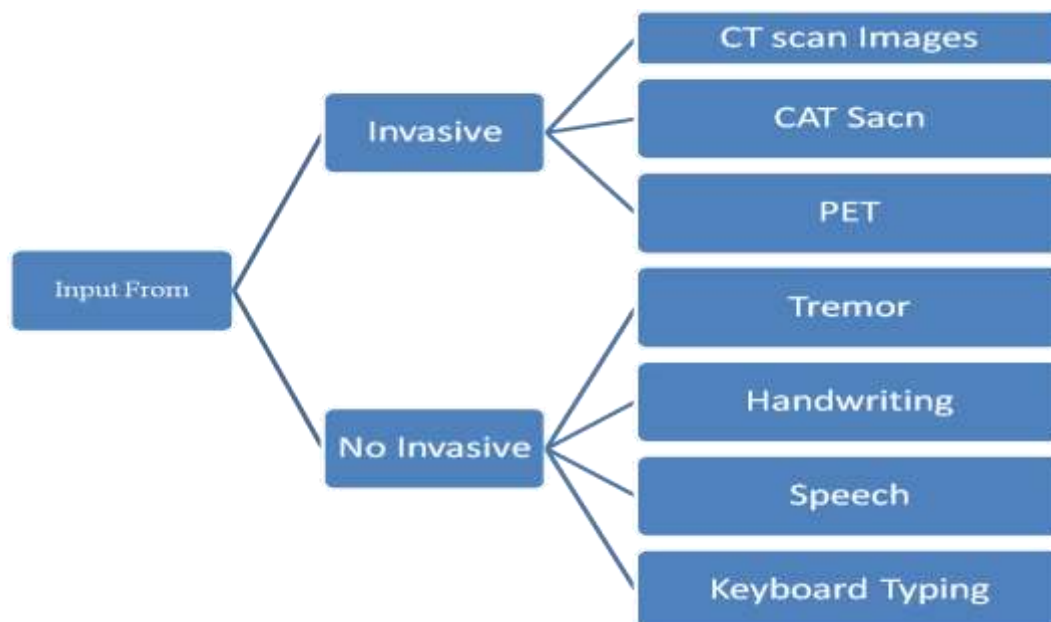


Figure 6: Invasive vs Non Invasive Data source.

II. EXPERIMENTAL SETUP FOR PARKINSON DISEASE DETECTION

The data set was down loaded from MIT neuroQwerty. L. Giancardo and e[10] has set up an experimental set up where in patients and normal people were asked to type on keyboard & their hand movement, spelling mistakes & types of mistakes in typing was observed to Detect any psychomotor defect was observed based on a finger interactions with a computer keyboard during natural typing. Discovery of patterns in the time series of key hold times was done . In this process the attributes which were chosen were:

- 1)Patient ID
- 2) UPDRS108 score
- 4.)Alternating finger tapping (afTap)
- 5.)Single key tapping (sTap)
- Typing speed

Comparing the Result of Two different Data Set: PD1,PD2[10]

Comparing the Experimental Result	Data Set(Pd1)	Data Set(Pd2)
Highest correlation between gt and UPDRS 10	.83	.89
size	31X8	54X 6 columns
train_test_split(X, Y, test_size=0.3)	(31, 8) (21, 8) (10, 8)	(54, 6) (37, 6) (17, 6)
With K=3	[1 1 1 0 1 1 1 1 1 0 0 1 1 1 1 1 1]	[1 0 0 1 0 1 0 0 1 1 1 1 0 1 0 0 1 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 0]
With K=3	Accuracy: 0.8 Accuracy: 0.625	Accuracy: 0.6666666666666666
K=5	Accuracy: 0.625	0.6666666666666666
K=10	Accuracy: 0.6875	Accuracy: 0.7407407407407407
Confusion Matixs	array([[2, 5], [0, 9]])	array([[14, 3], [4, 6]])
test_size=0.5)	(31, 6) (15, 6) (16, 6) Accuracy: 0.5625 array([[4, 2], [5, 5]])	(54, 6) (27, 6) (27, 6) Accuracy: 0.6666666666666666 array([[9, 3], [6, 9]])
Graph between Accuracy and K		
Decision Tree Classifier	Accuracy: 1.0	Accuracy: 0.9629629629629629
Random Forest classifier	Accuracy: 1.0	Accuracy: 1.0

III. CONCLUSION

The result of Experimentation reveals that with increasing the No of K accuracy decreases in KNN in given experiment. Random Forest and Decision Tree gives equally good Prediction results.

1) ML is preferred over Old Statistical because of its ability to Handle Mutidimensional Nonlinear Data.

2) ML's capability to interpret large and heterogeneous patient datasets including data types such as physiological waveforms, continuous electroencephalograms, laboratory tests, and image makes it an ideal situation to choose ML for Neurological Diseases Prediction

1) Multi dimensional data(i.e., age, sex, blood pressure, past medical history, thousands of potential drugs or procedures, imaging results composed of pixels with higher order structures, millions of genetic polymorphisms.

2) Multi Modal data form format

3) Non Linear non-linear relationships

4) Fail to provide relationship ...why is missing

5) MLs tend to have better predictive strength while SSAs tend to have better interpretability.

6) What will happen Vs Why it Happens

Future Research Direction: Algorithms show different accuracy on each data

Therefore, one must try multiple ML and SSA models for each dataset to identify the "best" model.

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