FACULTY OF ENGINEERING AND ARCHITECTURE

GROUP OF ARTIFICIAL INTELLIGENCE AND SPARSE MODELLING

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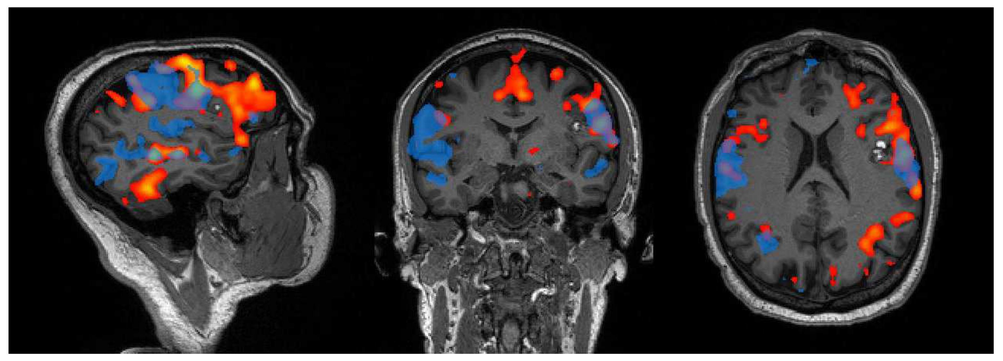
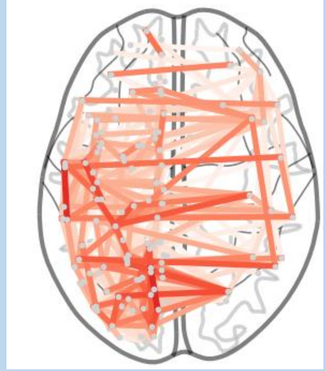
COUNTERFACTUAL FUNCTIONAL CONNECTOMES FOR NEUROLOGICAL CLASSIFIER SELECTION

Problem statement

Functional connectivity (FC): statistical relationship between the activations of different brain regions.

- functional connectome: the correlation matrix
- predictive power in detecting neurological disorders





Motivation

Counterfactual provide intuitive post-hoc classifier explanations:

- They fool the classifier by altering features relevant to their evaluation
- The produced counterfactuals are realistic and easy to interpret
- No available counterfactual method for FC classifiers

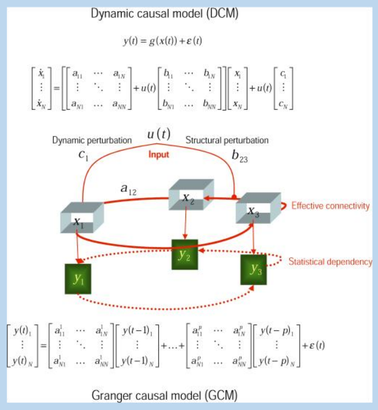
Counterfactual for model selection:

- Feedback loop with medical expert during model development
- Increase trust in the prediction

Challenges:

- Current counterfactual methods only work for specific model
- Some classifiers are not differentiable or not directly accessible
- Lack of unifying framework for comparing counterfactual explanations

Model development



Expert opinion

Use case

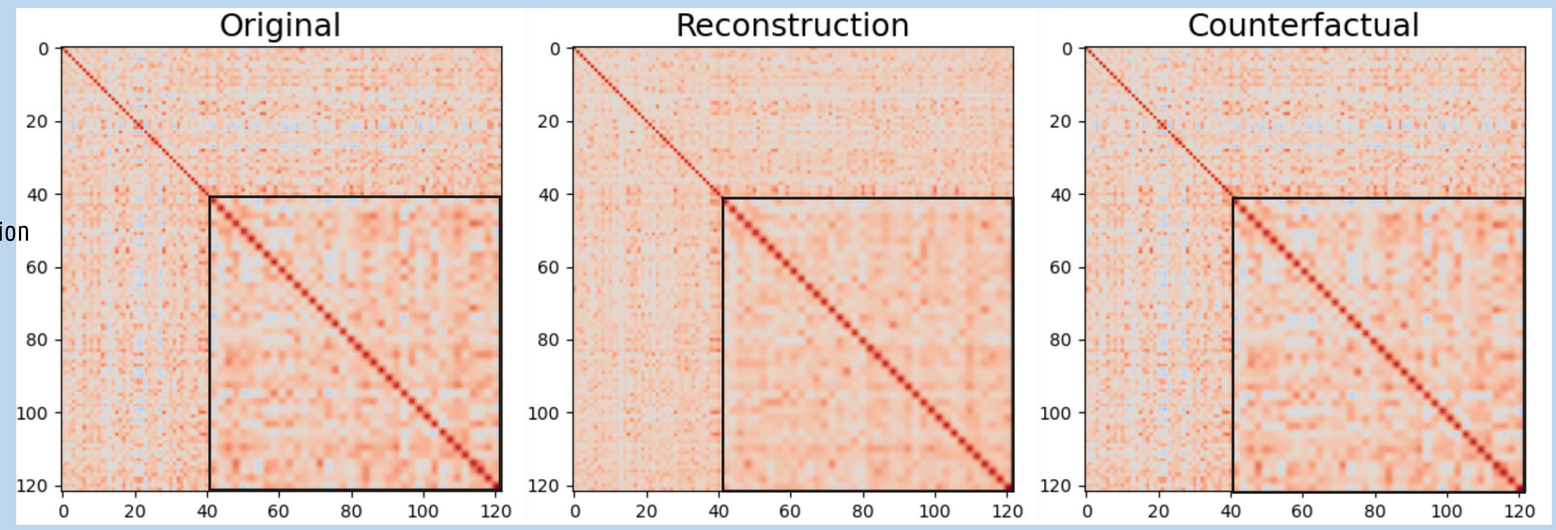
Proposed method

Builds on VAEX[1]:

- Hierarchical Variational autoencoder (HVAE)
- Condition HVAE on evaluation of the classifier
- Counterfactuals by conditioning the reconstruction with target evaluation

Active Noise Cancellation:

- Blurred generation create bias in the explanation
- Define noise as the difference between reconstruction and original
- Remove noise from the counterfactual



Experiments and results

Dataset: resting-state fMRI from ABIDE I

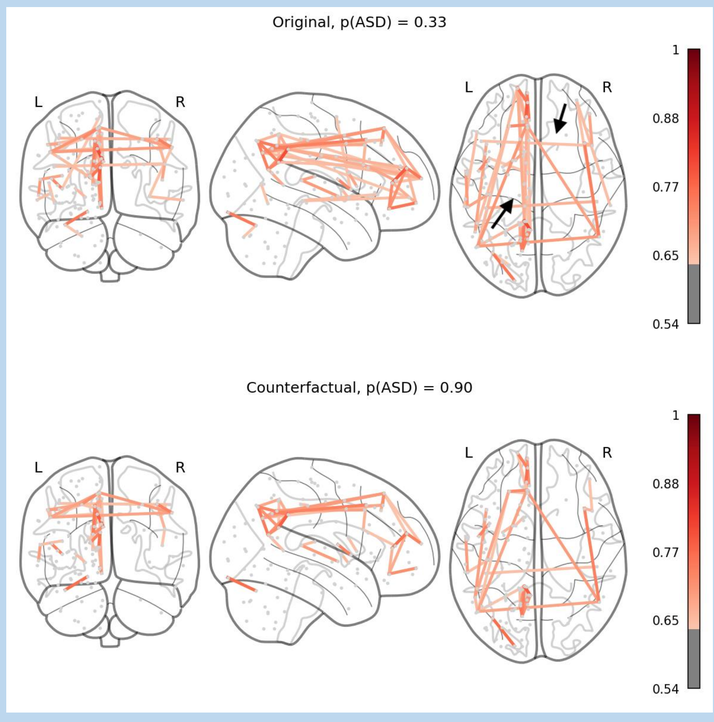
Label: Autistic Spectrum Disorder (ASD)

Classifiers:

- Support Vector machine (SVC)
- Multilayer Perceptron (MLP)
- MLP with autoencoder pretraining (MLP_{AE})

Metrics:

- Success Rate (SR) percentage of counterfactuals fooling the classifier
- Counterfactual Deviation (CD): shift in evaluation of the counterfactual
- Decision Boundary Success (DBS): perfect calibration when 0.5



Model	SR (%)	CD ($\times 10^{-2}$)	DBS ($\times 10^{-2}$)
SVC	100.0	45.9	63.6
MLP	100.0	54.9	47.1
MLP_{AE}	100.0	54.9	46.4

References:
[1] N. Vercheval, A. Pižurica, *Hierarchical variational autoencoders for visual counterfactuals.* ICIP, 2021.

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