

EEGNet

Brain functional network mapping

A probabilistic inference approach to brain network construction from data

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Road map

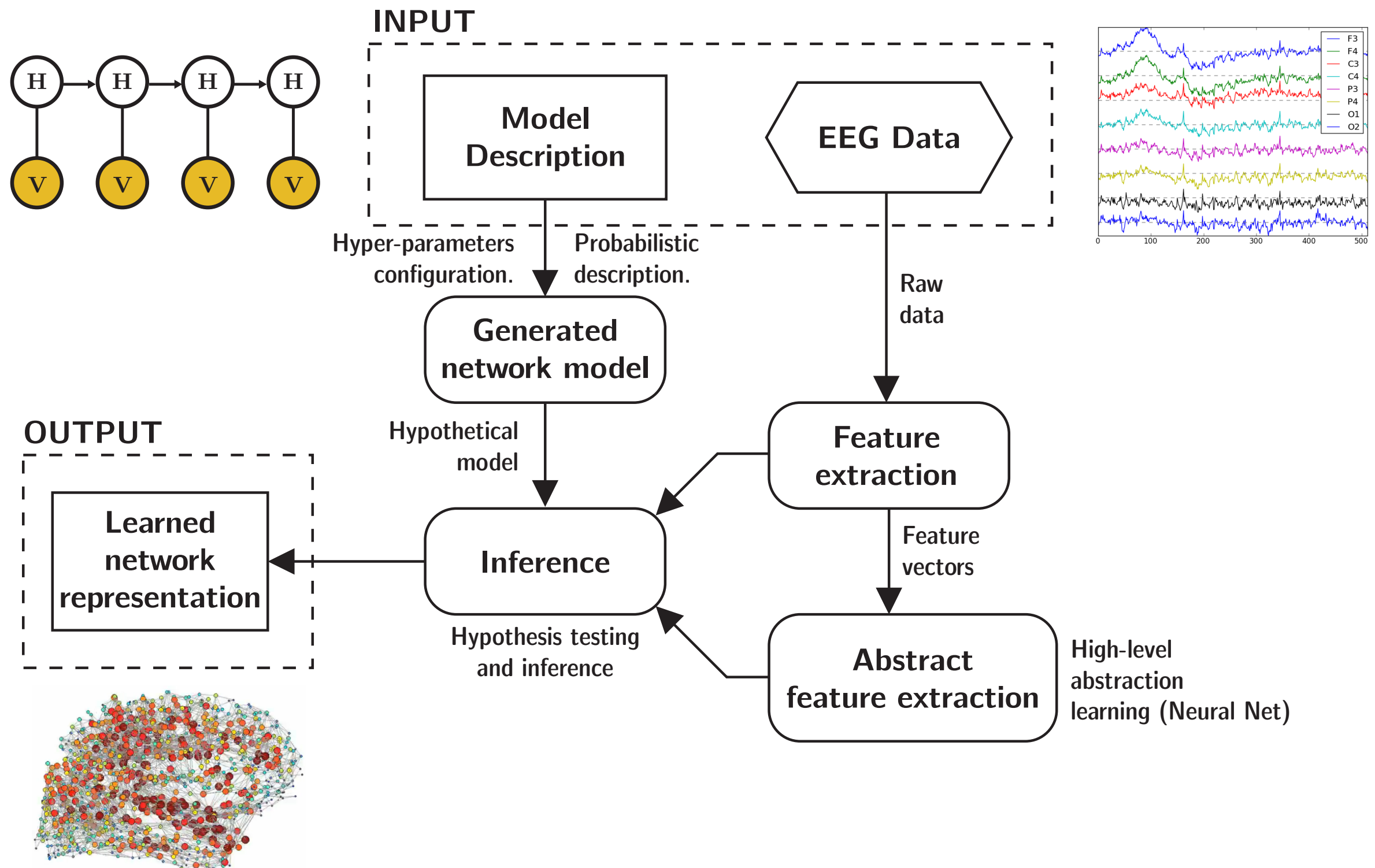
- Network construction with probabilistic inference.
- Motivation.
- Development framework and preliminary result.

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Network construction by probabilistic model

1

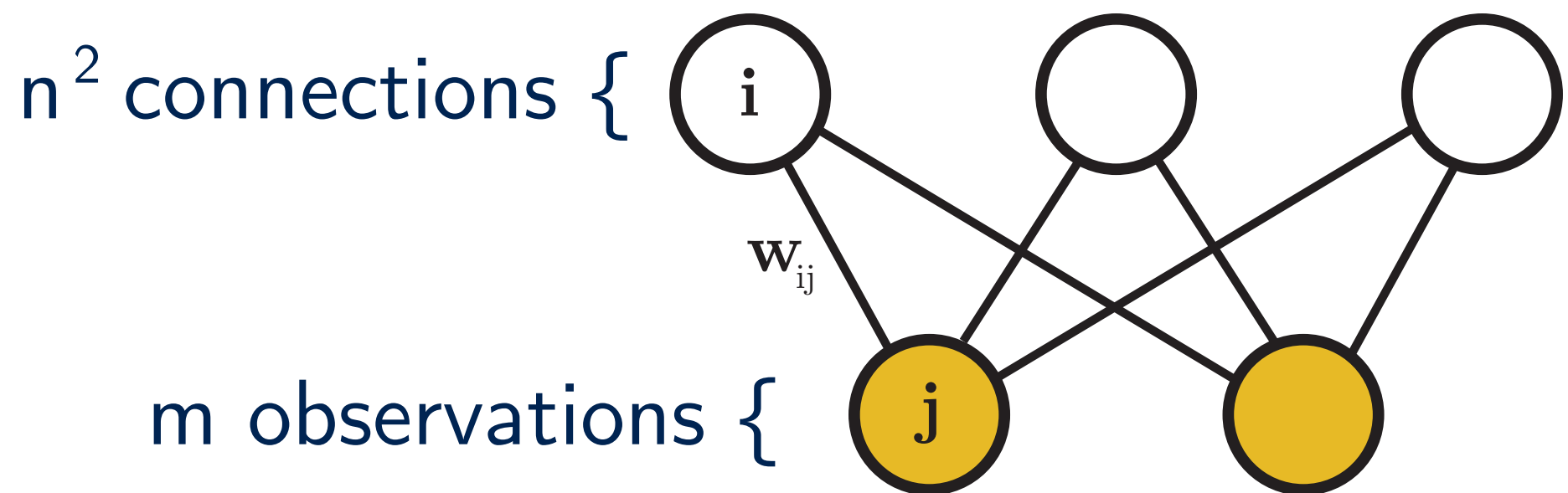


Advantages over traditional methods

2

Learning procedure is straight forward [Ghahramani'15]

- Represented as a $n \times n$ matrix.



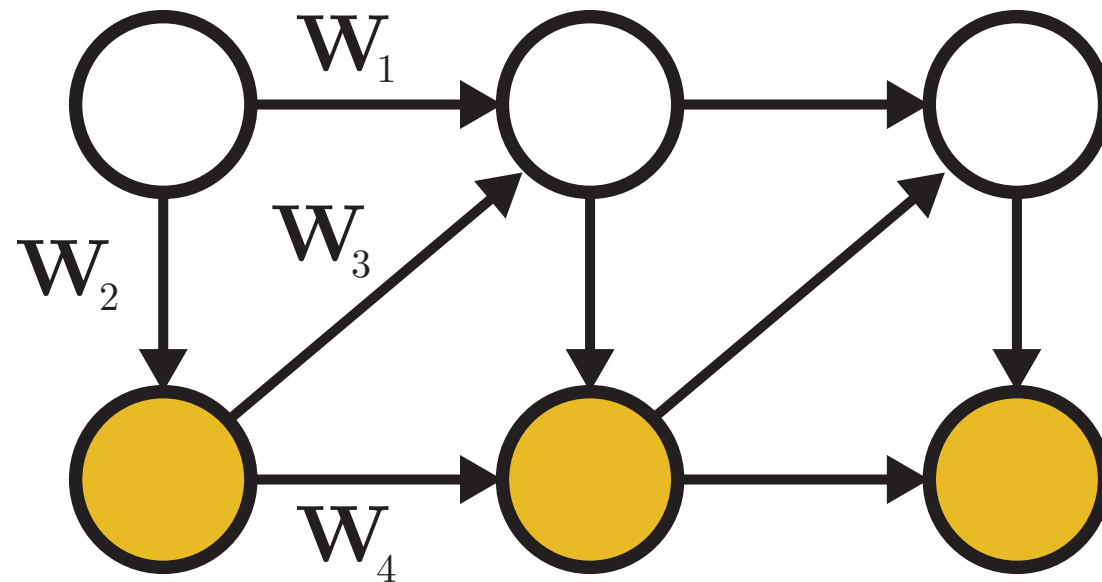
- Target distribution to learn: $P(N, \theta^H, Data)$
- Flexible model that user can defined.

Advantages over traditional methods

3

Potential: latent representation and temporal pattern

- Represented as a $n \times n \times T$ tensor.
- Temporal Sigmoid Belief Network model.



- Target distribution to learn: $P(N^T, \theta^H, Data)$

Road map

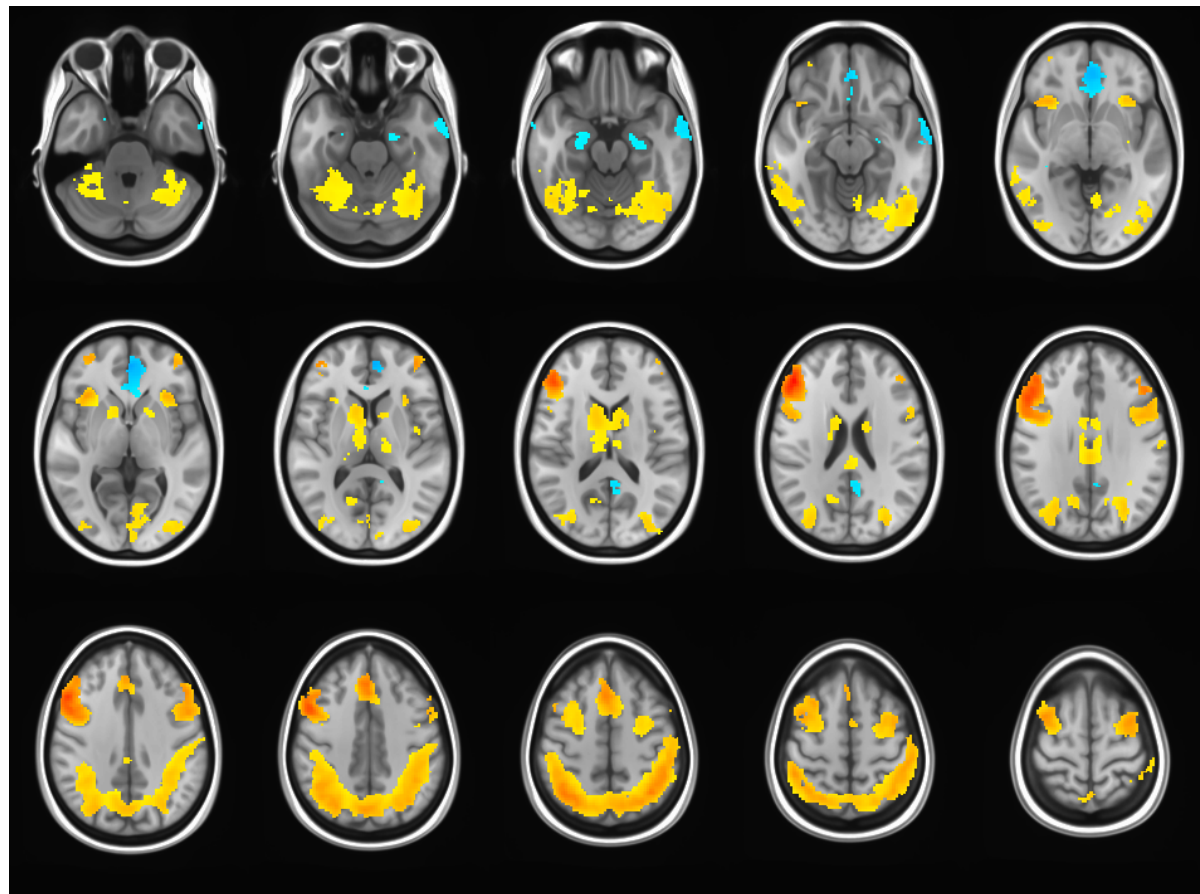
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Existing methods for constructing brain network

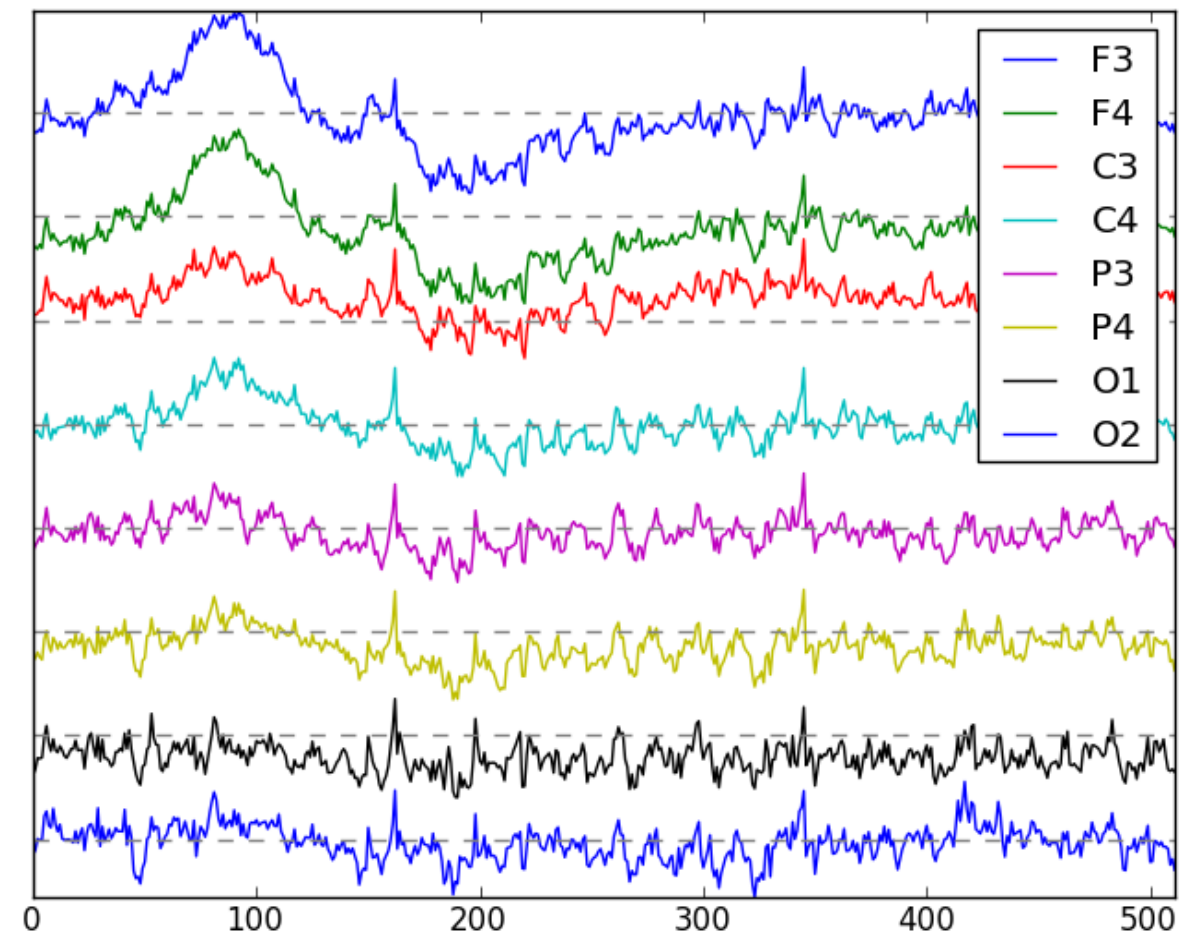
4

Imaging techniques

- fMRI



- EEG



Existing methods for constructing brain network

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Imaging techniques

- fMRI

- ◆ Measure blood flow.
- ◆ Good spatial resolution.
- ◆ Low temporal resolution.
- ◆ Requires expensive equipments.

- EEG

- ◆ Measure electrical potential.
- ◆ Low spatial resolution.
- ◆ High temporal resolution.
- ◆ Cheap equipments but prone to noise.

These two techniques are complementary to each other.

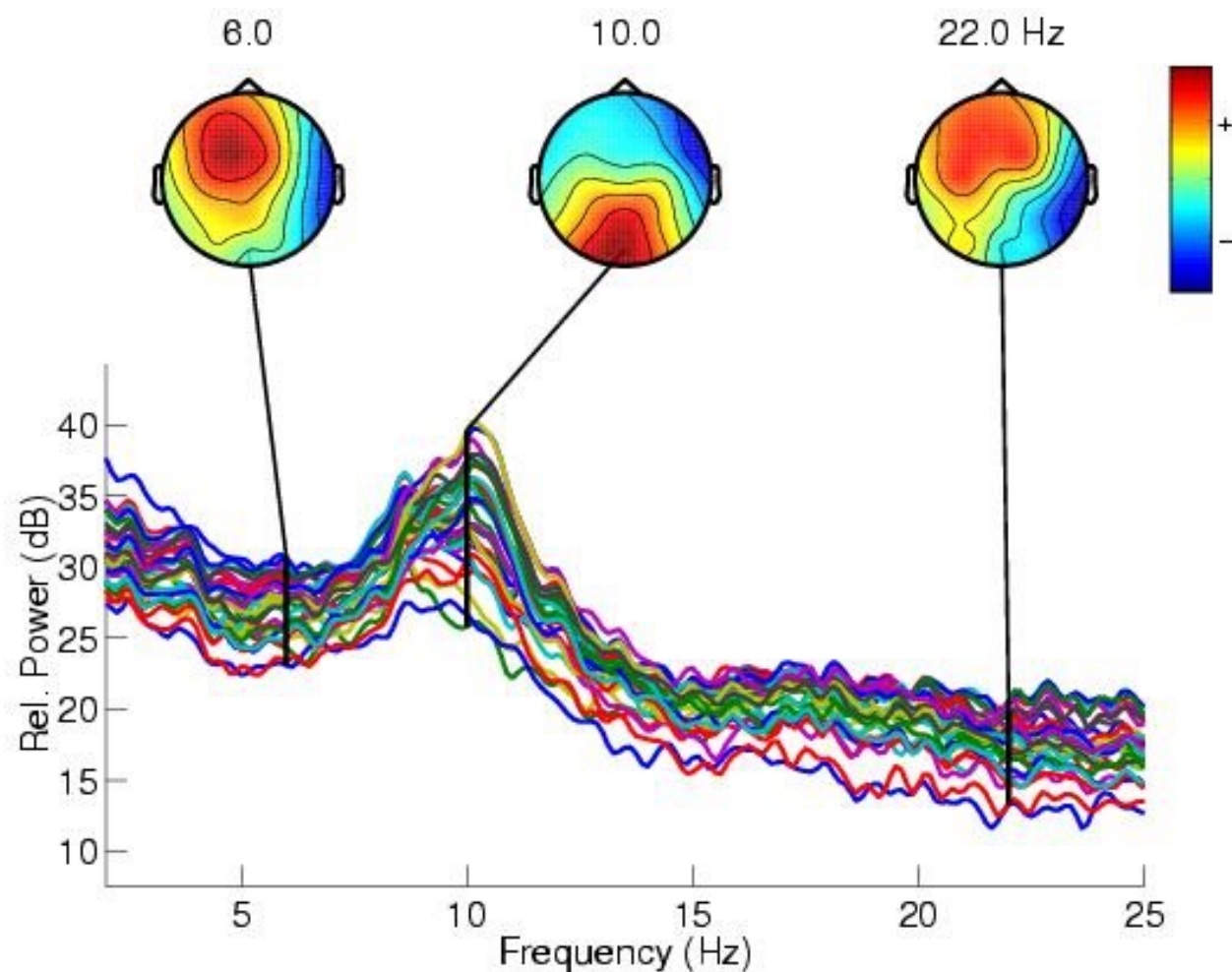
We want to take advantage of the EEG time series.

Existing methods for constructing brain network

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Frequency-based methods

- Coherence, Non-linear coherence.



$$\kappa_{xy}^2(f) = \frac{|\langle S_{xy}(f) \rangle|^2}{|\langle S_{xx}(f) \rangle| |\langle S_{yy}(f) \rangle|}$$

Challenges with EEG data

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Low spatial resolution

- 10-20 system with up to 345 electrode locations. [Oostenveld'01]
- Nodes in constructed network are electrodes.

High (excellence) temporal resolution

- Frequency domain and causality.
- Harnessing temporal resolution even more?
- E.g. Capturing dynamic pattern of constructed network?

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Julia programming language

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High performance computing with Julia:

- Very young programming language developed at MIT.
- Rapidly growing community. (EEG.jl, brainwave.jl, EEGNet.jl)



Benefit:

- Free, fast, scalable, support BigInt and BigFloat.
- Extensively support matrix operations and GPU computing.

Preliminary Result

References

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