Retraction

Retraction: Analysis and Prediction of Epilepsy Using Heart Rate by Application of Ensemble Learning and Linear Regression (J. Phys.: Conf. Ser. 1916 012213)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Analysis and Prediction of Epilepsy Using Heart Rate by Application of Ensemble Learning and Linear Regression

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Abstract. In the existing methods the epilepsy was analysed using the PPG, EEG, ECG. The output obtained from the two different signals were analysed and found that the signal obtained while using ECG wearable sensor was more accurate and reliable when compared to the result obtained while using PPG. The main drawback while using EEG signal is the placement of wet scalp electrodes. Hence heart rate is used to analyse epilepsy in the proposed method in order to obtain accurate and reliable result. In this method analysing the heart rate signal of the patient and epilepsy death rate prediction are two main goals of the project. The biomedical sensors and wearable sensors currently available in the market was studied. Sensors like EEG, ECG, PPG characteristics, and their working were studied completely. In this paper, we have not used any biomedical sensors or wearable sensors. For the heart rate signal, the dataset from the “fitbase” website was collected. Heart rate data collection per minute average heartbeat of the person. heart rate signal data length was 12,000 But only 90 samples were used for ensemble averaging. Not only a heart rate of the signal we focused on epilepsy so we collected the epilepsy death rate data from the Statista. Epilepsy data contains year and death for future prediction; a linear regression algorithm was used.

Keywords: Ensemble learning, Linear regression, heart rate, epilepsy

1. Introduction
Analyzing the heart rate signal of the patient and epilepsy death rate prediction are two main goals of the project. First, we started to study the biomedical sensors and wearable sensors currently available in the market. To execute the idea, a research journal aids us to move on the right path. Sensors like EEG, ECG, PPG characteristics, and their working were studied completely [1]. In this paper, we have not used any biomedical sensors or wearable sensors. For the heart rate signal, the dataset from the “fitbase” website was collected. Heart rate data collection per minute average heartbeat of the person. Heart rate signal data length was 12,000 samples but in this paper, we had used only 90 samples for ensemble averaging. Not only a heart rate of the signal we focused on epilepsy as we collected the epilepsy death rate data from the Statista. Epilepsy data contains year and death for future prediction; we used a linear regression algorithm [2].

2. Heart rate signal processing:
The heart rate signal has a length of 12,000 sample signals to look like a random signal. In this paper, we had taken only 90 samples of heart rate signals [3]. Heart rate signals data consists of average heartbeat per minute. For 90 samples hear rate data denote 90 minutes time length. Our goal is to find the exact heartbeat for the 90 minutes of the person. To determine the heartbeat signals per minute data applied to the statistical ensemble learning method. Reason to choose the ensemble learning, This algorithm gives better performance to predict the heart rate per minute data [4].

Data signals samples consist of random data. To process the random data we used the ensemble learning averaging method. The first step picked the 90 data samples from the 12000 samples of the dataset and segregated the 90 data samples into three parts. Sample one 30 minutes data, sample two 30 minutes of data, and sample three 30 minutes of data heart signal. Processed the three different samples individually, each sample had a different mean value [5]. These three mean values are taken into account and divided by the total number of samples of signals. After processed ensemble learning, predicted heart rate signal for 90 minutes data was 55.488 beats/minutes [6].

**Heart Rate Analysis:**
The dataset of a person affected by epilepsy is collected from fitbase containing the heart rate for 90 minutes. The data set consists of heart rate of the paint in beats per minute as shown in Figure 1 [7].

**Data Separation and Averaging:**
The sample is segregated for 3 sets containing 30 minutes data each. Graph is plotted for the three samples, sample 1, sample 2, sample 3 respectively. Graph is plotted for each sample with heart rate in y-axis and duration in x-axis respectively [8].

**Ensemble Averaging:**
It is a method used in machine learning to obtain better predictive performance and remove the randomness from a signal. We are using averaging technique in order to remove the error component and find the accurate heart rate. Ensemble averaging is used to find the mean of the samples. It is obtained by using the formula sum of the samples divided by total number of samples. The average
heart rate is obtained using ensemble learning [9].

3. **Epilepsy rate Future prediction:**

Epilepsy data was taken from the Statista public dataset. The death rate of epilepsy patients in the United states country taken into account as shown in Figure 2. Samples had 18 data samples x-axis denotes the number of years 2002 to 2020 and the Y-axis denotes the Number of death rates of epilepsy patients per year. To process these signals we had used the linear regression technique. After executed the algorithm we obtained the slope and intercept of the epilepsy data. Using this slope and intercept of the mathematical algorithm we can predict the future value and year of an epilepsy death rate [10-15].

![Epilepsy Dataset](https://via.placeholder.com/150)

**EPILEPSY DATASET**

![Linear Regression Algorithm](https://via.placeholder.com/150)

**LINEAR REGRESSION ALGORITHM**

![Future Data Analysis](https://via.placeholder.com/150)

**FUTURE DATA ANALYSIS**

**Figure 2. Epilepsy Rate Future Prediction**

*Epilepsy dataset:*

Epilepsy data is taken from statista public dataset. Samples have 18 data samples x-axis denotes the number of years 2002 to 2020 and the Y-axis denotes the Number of death rates of epilepsy patients per year [16].

*Linear Regression Algorithm:*

Linear regression algorithm is used to predict the future outcome using the past available data.

\[ y = mx + c + e \]

- \( y \): total population that will be affected by epilepsy in the future
- \( m \): slope
- \( x \): duration (in year)
- \( c \): intercept
- \( e \): error component

*Future Data Analysis:*

After executing the algorithm the slope and intercept of the epilepsy data is obtained. Using this slope and intercept of the mathematical algorithm the future value and year of an epilepsy death rate can be predicted [17].
4. Resultant Graphs:

![Graphs showing heart rate samples](image)

**Figure 3.** Sample 1 (1-30mins), Sample 2 (30-60 mins), Sample 3 (60-90 mins), Sample (Mean of the samples)

Sample 1: It indicates the heart rate of the epileptic patient for the first 30 minutes.
Sample 2: It indicates the heart rate of the epileptic patient for 30-60 minutes.
Sample 3: It indicates the heart rate of the epileptic patient for 60-90 minutes.
Total Sample: For obtaining total sample, we have applied Statistical averaging.

Ensemble = mean(S1+S2+S3)/3

Here, S1 – Sample 1, S2-Sample 2, S3 – Sample 3

Linear regression has been applied for the data set containing the total percentage of population affected by epilepsy from 2002 to 2020 as shown in Figures 3 and 4. With this data percentage of population is predicted that will be affected by epilepsy in the future [18].

**Formula:**
y = mx + c

Here,
y - epilepsy death rate
m - slope
x - duration(year)
c - randomness(error component)
5. Conclusion

There were many drawbacks while using EEG and PPG signals while analysing epilepsy. Hence heart rate is used in the analysis of epilepsy in the proposed method. The above explained method can be used to identify the average heart rate of the person affected by epilepsy. This method can also be used for future prediction of percentage of population that will be affected by epilepsy. Measuring the heart rate of the human ECG biomedical device and wearable device gives a better result but PPG doesn't give proper heart rate signals. In this paper heart rate signals taken from the Fitbase public dataset and processed heart rate signal in the ensemble learning averaging method. Epilepsy death rate signals data processed in linear regression and predicted the future value death rate [19].

References

[1] Amengual-Gual, M., Ulate-Campos, A., & Loddenkemper, T. (2019). Status epilepticus prevention, ambulatory monitoring, early seizure detection and prediction in at-risk patients. Seizure: The Journal of the British Epilepsy Association, 68, 31–37.
[2] Brotherstone, R., McLellan, A., Graham, C., & Fisher, K. (2020). A clinical evaluation of a novel algorithm in the reliable detection of epileptic seizures. Seizure: The Journal of the British Epilepsy Association, 82, 109–117.
[3] Bruno, E., Biondi, A., Thorpe, S., Richardson, M. P., & RADAR-CNS Consortium. (2020). Patients self-mastery of wearable devices for seizure detection: A direct user-experience. Seizure: The Journal of the British Epilepsy Association, 81, 236–240.
[4] Chatterjee, S., Ray Choudhury, N., & Bose, R. (2017). Detection of epileptic seizure and seizure-free EEG signals employing generalised S-transform. IET Science, Measurement and Technology Technology, 11(7), 847–855.
[5] De Cooman, T., Varon, C., Van de Vel, A., Jansen, K., Ceulemans, B., Lagae, L., & Van Huffel, S. (2018). Adaptive nocturnal seizure detection using heart rate and low-complexity novelty detection. Seizure: The Journal of the British Epilepsy Association, 59, 48–53.
[6] Fergus, P., Hignett, D., Hussain, A. J., & Al-Jumeily, D. (2014). An advanced machine learning approach to generalised epileptic seizure detection. In Intelligent Computing in Bioinformatics (pp. 112–118). Cham: Springer International Publishing.
A., & Zhang, Y. (2020). Epilepsy seizure detection using complete ensemble empirical mode decomposition with adaptive noise. Knowledge-Based Systems, 191(105333), 105333.

[9] Jiang, Y., Cai, M.-Y., Yang, Y., Geng, J.-H., Zhang, Y., Zhang, L.-P., … Ni, F.-L. (2021). Prediction of in-hospital mortality in status epilepticus: Evaluation of four scoring tools in younger and older adult patients. Epilepsy & Behavior: E&B, 114(Pt A), 107572.

[10] S, D., & H, A. (2019). AODV Route Discovery and Route Maintenance in MANETs. 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS). doi:10.1109/icaccs.2019.8728456

[11] H. Anandakumar and K. Umamaheswari, An Efficient Optimized Handover in Cognitive Radio Networks using Cooperative Spectrum Sensing, Intelligent Automation & Soft Computing, pp. 1–8, Sep. 2017. doi:10.1080/10798587.2017.1364931 .

[12] Mahmoodian, N., Boese, A., Friebe, M., &Haddadnia, J. (2019). Epileptic seizure detection using cross-bispectrum of electroencephalogram signal. Seizure: The Journal of the British Epilepsy Association, 66, 4–11.

[13] van Westhreren, A., Souhoka, T., Ballieux, M. E., & Thijs, R. D. (2021). Seizure detection devices: Exploring caregivers’ needs and wishes. Epilepsy & Behavior: E&B, 116(107723), 107723.

[14] Witt, J.-A., Krutenko, T., Guedeke, M., Surges, R., Elger, C. E., &Helmstaedter, C. (2019). Accuracy of expert predictions of seizure freedom after epilepsy surgery. Seizure: The Journal of the British Epilepsy Association, 70, 59–62.

[15] Witt, J.-A., Krutenko, T., Guedeke, M., Surges, R., Elger, C. E., &Helmstaedter, C. (2019). Accuracy of expert predictions of seizure freedom after epilepsy surgery. Seizure: The Journal of the British Epilepsy Association, 70, 59–62.

[16] Yan, P., Melman, T., Yan, S., Otgonsuren, M., &Grinspan, Z. (2017). Evaluation of a novel median power spectrogram for seizure detection by non-neurophysiologists. Seizure: The Journal of the British Epilepsy Association, 50, 109–117.

[17] Yan, P., Melman, T., Yan, S., Otgonsuren, M., &Grinspan, Z. (2017). Evaluation of a novel median power spectrogram for seizure detection by non-neurophysiologists. Seizure: The Journal of the British Epilepsy Association, 50, 109–117.

[18] Yan, P. Z., Wang, F., Kwok, N., Allen, B. B., Keros, S., &Grinspan, Z. (2019). Automated spectrographic seizure detection using convolutional neural networks. Seizure: The Journal of the British Epilepsy Association, 71, 124–131.

[19] Yang, A., Arndt, D. H., Berg, R. A., Carpenter, J. L., Chapman, K. E., Dlugos, D. J., … Abend, N. S. (2015). Development and validation of a seizure prediction model in critically ill children. Seizure: The Journal of the British Epilepsy Association, 25, 104–111.

[20] Yuan, Q., Zhou, W., Zhang, L., Zhang, F., Xu, F., Leng, Y., … Chen, M. (2017). Epileptic seizure detection based on imbalanced classification and wavelet packet transform. Seizure: The Journal of the British Epilepsy Association, 50, 99–108.

[21] Zibrandtsen, I. C., Kidmose, P., &Kjaer, T. W. (2018). Detection of generalized tonic-clonic seizures from eeg-EEG based on EMG analysis. Seizure: The Journal of the British Epilepsy Association, 59, 54–59.