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Detecting Stroke Persons Using Eye Movements with Machine Learning

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ABSTRACT:

Nowadays, Conventional neuropsychological tests are not enough to represent the complex and dynamic situations encountered in daily life. Instead of them, Immersive Virtual Reality simulations can be used to simulate dynamic and interactive situations in a controlled manner. VR Simulations are very useful to identify the mental functioning of a person basing on the Eye movements. So, for that Eye tracking can be used to provide highly detailed outcome measures and it is very useful in neuropsychological assessment. Here to implement the Eye tracking, an experiment is conducted on the people consists of stroke patients and normal people. In this experiment, they are instructed to select a number of items (3 or 7) that are to be searched from a shopping list in a virtual super market environment in which eye movements of participants is being recorded. To differentiate the stroke person with normal person, Machine Learning Classifier algorithms like Logistic Regression, Linear Regression, Decision Tree (CART), Support Vector Machine, Random Forest (RF), Naive Gauss Bayes are used for the experiment. In above mentioned algorithms, Logistic Regression and Support Vector Machine have produced good results in predicting the stroke patient percentage from the group of participants in this experiment. The percentage of the stroke patients and normal persons is represented with a curve called as an Area Under Curve (AUC). Using VR Simulation, collected efficient Eye movements data which is beneficiary in detecting the cognitive deficits and has given birth to some other standard clinical applications.

INTRODUCTION

Nowadays, Conventional neuropsychological tests are not enough to represent the complex and dynamic situations encountered in daily life. Instead of them, Immersive Virtual Reality simulations can be used to simulate dynamic and interactive situations in a controlled manner. VR Simulations are very useful to identify the mental functioning of a person basing on the Eye movements. So, for that Eye tracking can be used to provide highly detailed outcome measures and it is very useful in neuropsychological assessment. Here to implement the Eye tracking, an experiment is conducted on the people consists of stroke patients and normal people. In this experiment, they are instructed to select a number of items (3 or 7) that are to be searched from a shopping list in a virtual super market environment in which eye movements of participants is being recorded. To differentiate the stroke person with normal person, Machine Learning Classifier algorithms like Logistic Regression, Linear Regression, Decision Tree (CART), Support Vector Machine, Random Forest (RF), Naive Gauss Bayes are used for the experiment. In above mentioned algorithms, Logistic Regression and Support Vector Machine have produced good results in predicting the stroke patient percentage from the group of participants in this experiment. The percentage of the stroke patients and normal persons is represented with a curve called as an Area Under Curve (AUC). Using VR Simulation, collected efficient Eye movements data which is beneficiary in detecting the cognitive deficits and has given birth to some other standard clinical applications.

LITERATURE SURVEY

[1]. Brouwer, V. H., Stuit, S., Hoogerbrugge, A., Ten Brink, A. F., Gosselt, I. K., Van derStigchel, S., & Nijboer, T. C. (2022). Applying machine learning to dissociate between stroke patients and healthy controls using eye movement features obtained from a computer game task. Heliyon, 8(4), e09207. eye tracking hardware, there's great promise in applying machine learning techniques to improve neuropsychological assessment using non-invasive, sensitive measures.All models were trained employing a 70/30 stratified training-test set split, meaning that 70% of knowledge was used to train the model and 30% was used to validate the model's accuracy after training. This split was stratified, which suggests that both the train- and test set maintained a roughly equal proportion of data of both classes (long vs short list, patients vs controls). To tackle residual imbalances in classes, model accuracies were measured by calculating Area Under the Curve (AUC).

[2]. Hosoda, C., Futami, K., Hosokawa, K., Isogaya, Y., Terada, T., Maruya, K., & Okanoya, K.(2021). The structure of the superior and inferior parietal lobes predicts inter-individual suitability for computer game . Scientific Reports, 11(1), 1-12. . We hypothesized that this will be attributed to differences in brain structure and function, especially within the SPL, the IPL, and therefore the CN. to deal with this hypothesis, we administered long-term VR sports training and tested whether patterns in specific brain areas, particularly the SPL, IPL, and CN, predicted the ability/inability to accumulate a high benefit from the VR training (high/low VR suitability).Subsequently, to verify the generalization in another task of the predictor for VR suitability, we tested whether the predictor of VR suitability created from VR sports training could also predict the suitability for VR short-term attention tasks (MOT).The results of the VR sports training suggested that the neural correlates of the VR suitability could be the SPL, IPL, and CN, which are liable for the stereoscopic vision and depth perception These results strongly support

our hypothesis that the common neural basis in the different tasks of VR suitability lies in the IPL, SPL, and CN.

[3]. Franceschiello, B., Di Noto, T., Bourgeois, A., Murray, M. M., Minier, A., Pouget, P., ... & Anselmi, F. (2022). Machine learning algorithms on eye tracking trajectories to classify patients with spatial neglect. Computer Methods and Programs in Biomedicine, 106929.We use traditional machine learning algorithms along with deep convolutional networks (both 1D and 2D) to automatically analyze eye trajectories. Moreover, the 1D convolutional neural network scores correlated with the degree of severity of neglect behavior as estimated with standardized paper-and-pencil tests and with the integrity of substantia alba tracts measured from Diffusion Tensor Imaging (DTI).

[4]. Mitre-Ortiz, A., Muñoz-Arteaga, J., & Cardona-Reyes, H. (2022). Developing a model to guage and improve user experience with hand motions in computer game environments. Universal Access within the knowledge Society, 1-15. within the sector of entertainment, the pc game industry is the one that has presented the greatest growth, and is that the foremost preferred by people. In 2019, the worldwide computer game market generated revenues of $152.1 billion, with a year-on-year increase of +9.6 percent, and by 2020 the estimated value was $196.0 billion with a Compound Annual rate of growth (CAGR) of +9.0 to face proud of 2018 to 2022. The results of this study showed that games are often implemented in computer game to improve the overall gaming experience. In general, most of these works address one or a few aspects of virtual reality environments.

[5]. Eye tracking could also be a non-invasive advanced technology that provides reliable multifaceted measures of an individual's saccades (rapid eye movements) whilst performing tasks. As a result, the utility of low-cost eye-tracking technologies in distinguishing an array of neurodegenerative disorders from their healthy counterparts has received much interest.

METHODOLOGY

This is the classification model in which the goal is to predict the discrete value like {0,1} or (yes, no) or (spam, not spam)..There are three sorts of classifications:

1. Binary Classification: Classification task with two possible outcomes.
2. Multi-class Classification: Classification with quite two classes.
3. Multi-label Classification: Classification task where each sample is mapped to line of target labels (more than one class).

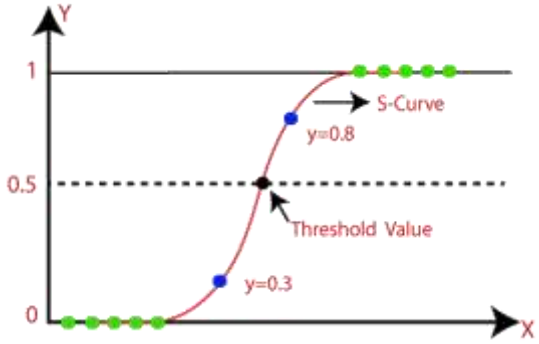
Methods used for classification are:

1. Logistic Regression
2. Decision Tree
3. K-Nearest Neighbours
4. Random Forest
5. Support Vector Machines

Logistic Regression:

Logistic regression could even be a machine learning algorithm for classification. during this algorithm, the probabilities describing the possible outcomes of a single trial are modelled using a logistic function.

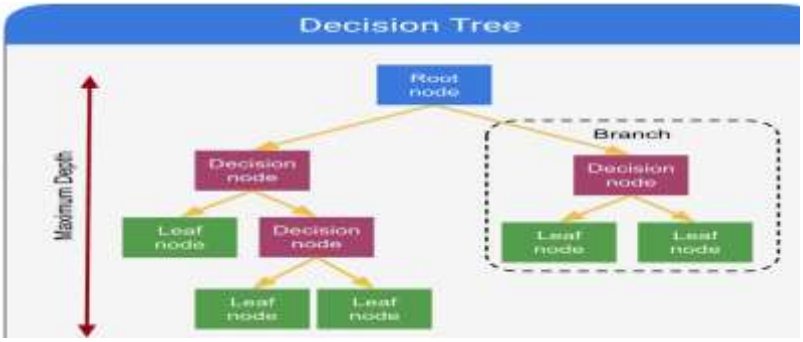
Logistic regression predicts the output of a categorical variable. Consequently, the outcome must be a discrete or categorical value.It are often either Yes or No, 0 or 1, true or False, etc. but 0 and 1. It provides probabilistic values between 0 and 1, rather than the precise value between 0 and 1.



It's designed for this purpose (classification), and is most useful for understanding the influence of several independent variables on one outcome variable. It Works only the anticipated variable is binary, assumes all predictors are independent of every other and assumes data is free of missing values.

Decision Tree:

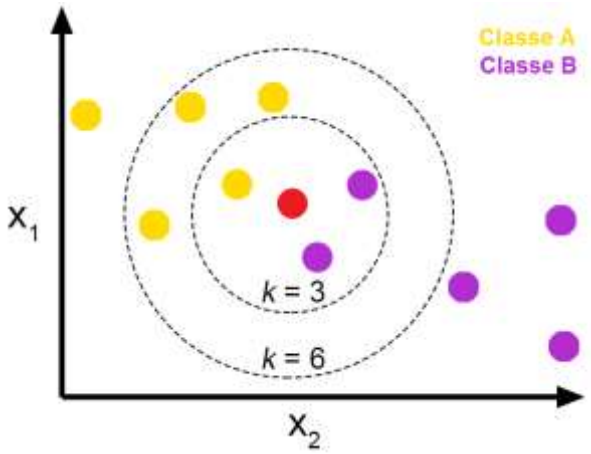
Decision Tree may be a supervised Learning technique that can be used for both classification and Regression problems, but mostly it's preferred for solving Classification problems. it's a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the choice rules and each leaf node represents the outcome.



Decision tree can create complex trees that don't generalize well, and decision trees are often unstable because small variations in the data might result in a completely different tree being generated.

K-Nearest Neighbor(KNN):

Neighbours based classification may be a type of lazy learning as it does not attempt to construct a general internal model, but simply stores instances of the training data. Classification is computed from an easy majority vote of the k nearest neighbours of each point.



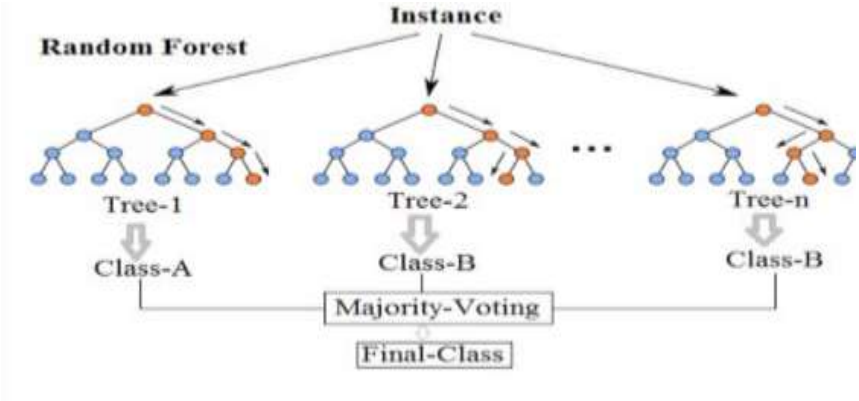
This algorithm is straightforward to implement, robust to noisy training data, and effective if training data is large. Have to determine the value of K and the computation cost is high as it needs to compute the distance of each instance to all the training samples

Random Forest:

Another well-known machine learning algorithm that uses the supervised learning method is Random Forest.. It is frequently used for ML issues involving both classification and regression. it's supported the concept of ensemble learning, which can be a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

Training time is less as compared to other algorithms.

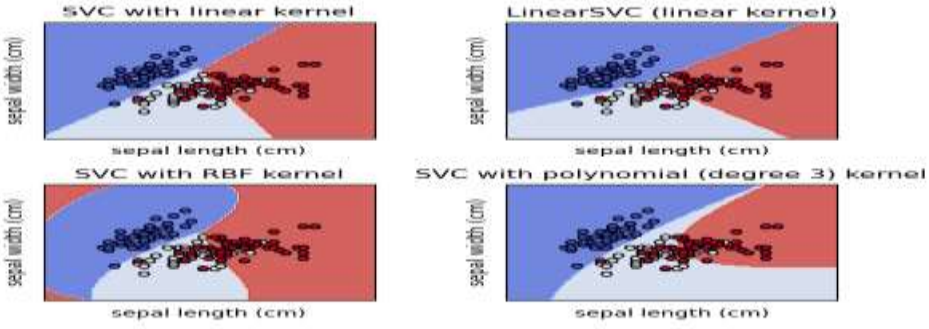
When a significant amount of the data is absent, accuracy can still be maintained..



Support Vector Machines:

Support Vector Machine or SVM is one among the most popular Supervised Learning algorithms, which is employed for Classification as well as Regression problems. However, primarily, it's used for Classification problems in Machine Learning.

- Linear SVM: Linear SVM is employed for linearly separable data, which suggests if a dataset can be classified into two classes by using a single straight line, then such data is termed as linearly separable data, and classifier is employed called as Linear SVM classifier.
- Non-linear SVM: Non-Linear SVM is employed for non-linearly separated data, which suggests if a dataset cannot be classified by using a straight line, then such data is termed as non-linear data and classifier used is named as Non-linear SVM classifier.



RESULT AND DISCUSSION

- There are three types of results like Low, Medium and High.
- These outputs are better in order to know the level of the disease.

S.No	Method	Accuracy
1.	Logistic Regression	67%
2.	Decision Tree	70%
3.	K-Nearest Neighbours	75%
4.	Random Forest	77%
5.	Support Vector Machines	80%

Conclusion

During this review we have attempted to explain and compare the performances of different machine learning algorithms on Eye Movement Tracking. This data suggest that the mechanisms underlying the weighted pattern voting algorithm are robust enough for a useful target estimation in a variety of human–computer interfaces. Our target inference algorithms are often adapted to various display types, since image filters commonly utilized in computer vision and behavioral studies can transform any display into a matrix of feature vectors. Moreover, the present data advocate that the future

designers of smart, gaze-controlled human–computer interfaces should keep the spatial complexity of display objects low so as to induce more distinctive patterns of eye movements for individual search targets.

Specifically, we identified variety of trends with respect to the types of machine learning methods being used, the kinds of training data being integrated, the sorts of endpoint predictions being made. the varied methods applied are LR, DT, KNN,RF,SVM. Among all SVM gives the more accuracy in Prediction of Stroke Patients. But within the KNN also we need to take care about the value of 'K', because supported the 'K' value accuracy differs more.

References:

[1]. Brouwer, V. H., Stuit, S., Hoogerbrugge, A., Ten Brink, A. F., Gosselt, I. K., Van der Stigchel, S., & Nijboer, T. C. (2022). Applying machine learning to dissociate between stroke patients and healthy controls using eye movement features obtained from a virtual reality task. Heliyon, 8(4), e09207.

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[5]. Readman, M. R., Polden, M., Gibbs, M. C., Wareing, L., & Crawford, T. J. (2021). ThePotential of Naturalistic Eye Movement Tasks in the Diagnosis of Alzheimer's Disease: A Review. Brain sciences, 11(11), 1503.

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