OPTIMIZING ELECTROCONVULSIVE THERAPY PARAMETERS USING MACHINE LEARNING

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Presentation Outline

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Project background

Electroconvulsive therapy (ECT) is a medical treatment that involves passing a carefully controlled electrical current through the brain.[1]

ECT is utilized for severe psychiatric disorders, often when other treatments such Medication and Psychotherapy prove ineffective.

Patient undergoing ECT

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[1] American Psychiatric Association. (2016). The Practice of Electroconvulsive Therapy: Recommendations for Treatment, Training, and Privileging. American Psychiatric Association Publishing.

Project background

The process of ECT includes:

- Preparation and Evaluation
- Anesthesia
- Muscle Relaxant
- Electrode Placement
- Electric Stimulation
- Monitoring
- Recovery

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[2] American Psychiatric Association "Electroconvulsive Therapy (ECT)", https://www.psychiatry.org/patients-families/ect#:~:text=At%20the%20time%20of%20each,lasts%20for%20approximately%20a%20minute, Published: January 2023,Accessed: November 16, 2023

Project background

Key Factors Affecting ECT Success (Parameters)[3]

- Electrical stimulation (pulse stimuli and wave stimuli)
- Electrode placement (Bilateral or Unilateral)
- Induced seizure duration (usually 20s-30s)
- Pulse width and Pulse frequency
- Sex
- Blood pressure
- Weight

[3] Andrade C. Electroconvulsive therapy. In: Bhugra D, Ranjith G, Patel V, editors. *Handbook of Psychiatry: A South Asian Perspective.* New Delhi: Byword Publishers; 2005. pp. 553–68. [Google Scholar]

Project background

Key Factors Affecting ECT Success (Parameters)[3]:

- Stimulus dose (50-100 millicoulombs)
- Energy (ectonustim-constant-current-series)

Cognitive impairment and memory loss in electroconvulsive therapy are associated with the extent to which the stimulus dose surpasses the patient's suprathreshold [4]

[4] Andrade C. Electroconvulsive therapy. In: Bhugra D, Ranjith G, Patel V, editors. *Handbook of Psychiatry: A South Asian Perspective.* New Delhi: Byword Publishers; 2005. pp. 553–68. [Google Scholar]

Problem Statement

In practical situations, due to the unavailability of clear measures for the values of ECT parameters values, psychiatrists often either over or under-measure. Therefore, identifying an optimal approach is crucial to assist psychiatrists in applying accurate parameter values

Existing Solutions

1. **Prediction of the dosage of the electric stimulus needed for Electroconvulsive Therapy (ECT) based on patient's pre-ictal EEG using Artificial Intelligence [5]**

Aim: Use ML to develop a method for determining personalized electric stimulus dosages for Electroconvulsive Therapy (ECT) in MDD patients

Techniques Used: Fast Fourier Transform (FFT) and Fuzzy Causal Effect Variational Auto Encoder (FCEVAE) deep learning algorithm.

Flaws and limitations: FCEVAE model takes 30 minutes for ECT dosage prediction

[5] G. K. Nirush, B. N. Gangadhar, N. Janakiramaiah, and R. K. Lalla, "Seizure threshold in ECT: effect of stimulus pulse frequency," *Clinical Trial J ECT*, vol. 19, no. 3, pp. 133-135, Sep. 2003. DOI: 10.1097/00124509-200309000-00003.

Existing Solutions

2. Prediction of individual responses to electroconvulsive therapy in patients with schizophrenia: Machine learning analysis of resting-state electroencephalography

Aim: Aim was to predict individual responses to electroconvulsive therapy (ECT) in patients with schizophrenia using machine learning

Techniques Used: Transfer entropy from EEG data ,a random forest classifier, and RSFS.

Flaws and limitations: Small sample size(47).

[6]B. Min, M. Kim, J. Lee, J.-I. Byun, K. Chu, K.-Y. Jung and J. S. Kwon, "Prediction of individual responses to electroconvulsive therapy in patients with schizophrenia," *Schizophr Res*, vol. 216, pp. 147-153, Feb. 2020. doi: 10.1016/j.schres.2019.12.012. Epu 2019 Dec 26.

Existing Solutions

3. A Machine Learning Approach to Optimizing Electroconvulsive Therapy Parameters

Aim: To develop a ML model to optimize ECT parameters, including dosage, seizure duration, and stimulation frequency.

Techniques Used: Random Forest and LASSO were used for prediction, while Support Vector Machines was used for optimization and classification tasks.

Flaws and limitations: The study was limited by its small sample size(100).

[7] Sun et al. A Machine Learning Approach to Optimizing Electroconvulsive Therapy Parameters,Frontiers in Psychiatry,2022,https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2933093/

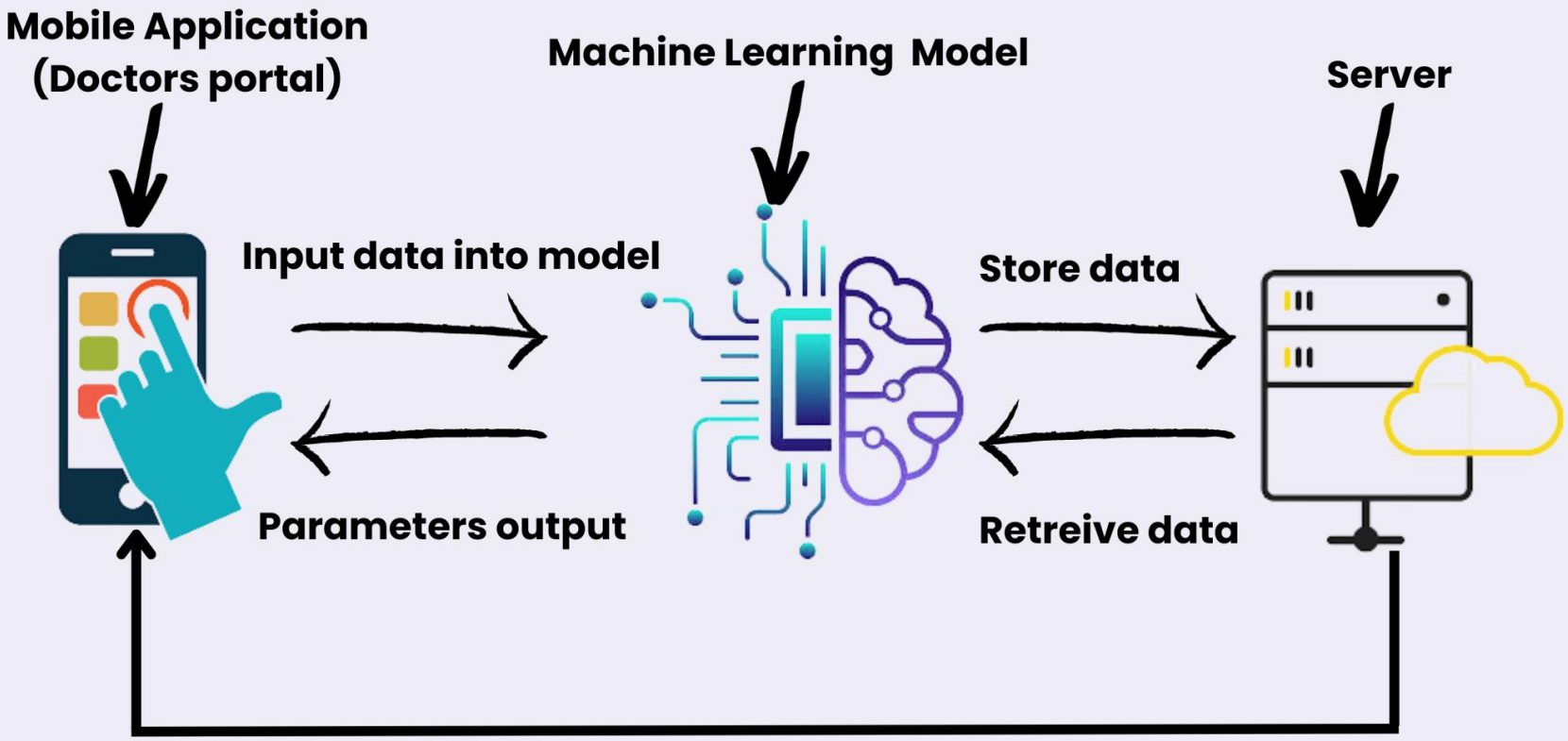
Proposed solution

We propose to use machine learning, specifically a genetic algorithm, to predict the accurate parameters needed for Electroconvulsive Therapy (ECT). The genetic algorithm will iteratively analyze patient data and the ECT device configuration, adapting and evolving parameter configurations to optimize precision.

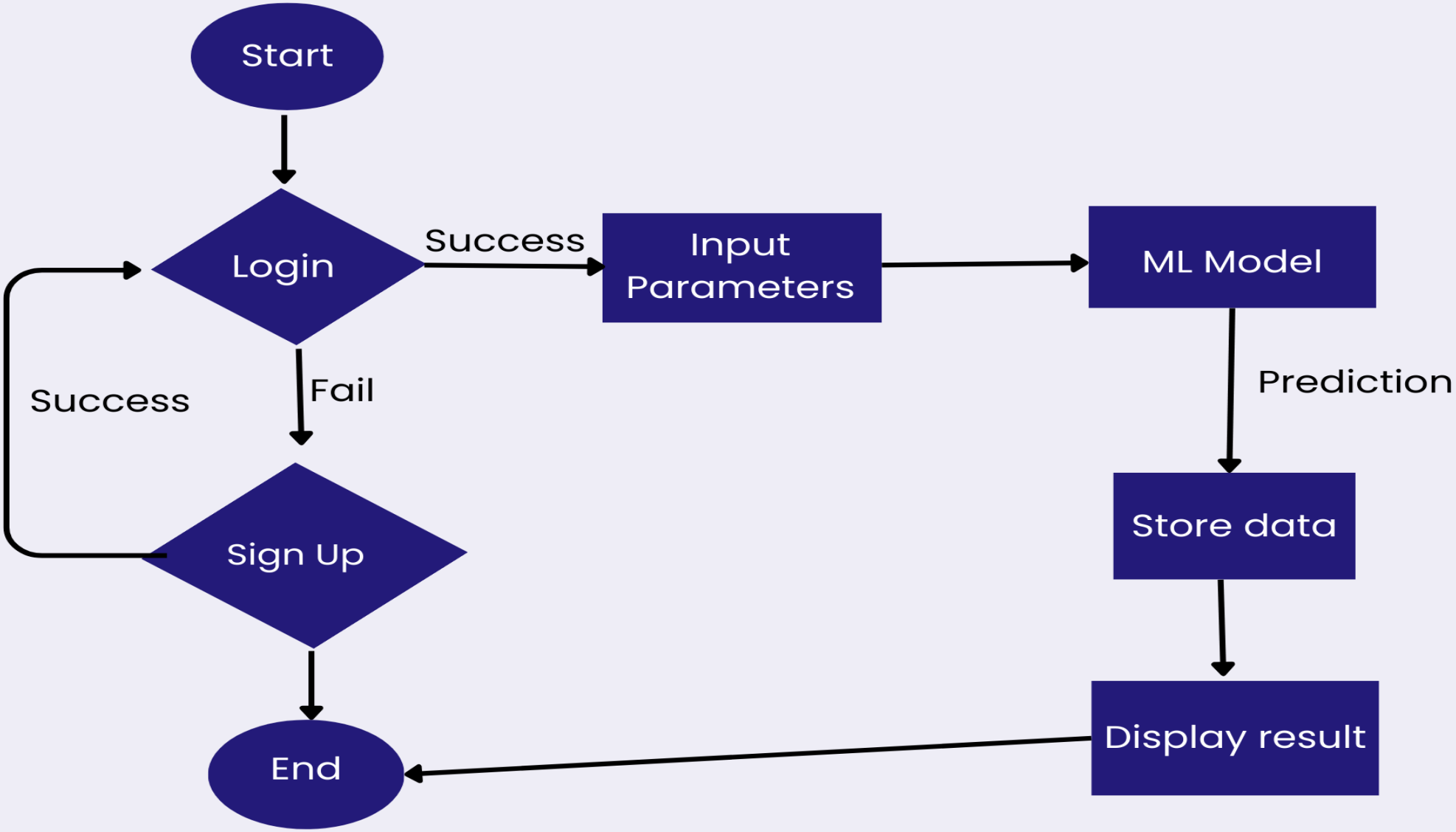
Objectives

1. Develop a machine learning model to help in optimizing ECT parameters.
2. Create a mobile app for the psychiatrists.
3. Generate statistics on patients' recovery based on the data we provide.

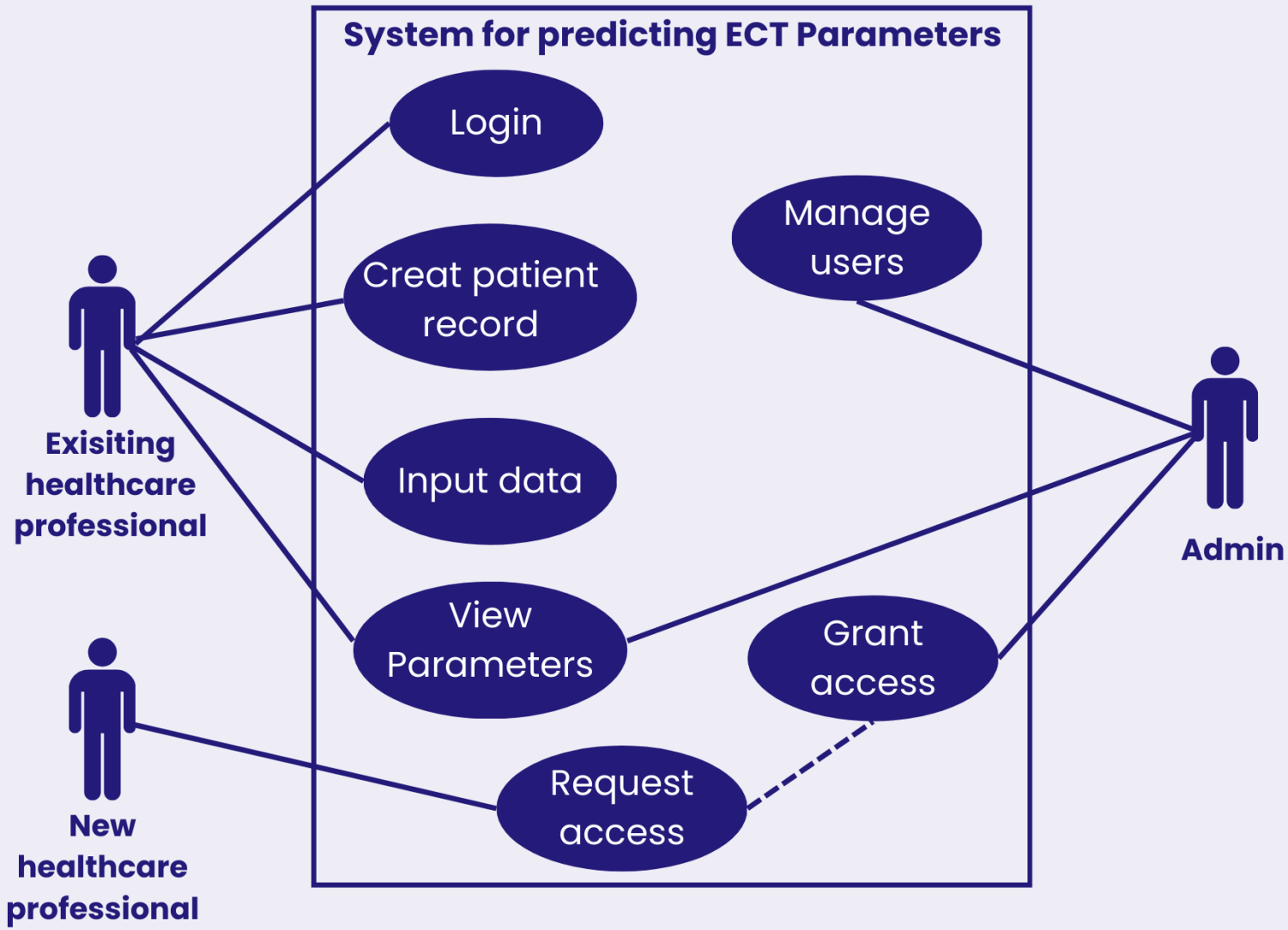
Architectural Diagram



Flow diagram



Use Case Diagram



Project Relevance

Upon successful completion, the project aims to:

1. Decrease the risk of electric stimulus overdose , thereby minimizing cognitive side effects and memory loss.
2. Alleviate the burden on psychiatric personnel by automating the calculation of parameters.

Material Requirements And Logistics

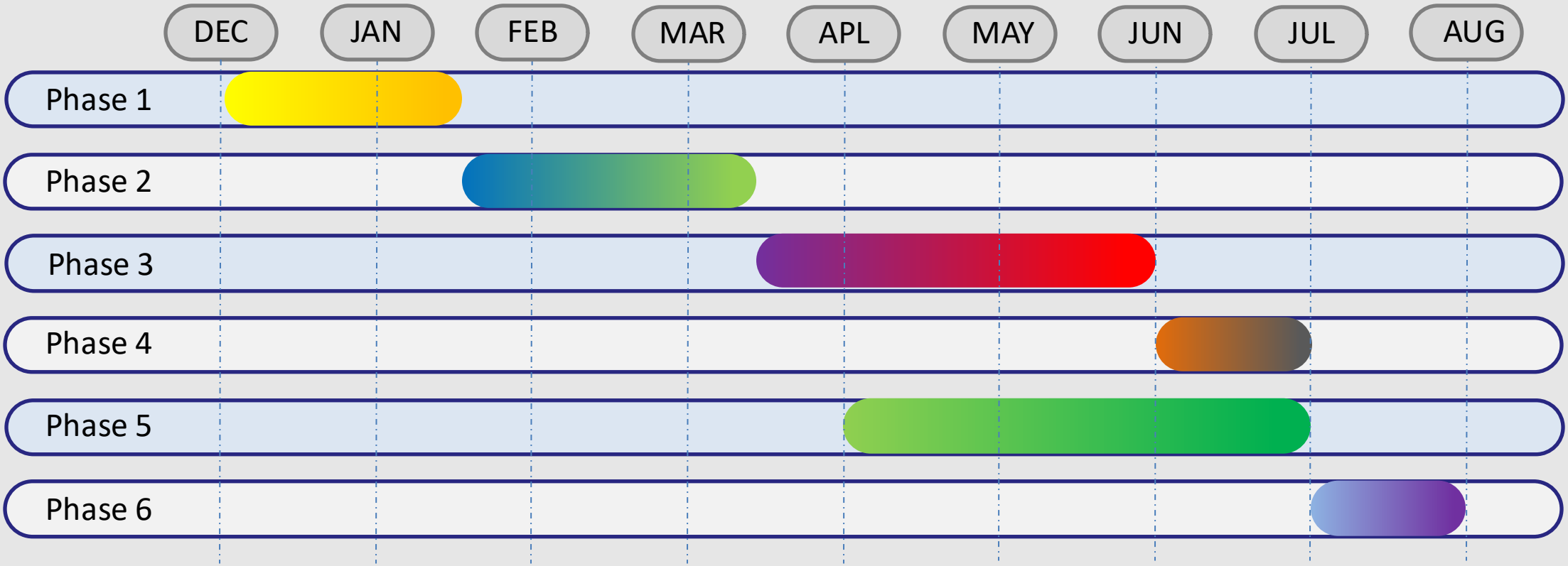
- MongoDB
- Python
- Google Cloud
- TensorFlow
- Datasets from health records
- React Native
- Nodejs

Estimated Cost

- MongoDB = 25 USD
- Render = 19 USD
- Google Cloud = 300 USD

Total cost = 344 USD

Project Timeline



Phase1: Data collection
Phase2: Data preprocessing
Phase3: Model Design and training
Phase4: Model evaluation and testing
Phase5: Mobile development
Phase 6: Integration of ML model into the mobile application and testing

Conclusion

- The project optimizes ECT parameters with a machine learning approach, utilizing a genetic algorithm.
- The model refines parameters based on patient data and device info, ensuring precision in Electroconvulsive Therapy.
- The mobile app and machine learning model provide psychiatrists an advanced, accessible tool, marking a significant step in integrating technology into psychiatric practice.

References

[1] American Psychiatric Association. (2016). The Practice of Electroconvulsive Therapy: Recommendations for Treatment, Training, and Privileging. American Psychiatric Association Publishing.
[2] American Psychiatric Association "Electroconvulsive Therapy (ECT)", https://www.psychiatry.org/patients-families/ect#:~:text=At%20the%20time%20of%20each,lasts%20for%20approximately%20a%20minute, Published: January 2023,Accessed: November 16, 2023
[3] Andrade C. Electroconvulsive therapy. In: Bhugra D, Ranjith G, Patel V, editors. *Handbook of Psychiatry: A South Asian Perspective.* New Delhi: Byword Publishers; 2005. pp. 553–68. [Google Scholar]
[4] McCall WV, Reboussin DM, Weiner RD, et al. Titrated moderately suprathreshold fix high-dose right unilateral electroconvulsive therapy: acute antidepressant and cognitive effects. Archive of General Psychiatry. 2000; 57:438-44.

References

[5] G. K. Nirush, B. N. Gangadhar, N. Janakiramaiah, and R. K. Lalla, "Seizure threshold in ECT: effect of stimulus pulse frequency," *Clinical Trial J ECT*, vol. 19, no. 3, pp. 133-135, Sep. 2003. DOI: 10.1097/00124509-200309000-00003.

[6] B. Min, M. Kim, J. Lee, J.-I. Byun, K. Chu, K.-Y. Jung and J. S. Kwon, "Prediction of individual responses to electroconvulsive therapy in patients with schizophrenia," *Schizophr Res*, vol. 216, pp. 147-153, Feb. 2020. doi: 10.1016/j.schres.2019.12.012. Epub 2019 Dec 26.

[7] Sun et al. A Machine Learning Approach to Optimizing Electroconvulsive Therapy Parameters,Frontiers in Psychiatry,2022,https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2933093/