# Riemannian manifold learning on connectivity matrices for diagnostic of depression and epilepsy

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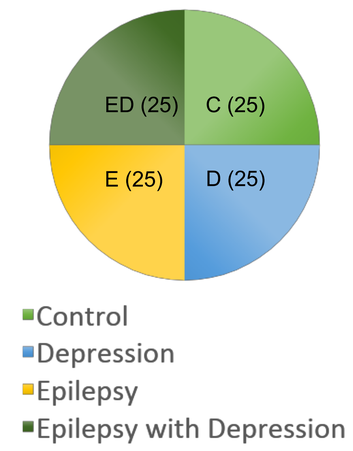
## Motivation

Depression is the most prevalent psychiatric illnesses nowadays, which not only influences patients' behavior and perception of the environment, but also increases risk of having epilepsy.

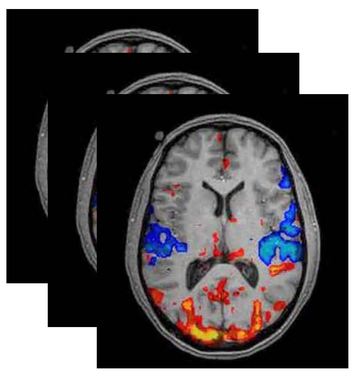
## Data Set

**100** T1 1.5T Resting state fMRI sets.

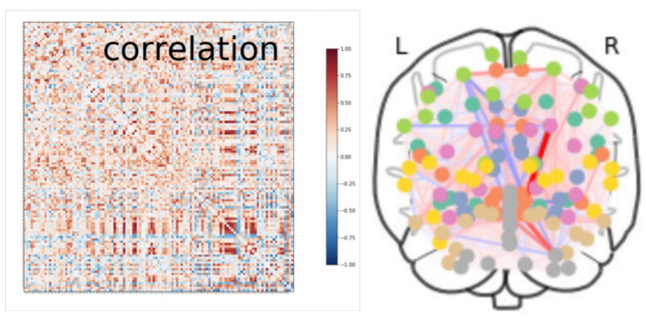
The research is conducted under collaboration with Solovyov Scientific and Practical Psycho-Neurological Center of the HDM.



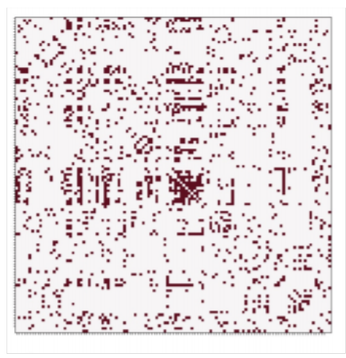

## Research structure



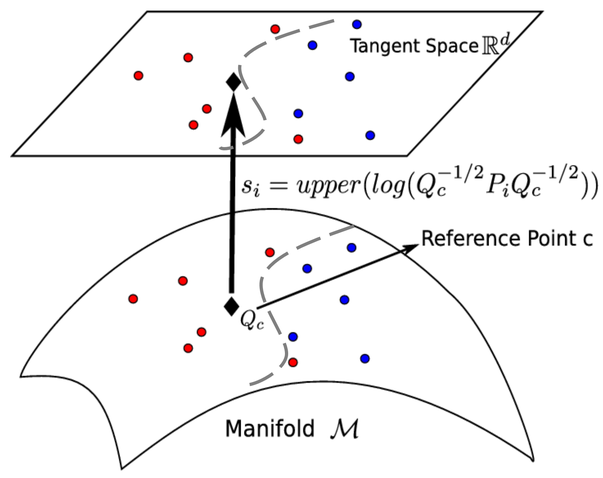
fMRI scans were preprocessed and denoised




Functionally connected areas of the brain were represented as a correlation matrix



Laplacian of the binarized correlation matrix is a point on the $\frac{n(n+1)}{2}$ dimentional manifold




Classification was performed on the Euclidean tangent space and directly on the manifold, using Riemannian metric tensor

**Figure 1.** Scheme, representing the transition from the classification of fMRI scans to the Riemannian manifold learning in the space of symmetric positive definite matrices

## Results

| | Best Model | Accuracy |
|---|---|---|
| **E/no E** | SVC | 0.57(0.17) |
| **D/no D** | SVC | 0.68(0.15) |
| **E/C** | SVC | 0.59(0.13) |
| **D/C** | LR | 0.67(0.22) |
| **DE/E** | SVC | 0.70(0.18) |
| **DE/D** | SVC | 0.73(0.17) |

**Table 2** Accuracy and standard deviation of the best models for each of the six classification problems

- For all of the studied problems, models with Riemannian kernel outperformed models with Euclidean kernel
- Predictive quality of the presented method is comparable to other models, trained on the same dataset (graph-based classification, classification of the vectorized MRI, CNNs)

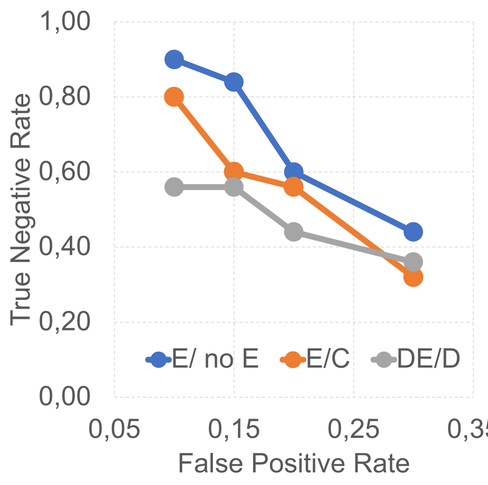



**Figure 3** Best models' TPR for different levels of FNR for epilepsy detection problems

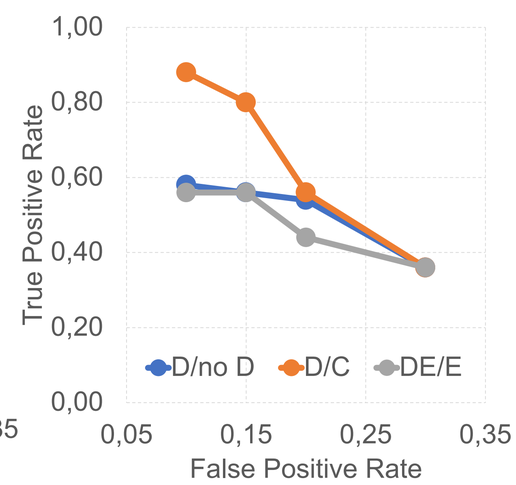



**Figure 4** Best models' TPR for different levels of FNR for depression detection problems

## Conclusion

Presented study indicates that Riemannian manifold learning produces results, which are comparable with other ML algorithms and therefore further research on this topic may lead to major improvement of the baseline results

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