

Bayesian topology learning of brain networks for detecting the Mozart effect

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Introduction

Motivation:

- Findings about the Mozart effect on brains can help to discover their psychological and physiological basis;

Research questions

- How can we estimate the "causal" connectivity of functional brain regions using functional magnetic resonance imaging (fMRI) data?
- What is the effect of listening to Mozart's Sonata K448 on the brain connectivity?

Methodology:

- Collect fMRI data of participants before and after they listen to Mozart's music;
- Conclusions are drawn by the change in the estimated brain connectivity.

Bayesian topology learning

Challenges for learning:

- Limited data length and a large number of unknown parameters.

Developed Bayesian approach [1]:

- Address the above challenges;
- Learning topology without necessarily estimating the dynamics using a nonparameterized approach;
- Compare possible structures using a Bayesian measure and return the optimal one.

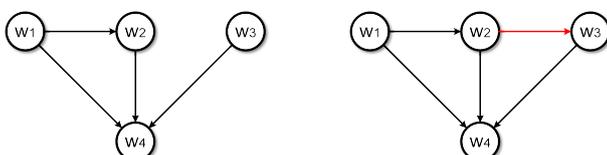


Figure 1: Comparison of two dynamic networks.

Learning for Mozart effect

- fMRI data is collected from 16 subjects, and connectivity is learned using the Bayesian approach;

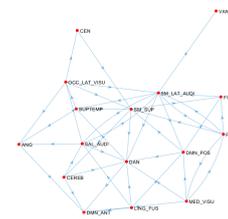


Figure 2: An estimated brain network.

- Find consistent changes in the estimated connectivity caused by listening to music.
- Connectivity changes differ from subject to subject depending on the listening duration.

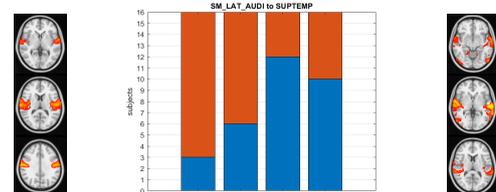


Figure 3: Connectivity change from the lateral motor region to the auditory network over the experiments.

Conclusions

- A new learning method is developed which performs well with limited data length;
- Several causal connections between brain regions related to cognition show consistent changes after subjects listened to Mozart music.

References

- [1] S. Shi, G. Bottegal and P. M. J. Van den Hof, "Bayesian topology identification of linear dynamic networks," 18th European Control Conference (ECC), 2019
- [2] R. J. C. Van Esch, "Topology detection in brain networks," Masters Thesis, Eindhoven University of Technology, 2019