

# **Interpretable Machine Learning of PET Imaging for Individualized Predictions of Seizure Outcomes after Temporal Lobe Epilepsy Surgery**

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## Introduction

## The Data

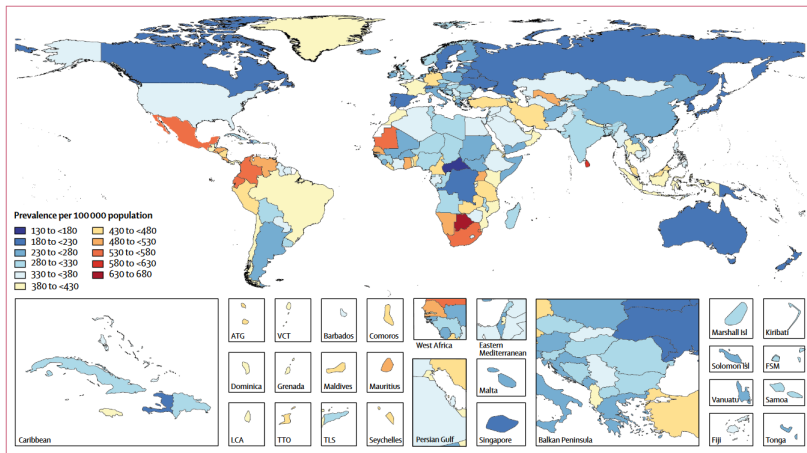
## The Model

## The Explanation

## Conclusion

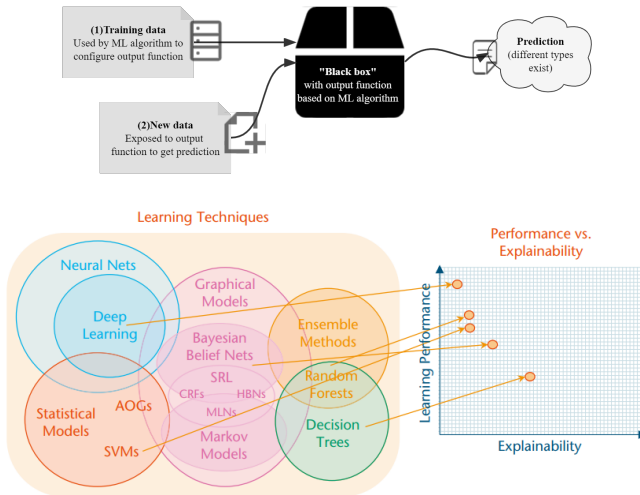
# Introduction

# Background



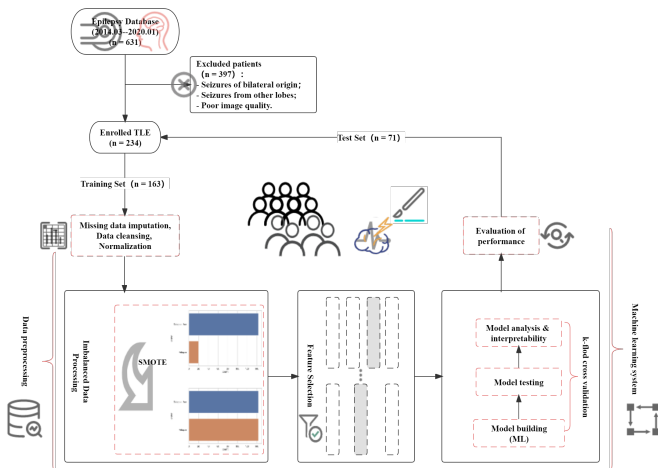
**Figure 1:** Epilepsy Epidemiology

# Aims



**Figure 2:** Focus on Interpretability of ML

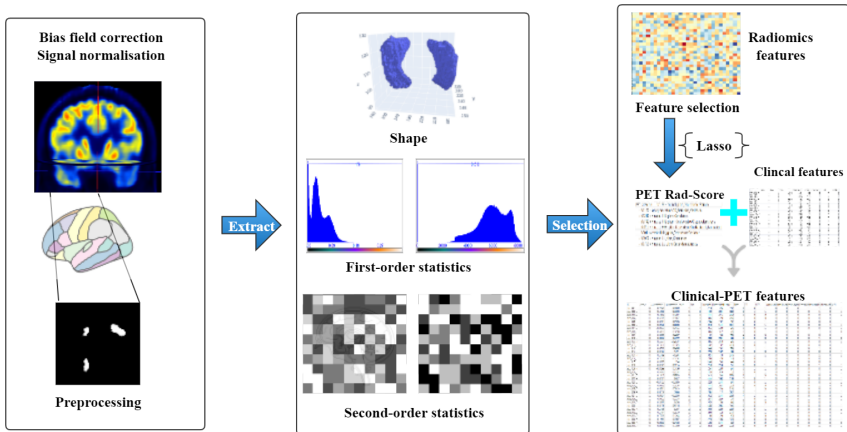
# Scheme



**Figure 3:** Flowchart of TLE Postsurgical IML

# The Data

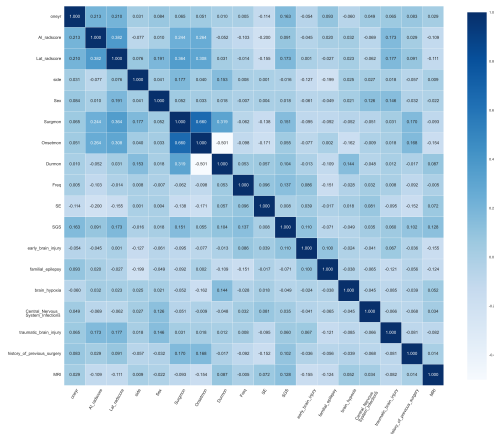
# Combined of PET Radiomics and Clinical Features



**Figure 4:** PET Radiomics Score and Clinical-PET Features



# Exploratory Data Analysis



**Figure 5:** Heatmap of Clinical-PET Features

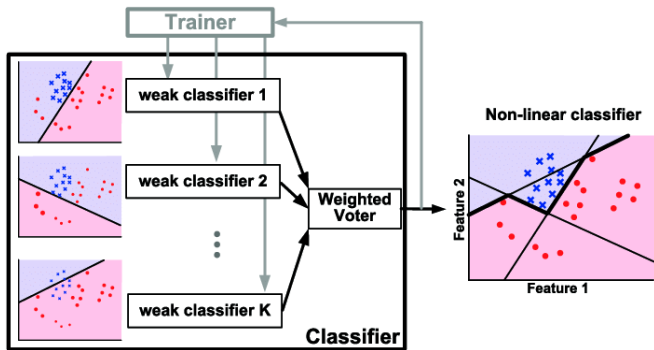
# The Model

# Benchmark

**Table 1:** Performance Comparison Eleven ML algorithms and K-folds Cross-validation of the Selected AdaBoost

Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC	Folds\Tuned_Ada Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC	APC
Ada Boost Classifier	0.883	0.789	0.400	0.433	0.393	0.345	0.357	1	0.882	0.733	0.000	0.000	0.000	0.000	0.361
Extreme Gradient Boosting	0.884	0.777	0.300	0.400	0.333	0.287	0.295	2	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Random Forest Classifier	0.884	0.763	0.200	0.350	0.250	0.217	0.230	3	0.824	0.550	0.000	0.000	0.000	-0.085	-0.091
Gradient Boosting Classifier	0.890	0.762	0.350	0.483	0.390	0.346	0.360	4	0.875	0.893	0.000	0.000	0.000	0.000	0.500
Light Gradient Boosting Machine	0.859	0.749	0.250	0.325	0.267	0.211	0.221	5	0.938	0.929	0.500	1.000	0.667	0.636	0.683
Logistic Regression	0.878	0.669	0.050	0.100	0.067	0.055	0.059	6	0.938	0.964	0.500	1.000	0.667	0.636	0.683
Extra Trees Classifier	0.884	0.662	0.100	0.200	0.133	0.118	0.127	7	0.875	0.554	0.000	0.000	0.000	0.000	0.321
K Neighbors Classifier	0.865	0.646	0.200	0.200	0.183	0.140	0.149	8	0.938	0.964	0.500	1.000	0.667	0.636	0.683
Linear Discriminant Analysis	0.884	0.642	0.100	0.200	0.133	0.119	0.128	9	0.938	1.000	0.500	1.000	0.667	0.636	0.683
Naive Bayes	0.251	0.586	0.900	0.129	0.226	0.014	0.072	10	0.938	0.679	0.500	1.000	0.667	0.636	0.683
Decision Tree Classifier	0.798	0.584	0.300	0.264	0.259	0.158	0.167	Mean	0.914	0.827	0.350	0.600	0.433	0.410	0.432
								Std	0.047	0.172	0.320	0.490	0.367	0.368	0.384

# AdaBoost Algorithm



**Figure 6:** Illustration of AdaBoost Algorithm

- `AdaBoostClassifier(algorithm='SAMME',  
base_estimator=None, learning_rate=0.2,  
n_estimators=230, random_state=123)`

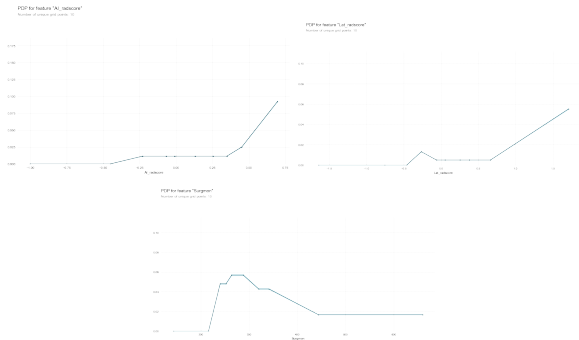
# The Explanation

# Permutation Importance

Weight Feature	
0.0394 ± 0.0329	AI_radscore
0.0197 ± 0.0138	Lat_radscore
0.0085 ± 0.0138	Durmon
0.0085 ± 0.0138	SGS
0.0028 ± 0.0113	Onsetmon
0 ± 0.0000	Freq
0 ± 0.0000	side
0 ± 0.0000	Sex
0 ± 0.0000	MRI
0 ± 0.0000	history_of_previous_surgery
0 ± 0.0000	early_brain_injury
0 ± 0.0000	familial_epilepsy
0 ± 0.0000	brain_hypoxia
0 ± 0.0000	Central_Nervous_System_Infections
0 ± 0.0000	traumatic_brain_injury
0 ± 0.0000	SE
-0.0028 ± 0.0113	Surgmon

**Figure 7:** Permutation Importance of AdaBoost

# Partial Dependence Plot



# Conclusion



## Key Points

- Metabolic radiomics are helpful to predict the postsurgical seizure outcomes;
- Combination of PET Radiomics and Clinical Features are more robust;
- IML technique can further deepen the understanding of the principle of ML models and the decision-making process for professional and intuitive interpretation

# Limitations

- More data, especially external validation cohort;
- Fusion of PET/MRI multimodal imaging;
- Other subtypes of drug-resistant epilepsy

For more theoretical approaches to machine learning model explanation, see [Interpretable Machine Learning: A Guide for Making Black Box Models Explainable](#), refer to (Beghi et al., 2019), (Rajpurkar, 2021), (Marc Becker, 2022), (Molnar, 2022).

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Introduction  
2022

The  
2022

The  
2022

The Explanation  
2022

Conclusion  
2022

Reference  
2022

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# THANKS !



# References I

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