基于人工智能技术在颞叶癫痫患者^{18}F-FDG PET/MRI多模态影像研究

汇报人：吴环华
导师：徐浩　教授*

暨南大学第一临床医学院

2023-02-14

暨南大学附属第一医院
THE FIRST AFFILIATED HOSPITAL OF JINAN UNIVERSITY
廣州華僑醫院
GUANGZHOU OVERSEAS CHINESE HOSPITAL

暨南大學
JINAN UNIVERSITY

第一部分绪论

Background

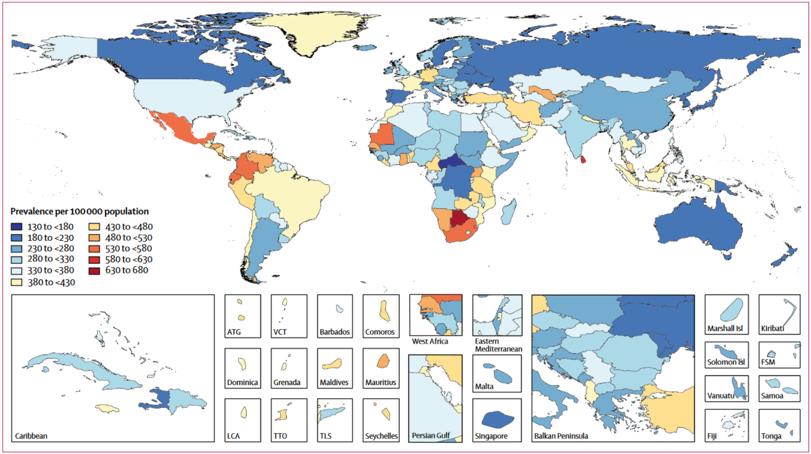


图 1: Epilepsy Epidemiology

Aims

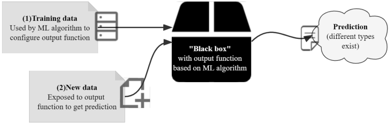


图 2: Black-box of AI

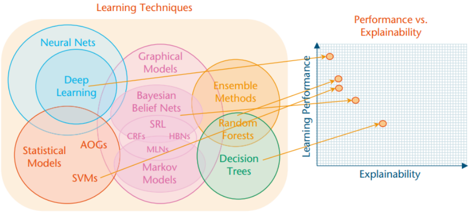


图 3: Learning Performance Versus Explainability Trade-Off of AI

Scheme

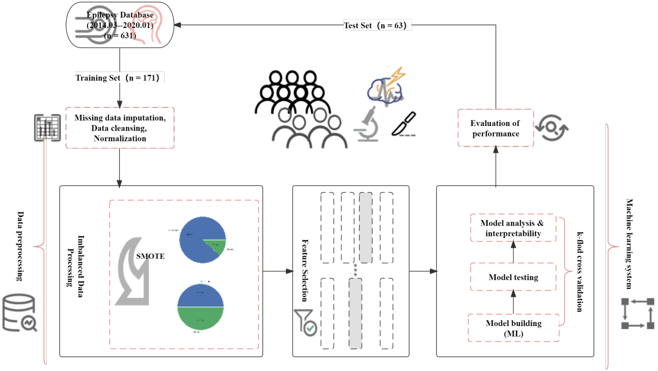


图 4: Flowchart of TLE Postsurgical IML

第二部分　颞叶癫痫患者术前定位研究

Combined of PET Radiomics and Clinical Features

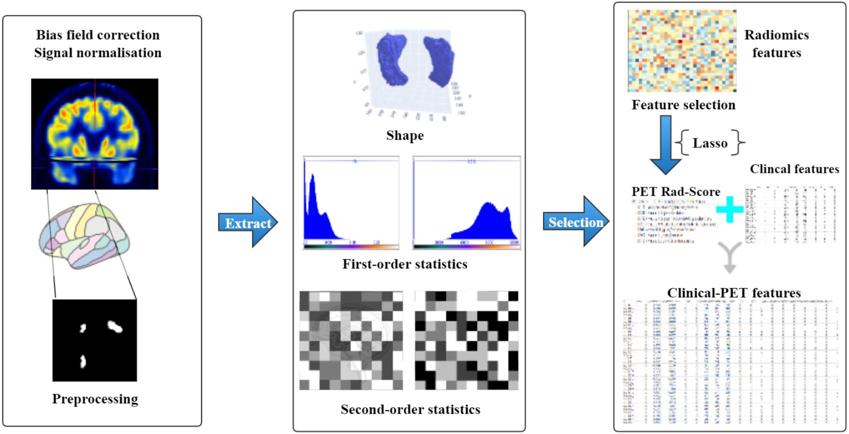


图 5: PET Radiomics Score and Clinical-PET Features

Exploratory Data Analysis

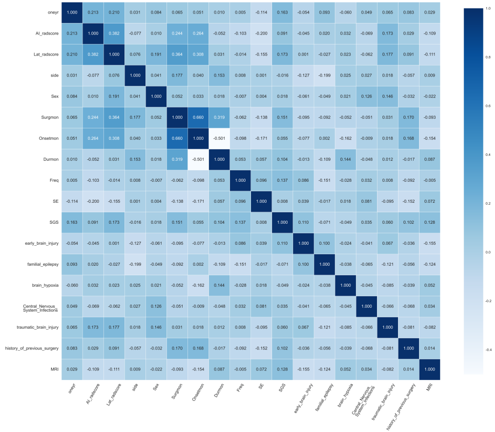


图 6: Heatmap of Clinical-PET Features

The Model

Benchmark

Table 1: Performance Comparison Eleven ML Algorithms

Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC	APC
Ada Boost Classifier	0.883	0.789	0.4	0.433	0.393	0.345	0.357	0.59
Extreme Gradient Boosting	0.884	0.777	0.3	0.4	0.333	0.287	0.295	0.607
Random Forest Classifier	0.884	0.763	0.2	0.35	0.25	0.217	0.23	0.612
Gradient Boosting Classifier	0.89	0.762	0.35	0.483	0.39	0.346	0.36	0.591
Light Gradient Boosting Machine	0.859	0.749	0.25	0.325	0.267	0.211	0.221	0.512
Logistic Regression	0.878	0.669	0.05	0.1	0.067	0.055	0.059	0.448
Extra Trees Classifier	0.884	0.662	0.1	0.2	0.133	0.118	0.127	0.443
K Neighbors Classifier	0.865	0.646	0.2	0.2	0.183	0.14	0.149	0.283
Linear Discriminant Analysis	0.884	0.642	0.1	0.2	0.133	0.119	0.128	0.418
Naive Bayes	0.251	0.586	0.9	0.129	0.226	0.014	0.072	0.332
Decision Tree Classifier	0.798	0.584	0.3	0.264	0.259	0.158	0.167	0.218
Std	0.047	0.172	0.320	0.490	0.367	0.368	0.384	0.200

AdaBoost Algorithm

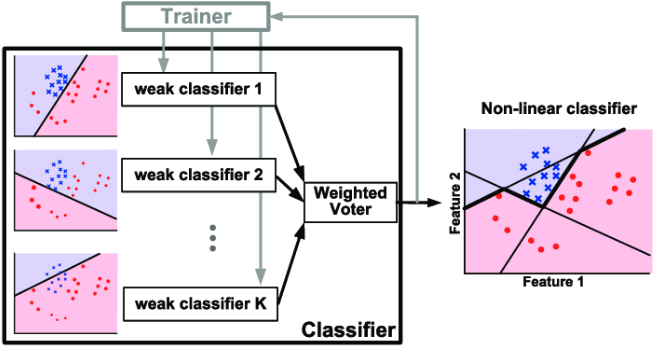


图 7: Illustration of AdaBoost Algorithm

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

Tuned AdaBoost

Table 2: K-folds Cross-validation of the Selected AdaBoost

Tuned_Ada	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC	APC
1	0.882	0.733	0.000	0.000	0.000	0.000	0.000	0.361
2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
3	0.824	0.550	0.000	0.000	0.000	-0.085	-0.091	0.183
4	0.875	0.893	0.000	0.000	0.000	0.000	0.000	0.500
5	0.938	0.929	0.500	1.000	0.667	0.636	0.683	0.750
6	0.938	0.964	0.500	1.000	0.667	0.636	0.683	0.833
7	0.875	0.554	0.000	0.000	0.000	0.000	0.000	0.321
8	0.938	0.964	0.500	1.000	0.667	0.636	0.683	0.833
9	0.938	1.000	0.500	1.000	0.667	0.636	0.683	1.000
10	0.938	0.679	0.500	1.000	0.667	0.636	0.683	0.591
Mean	0.914	0.827	0.350	0.600	0.433	0.410	0.432	0.637
Std	0.047	0.172	0.320	0.490	0.367	0.368	0.384	0.200

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

图 8: Permutation Importance of AdaBoost

Partial Dependence Plot

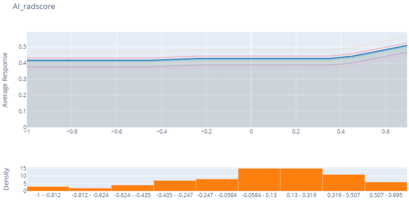
PDP plots:

Partial Dependence Plot

PDP plots:

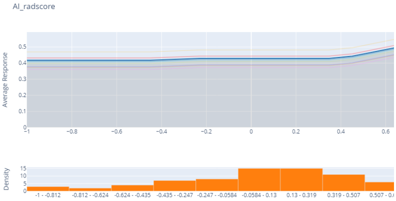
Partial Dependence Plot

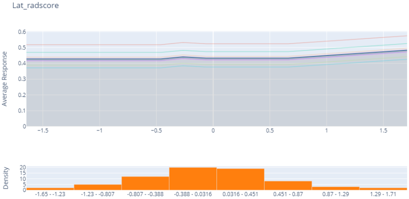
PDP plots:



Partial Dependence Plot

PDP plots:





Conclusion

Key Points

- Metabolic radiomics are helpful to predict the postsurgical seizure outcomes;

Key Points

- Metabolic radiomics are helpful to predict the postsurgical seizure outcomes;

- Combination of PET Radiomics and Clinical Features are more robust;

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;

Limitations

- More data, especially external validation cohort;
- Fusion of PET/MRI multimodal imaging;

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).

Email: wane199@outlook.com

THANKS !

Beghi, Ettore, Giorgia Giussani, Emma Nichols, Foad Abd-Allah, Jemal Abdela, Ahmed Abdelalim, Haftom Niguse Abraha, et al. 2019. "Global, Regional, and National Burden of Epilepsy, 1990–2016: A Systematic Analysis for the Global Burden of Disease Study 2016." *The Lancet Neurology* 18 (4): 357–75.

Marc Becker, et al. 2022. *Mlr3book*. https://mlr3book.mlr-org.com.

Molnar, Christoph. 2022. *Interpretable Machine Learning: A Guide for Making Black Box Models Explainable*. 2nd ed. https://christophm.github.io/interpretable-ml-book.

Rajpurkar, Pranav Samir. 2021. *Deep Learning for Medical Image Interpretation*. Stanford University.

暨南大學
JINAN UNIVERSITY