B.R.A.I.N. Lab
Biopsychological Research on Aging, Inflammation, and Neuropsychiatry
Studying Mental Illness and Wellness

Machine learning
Artificial intelligence
Neuro
Imaging
Focusing
On
Longevity &
Dementia
Laboratory

UCL

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Application of XAI to brain age prediction models

Hui Xin Ng

23 May 2024

Overview

- Predicting age from neuroimaging data
- Interpretability and explainability methods
- Factors to consider when applying interpretability and explainability methods
- Code Demo
- Relevance to multimodal AI

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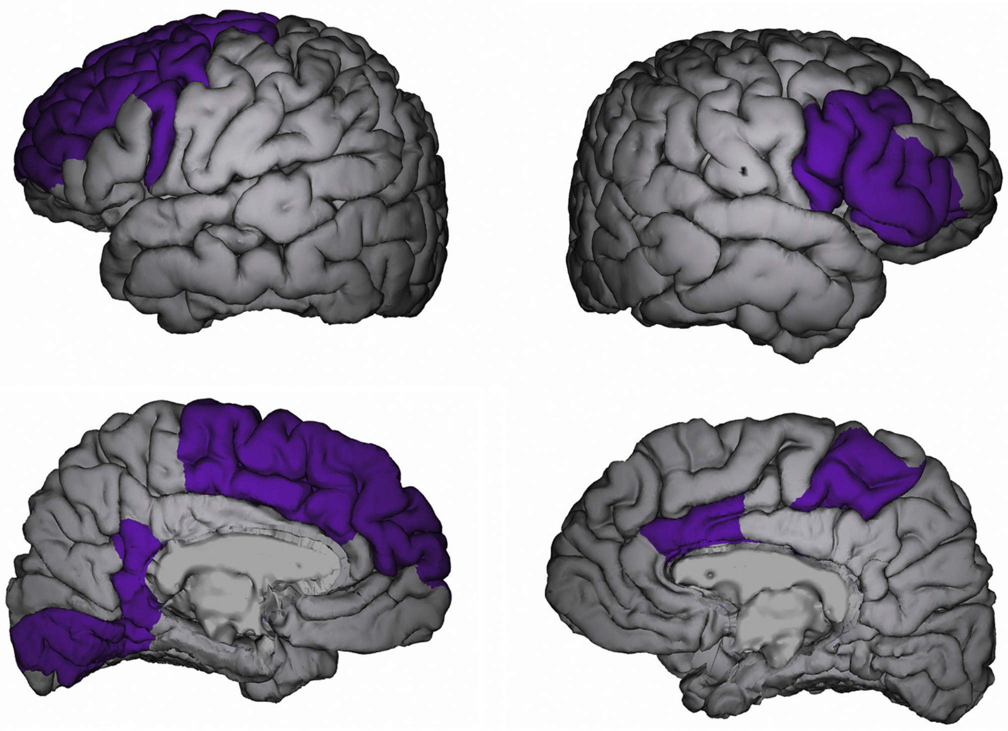
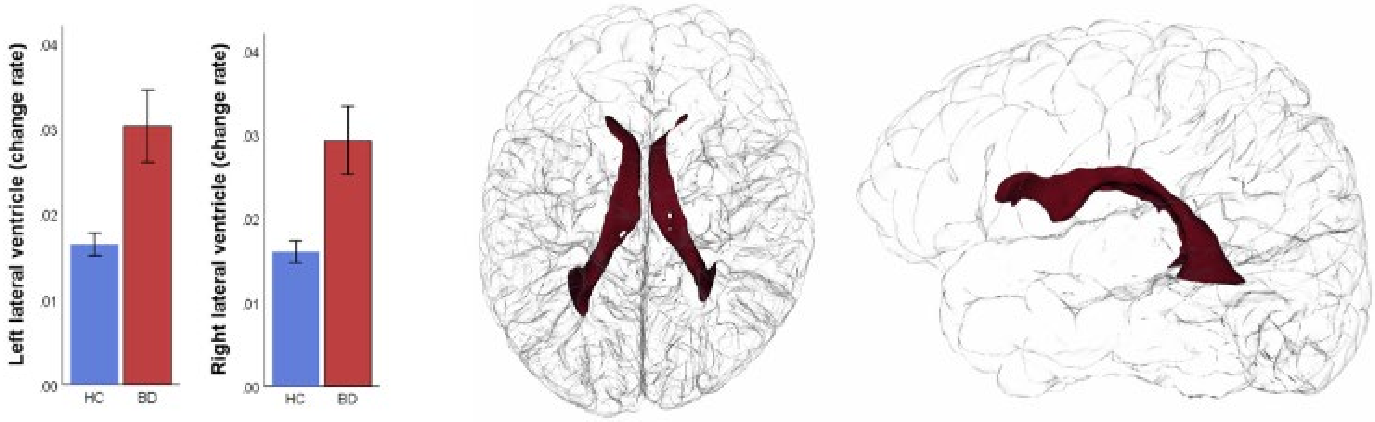
Age-like changes are found in Bipolar Disorder

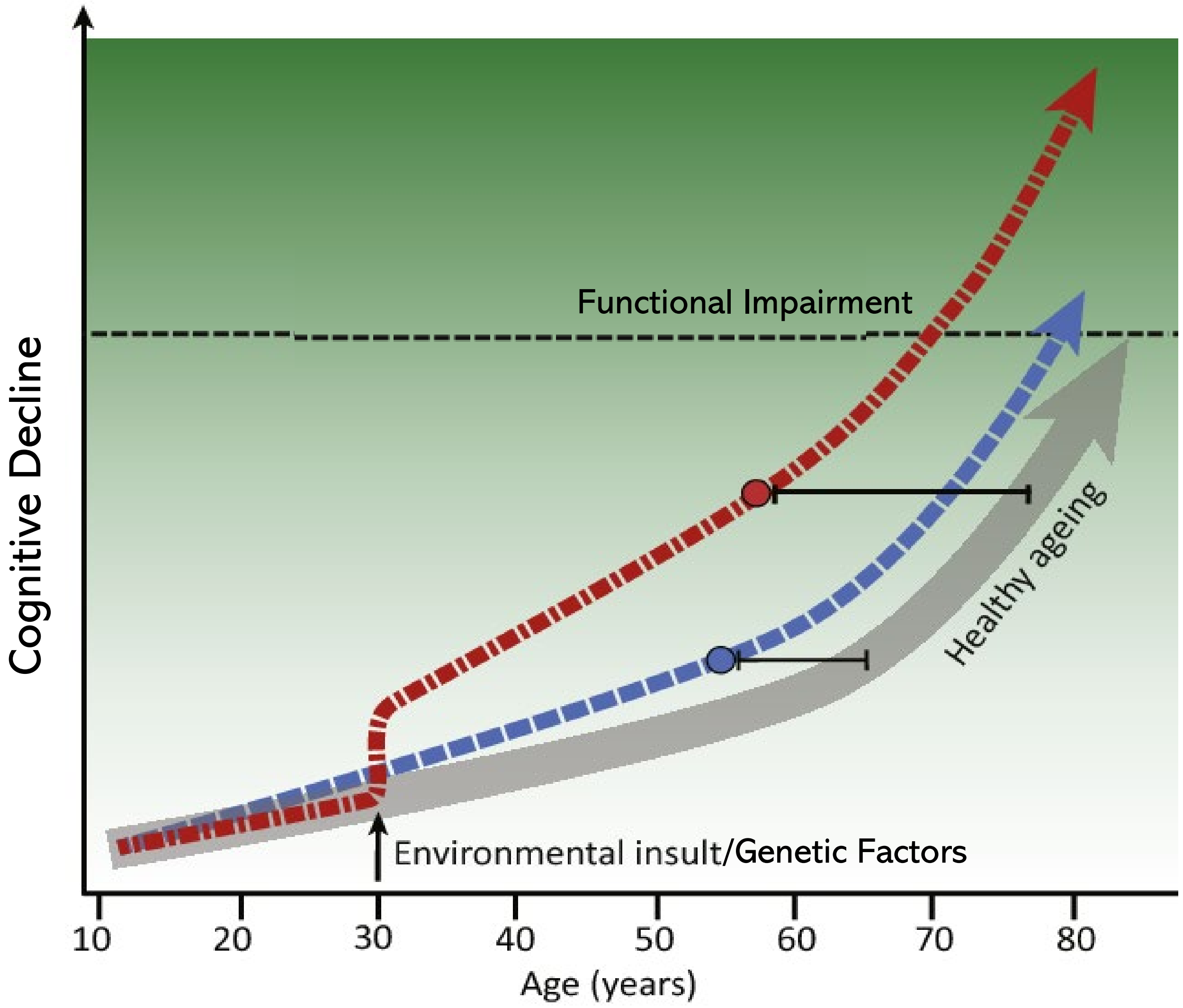
associations with (hypo)manic episodes



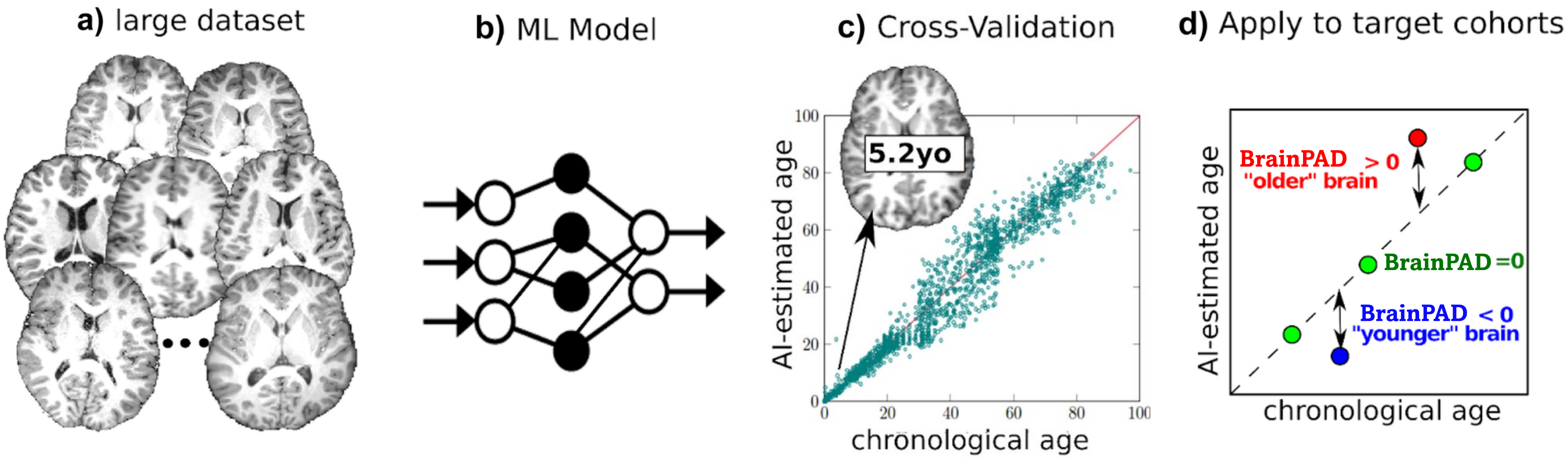
faster ventricular enlargement in BD



Onset of Bipolar Disorder may put individuals at an advanced aging trajectory



Brain Predicted Age Difference (Brain-PAD) as a marker of brain health



BrainPAD = Predicted age – Chronological age

Application of XAI to brain age prediction models

- Predicting age from neuroimaging data
- Interpretability and explainability methods
- Interpretability and explainability challenges in regression tasks
- Code Demo
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Importance of interpretability: Classifying dogs vs. wolves

Definitions of interpretability and explainability

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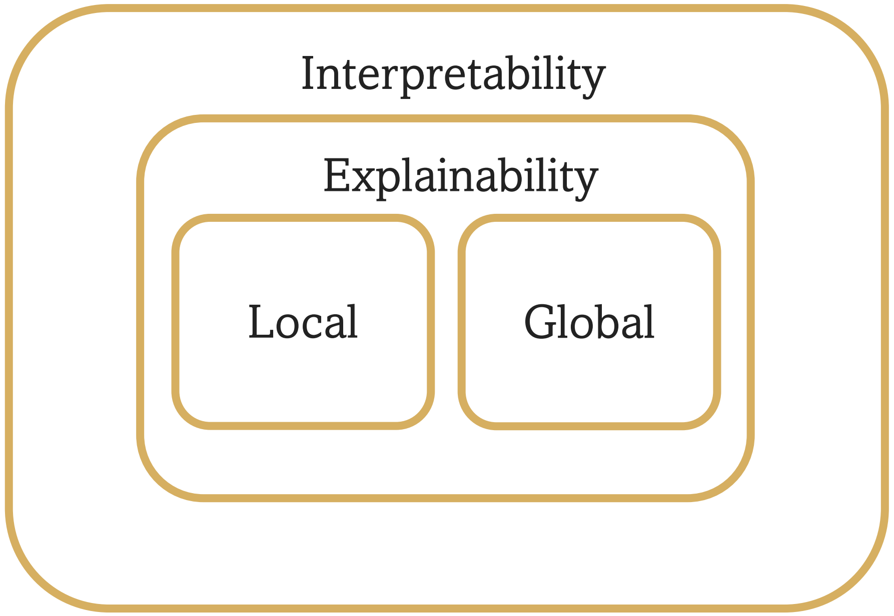

- Interpretability: Overall ability to understand and make sense of the model's decision-making process.
- Explainability: Model mechanisms and relative importance of features to the model
- Local: Why a model made a specific prediction for a single data point
- Global: Why a model made its predictions across all instances and scenarios?

Performance and interpretability as criteria for model selection in age prediction tasks

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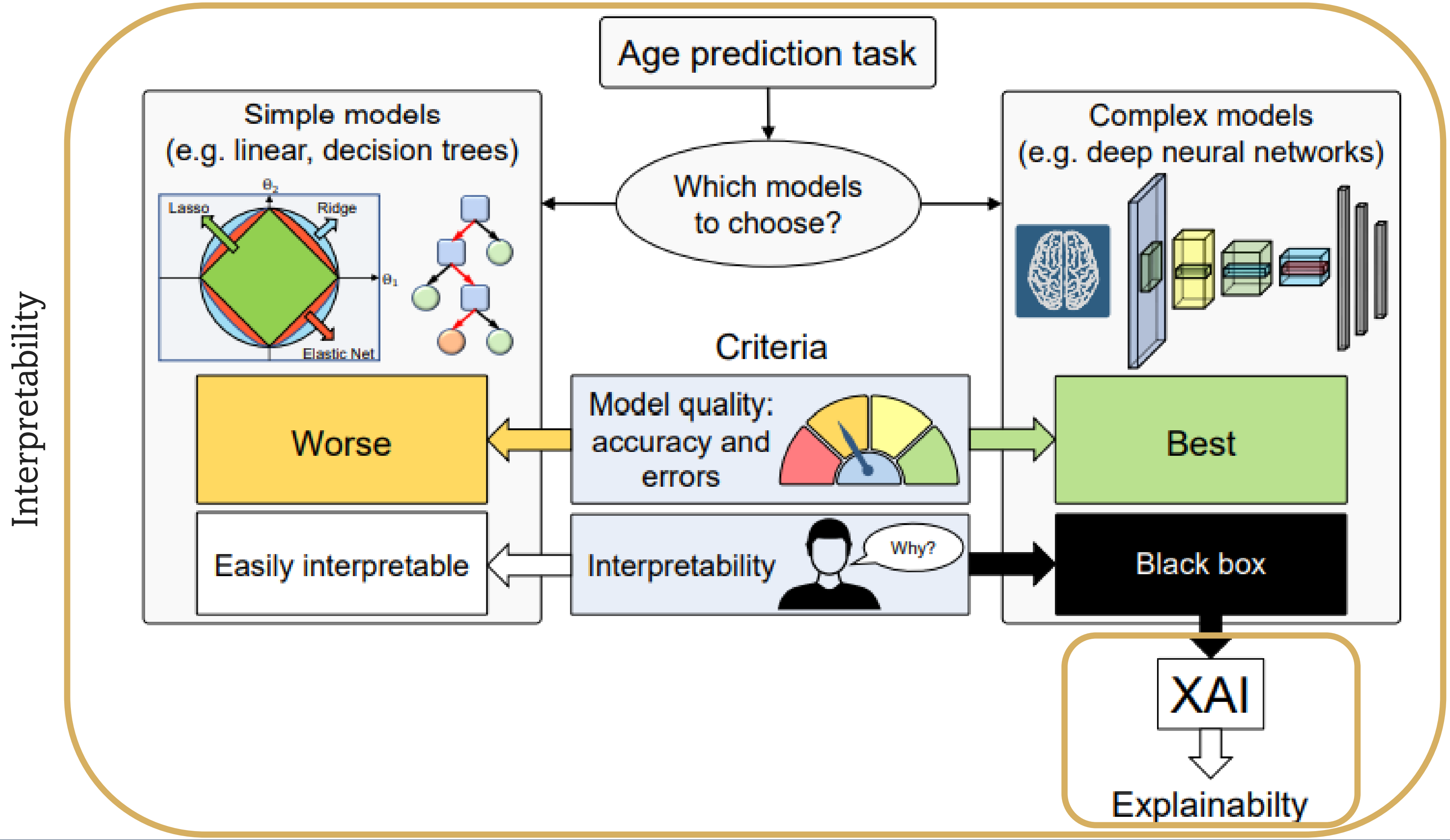

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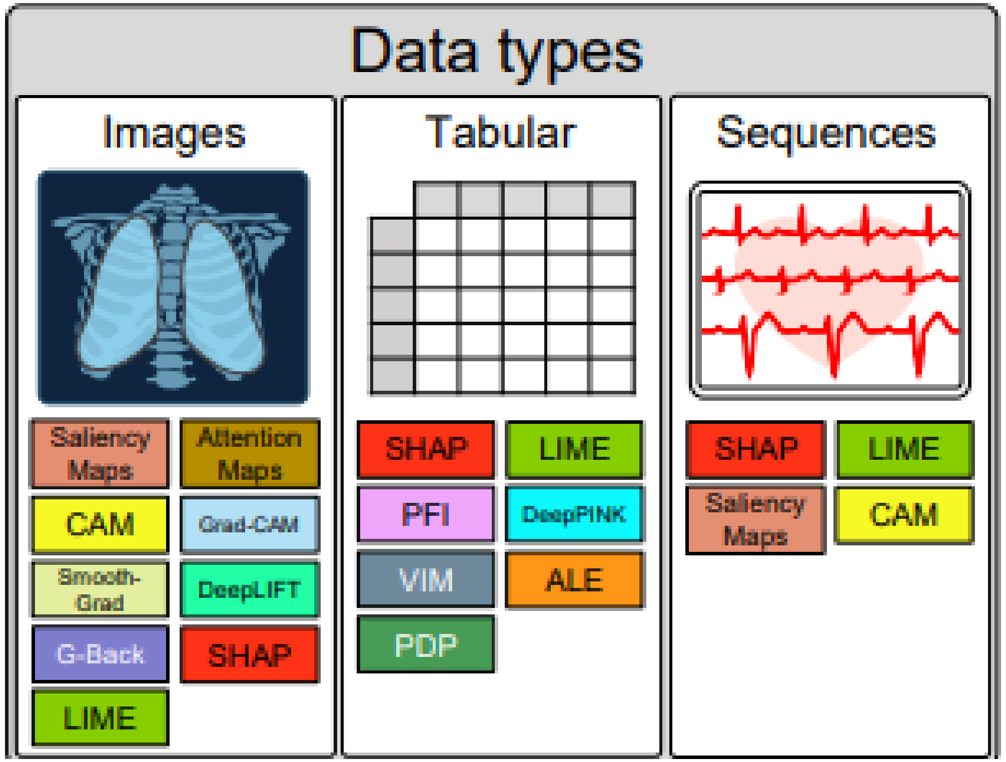
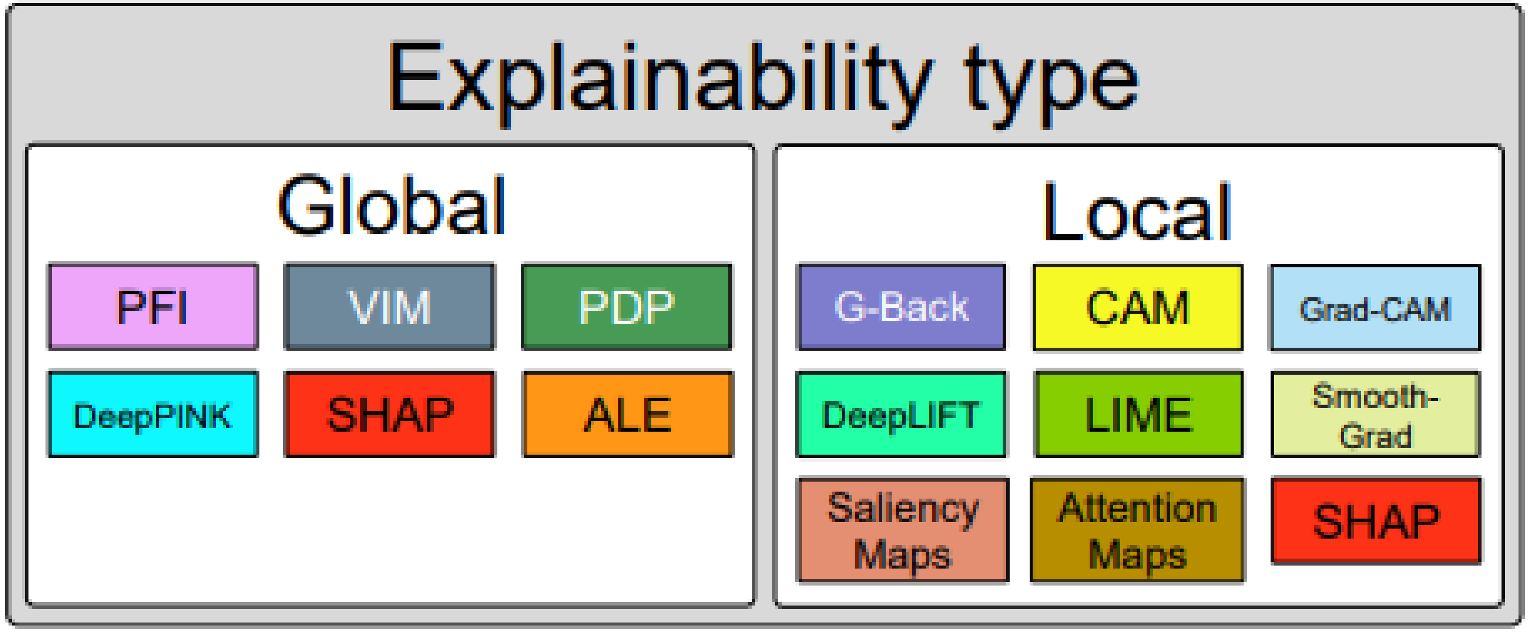
Factors to consider when applying interpretability and explainability methods to medical imaging

- Is the data in the form of **images** or pre-processed **tabular** or **time-series** data?



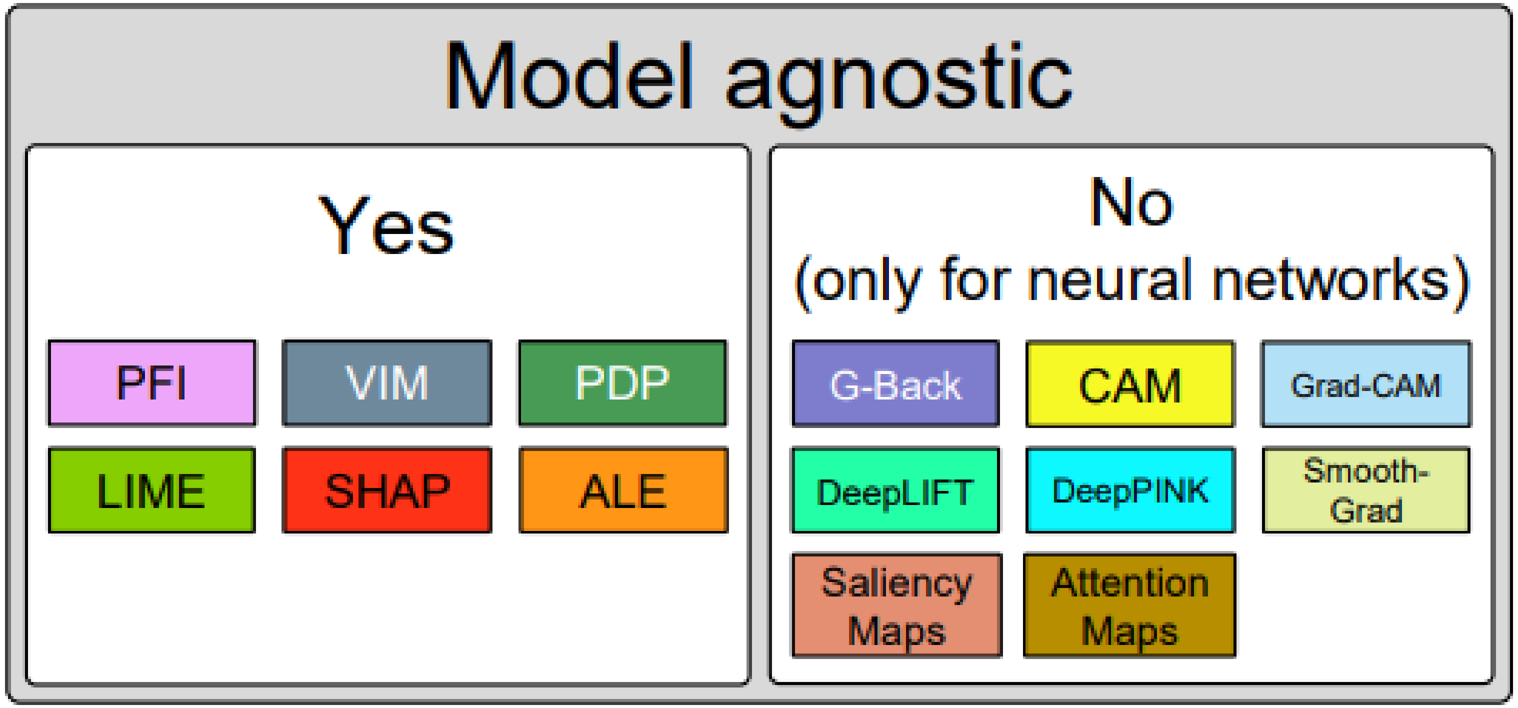
Factors to consider when applying interpretability and explainability methods to medical imaging

- Can the method explain the model's **overall behavior** or explain a **single prediction**?



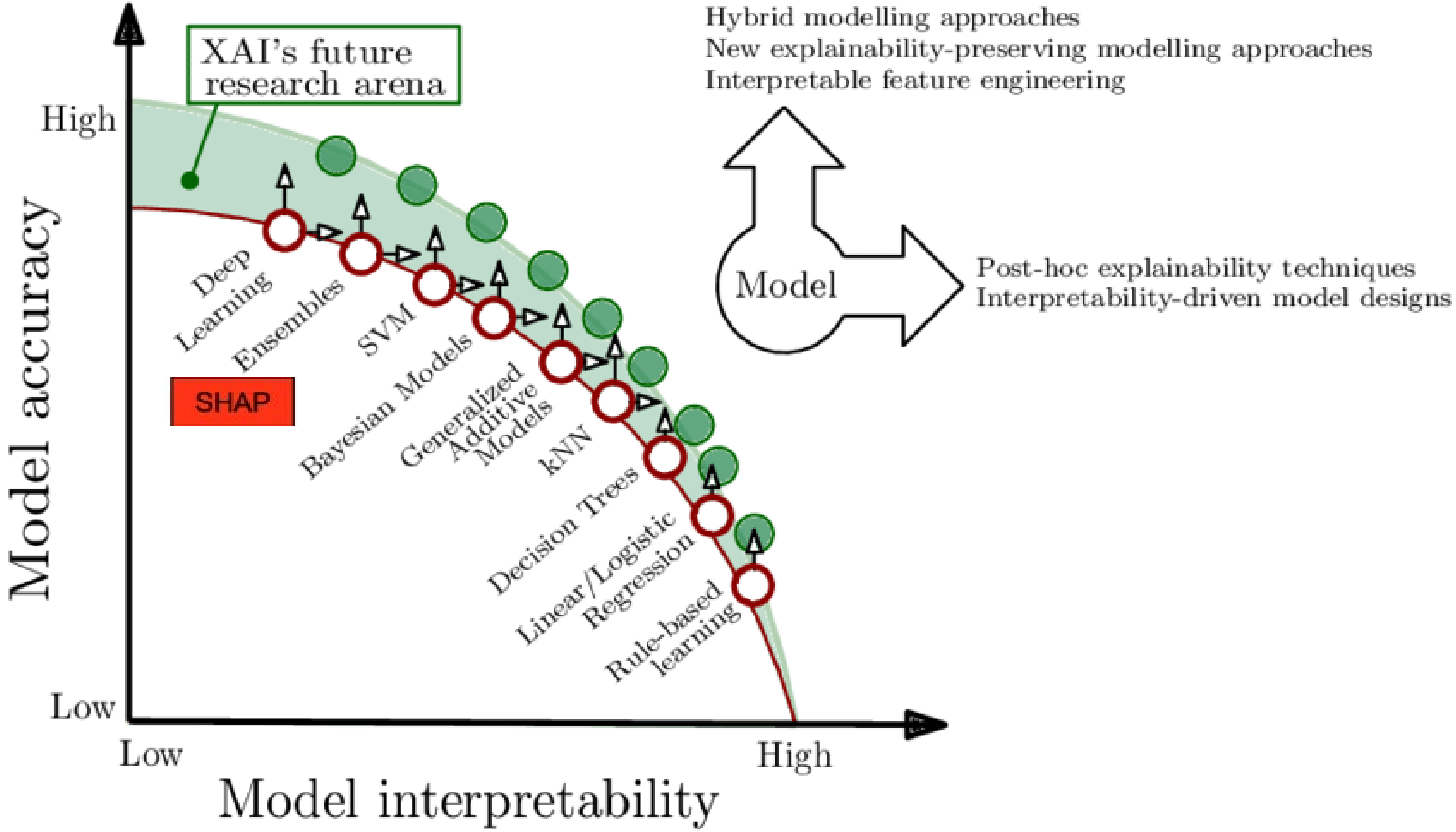
Factors to consider when applying interpretability and explainability methods to medical imaging

- Can this method be applied **independently** of the specific model being used?



Factors to consider when applying interpretability and explainability methods to medical imaging

- Should I use models that are **intrinsically** interpretable or use **post-hoc** interpretability methods?



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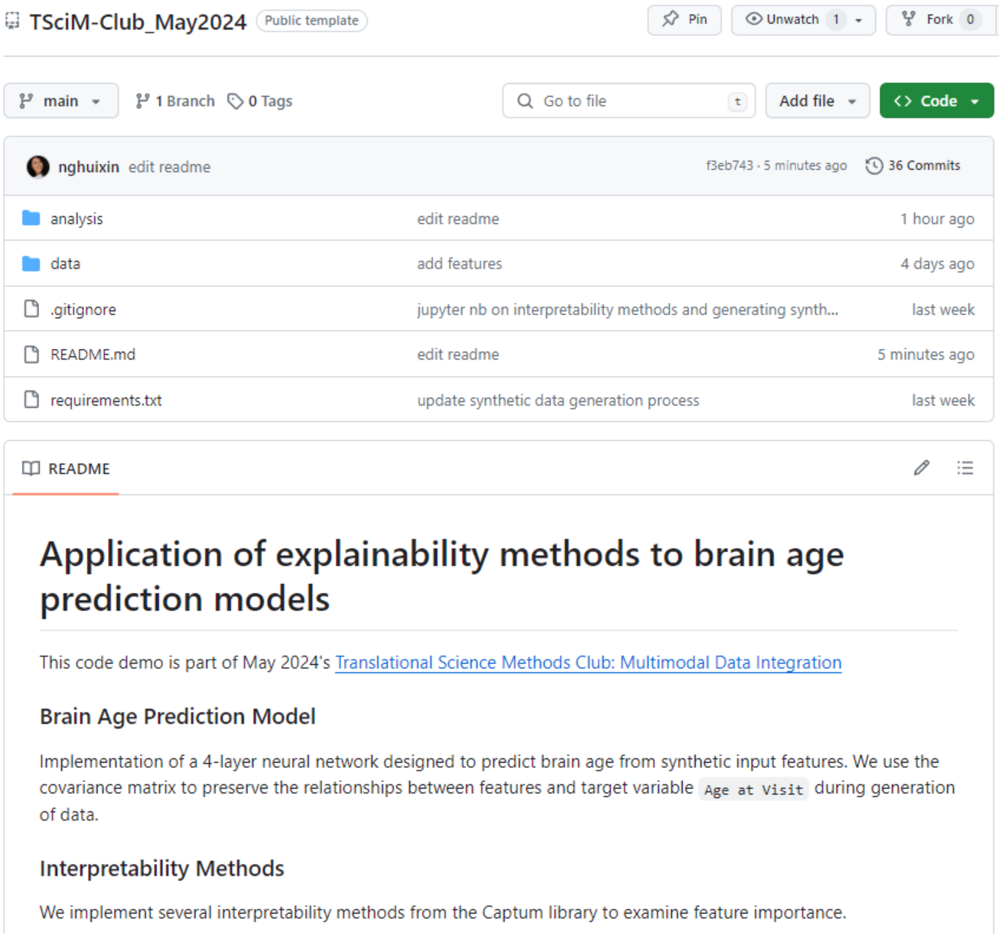
Application of Interpretability methods to a simple neural network model

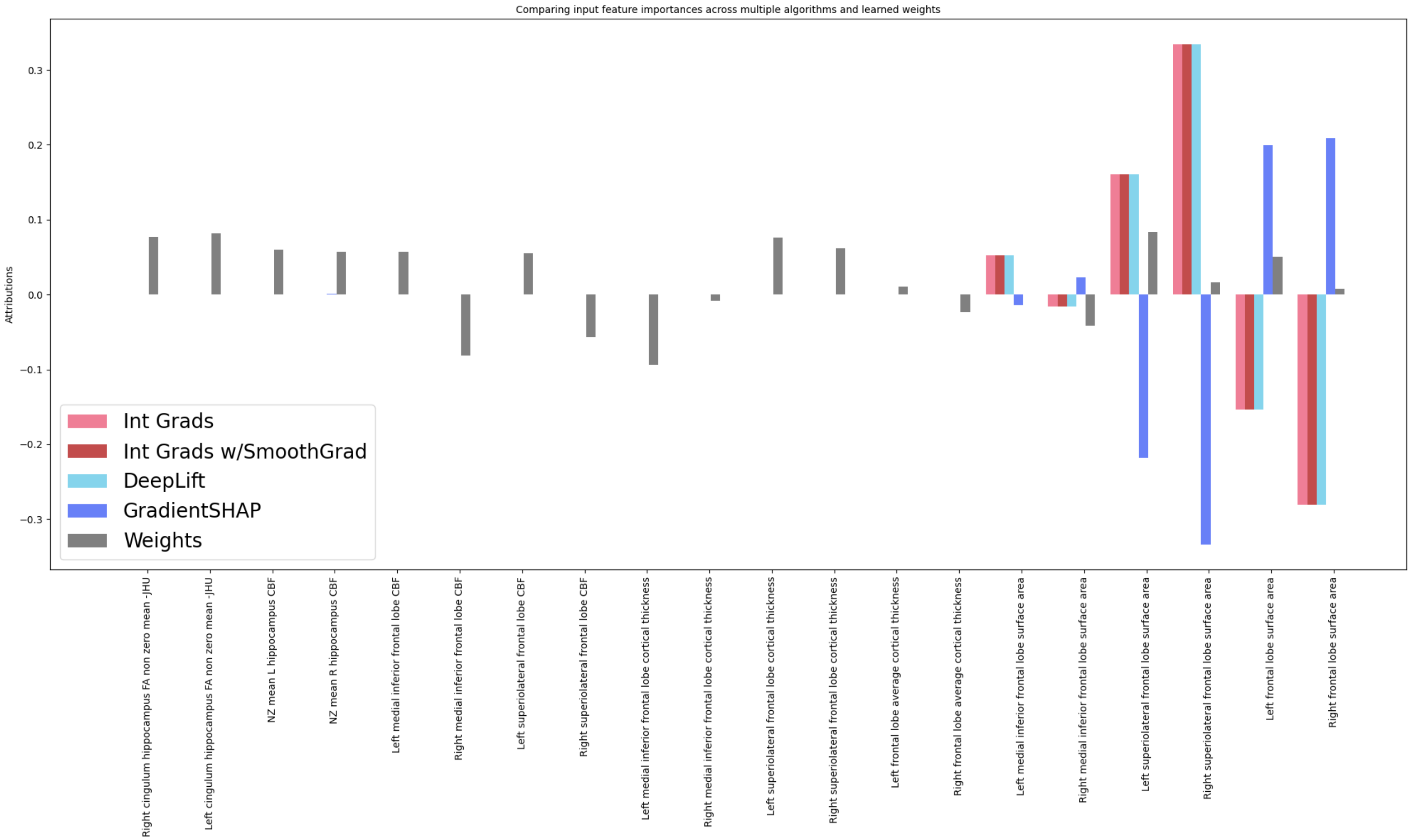
https://github.com/nghuixin/TSciM-Club_May2024



- Link to github repository in the chat
- Captum library helps standardize interpretability methods across projects/papers
- Dataset used:
  - Simulated dataset of healthy comparisons and individuals with BD
  - Brain features and age
- Attribution methods compared:
  - Integrated gradients
  - Integrated gradients with noise tunneling
  - Deep Learning Important FeaTures (DeepLift)
  - GradientSHAP
  - Model weights

Comparison of feature importance across algorithms and learned weights

https://github.com/nghuixin/TSciM-Club_May2024



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New tools facilitate our ability to evaluate algorithms on multimodal data

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fusilli: multimodal data fusion Python library

DATA

Image + Tabular

OR

Tabular + Tabular

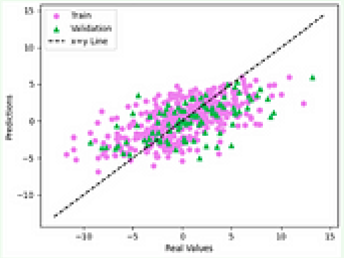
FUSION MODELS

Deep-learning based models:

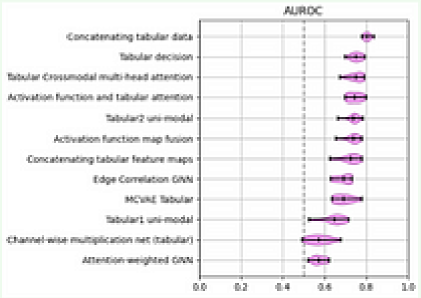
- Unimodal benchmarks
- Attention-based
- Graph Neural Networks
- Autoencoders
- and much more...

EVALUATE

For one model:

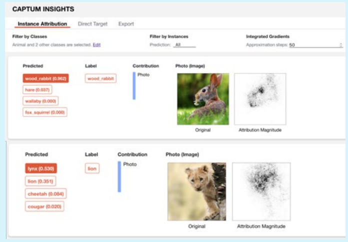


Comparing models:

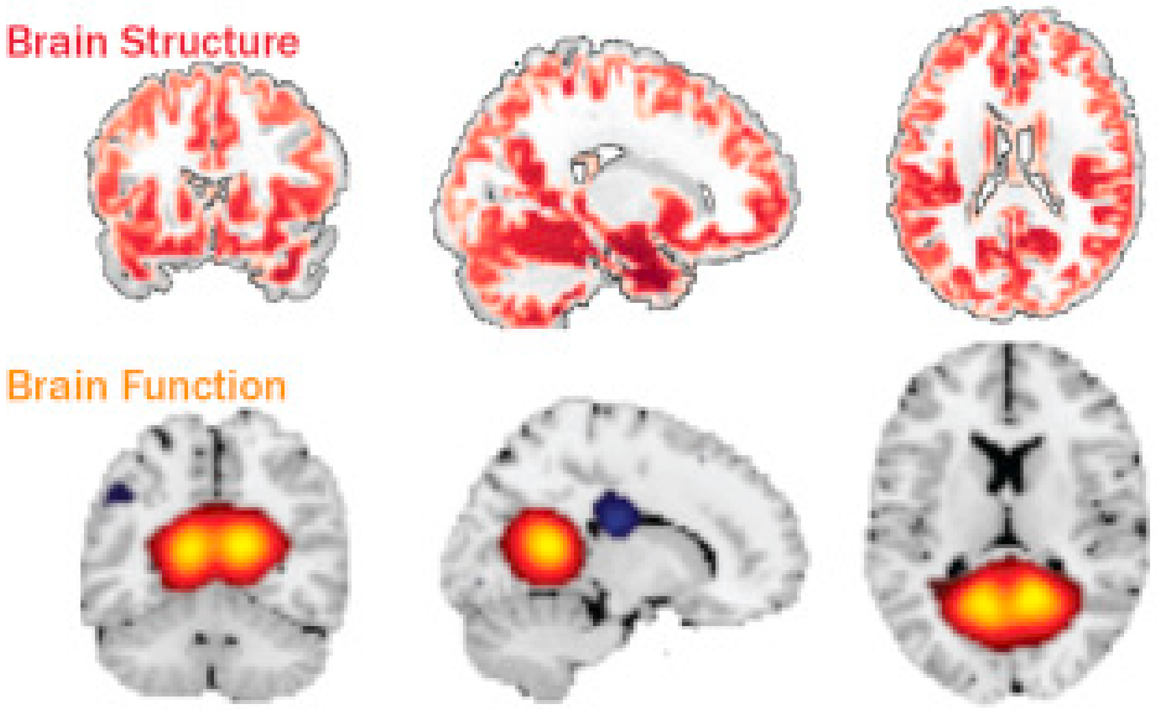


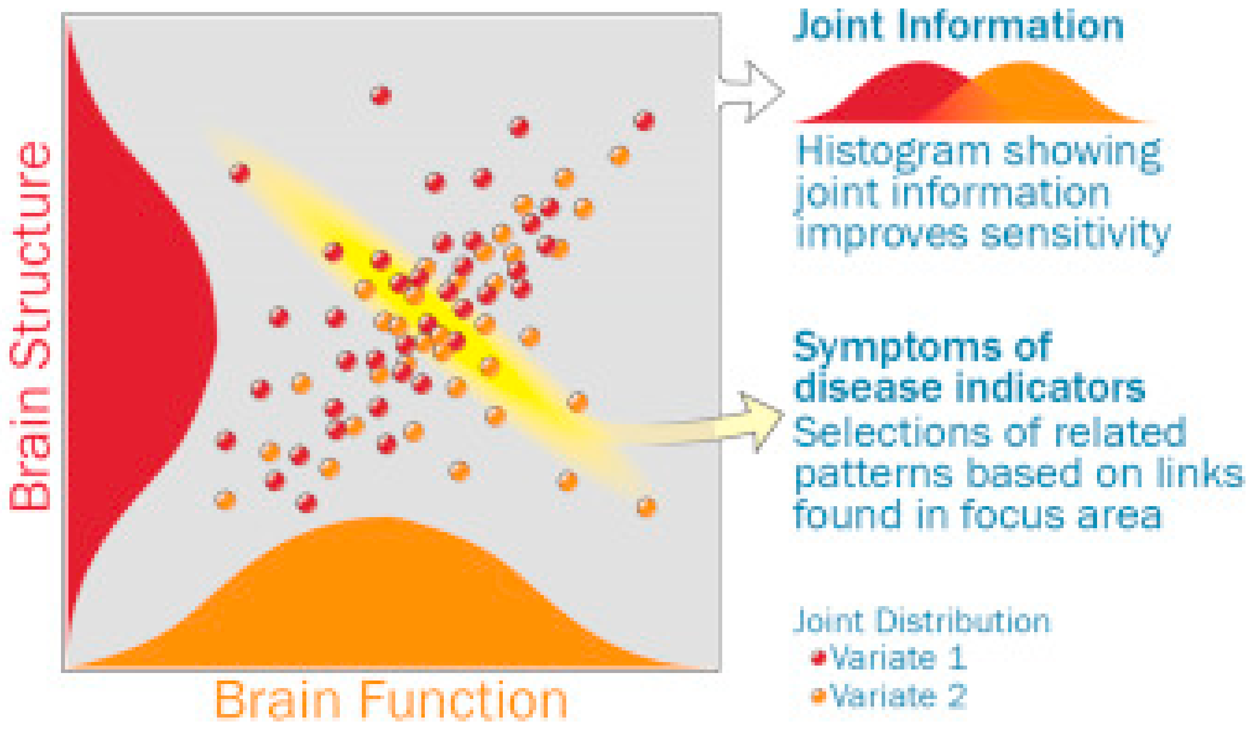
EXPLAIN

Captum

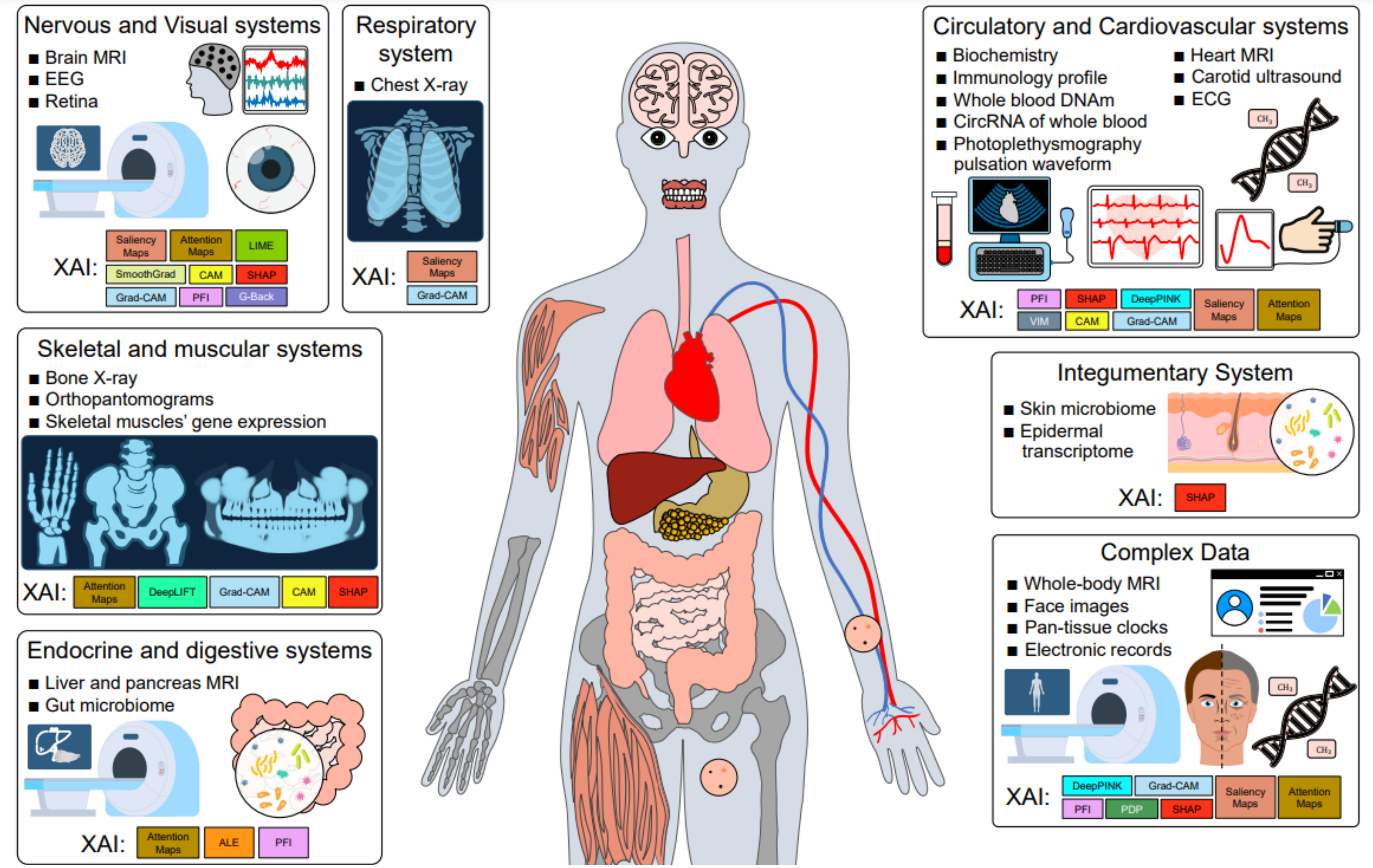


Utilization of multimodal data enhance our ability to distinguish neuropsychiatric illnesses





XAI methods applied to age prediction models across organ systems



Added value of applying XAI methods to age prediction tasks

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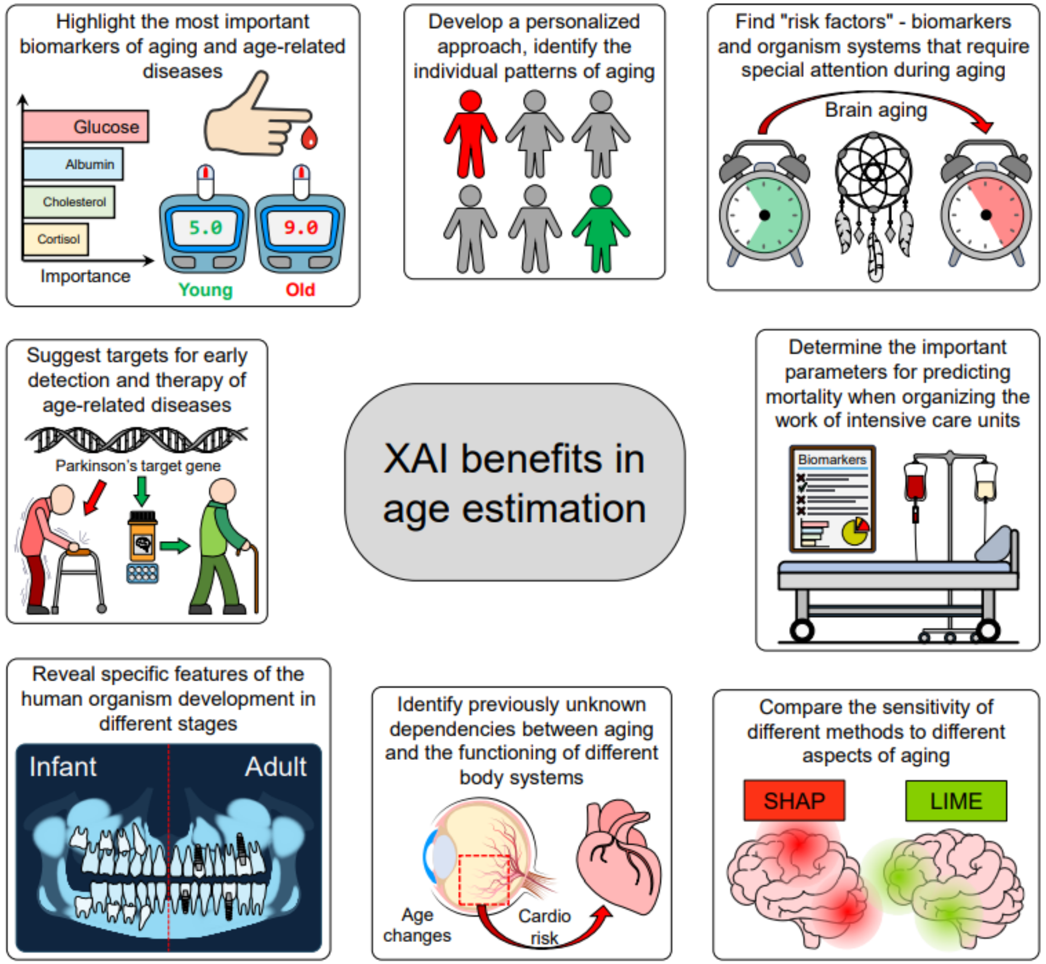

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