

Apr 25th, 4:15 PM - 4:35 PM

# Brain Network Structure and Interventions in a Computational Model of Epilepsy

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# **Brain Network Structure and Interventions in a Computational Model of Epilepsy**

Joe Emerson

# Neurobiological Background



## Epilepsy

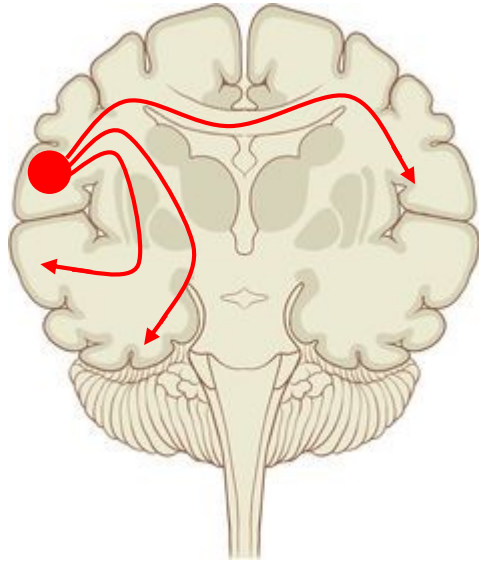
“...a chronic disorder, the hallmark of which is recurrent, unprovoked seizures”

- Epilepsy Foundation

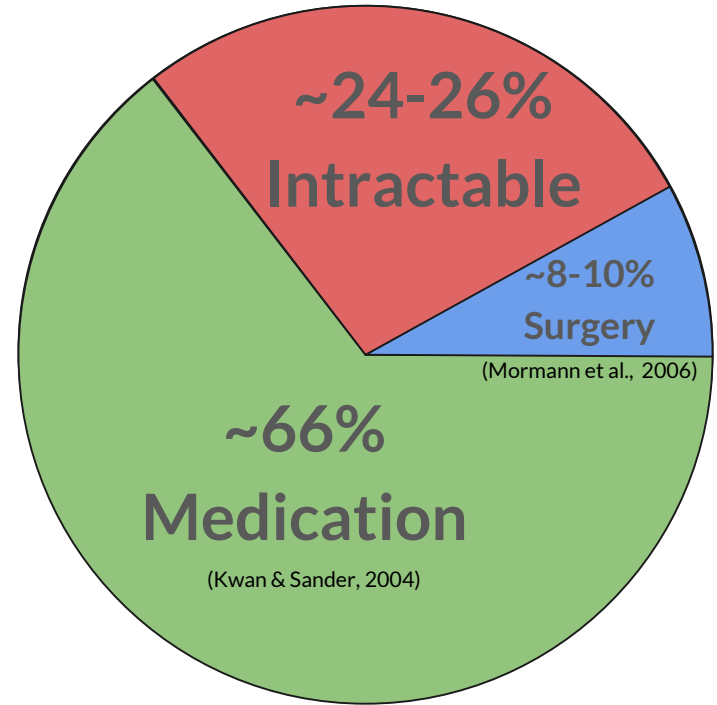
## Seizures

An abnormal behavior of the nervous system characterized by uncontrolled self-sustained firing of neurons leading to changes in behavior, sensation, and consciousness.

# Treatment



**Focal Epilepsy**

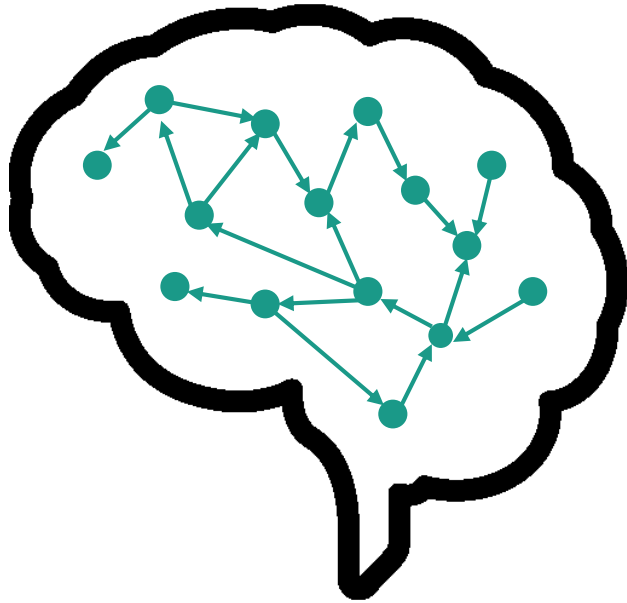


Only 52% of patients remain seizure free after surgery

(Tisa et al., 2011)

# A Gap in Our Understanding of Epilepsy

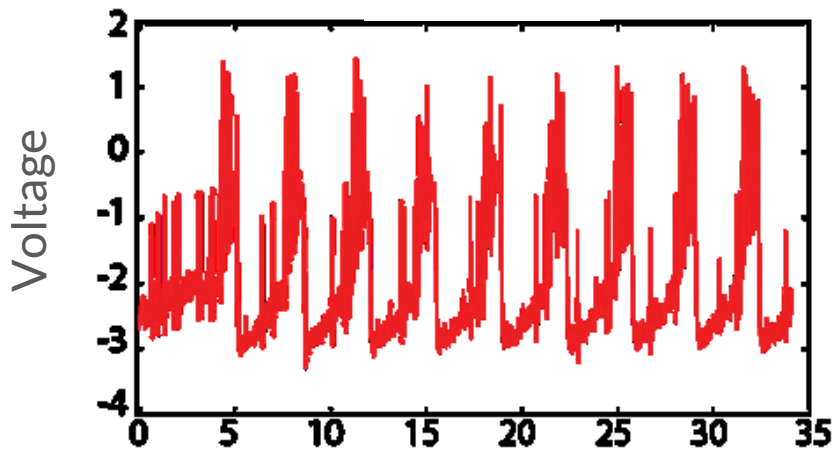
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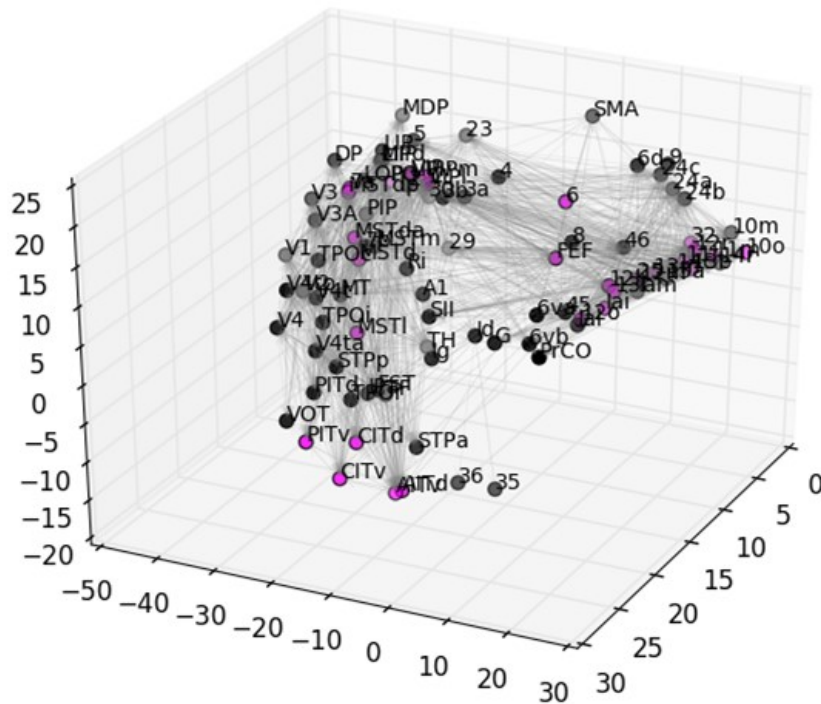
- Epilepsy as a brain network phenomenon
- Greater need for quantifiable network features
- Better understanding of network effects leads to better control

# A Computational Approach

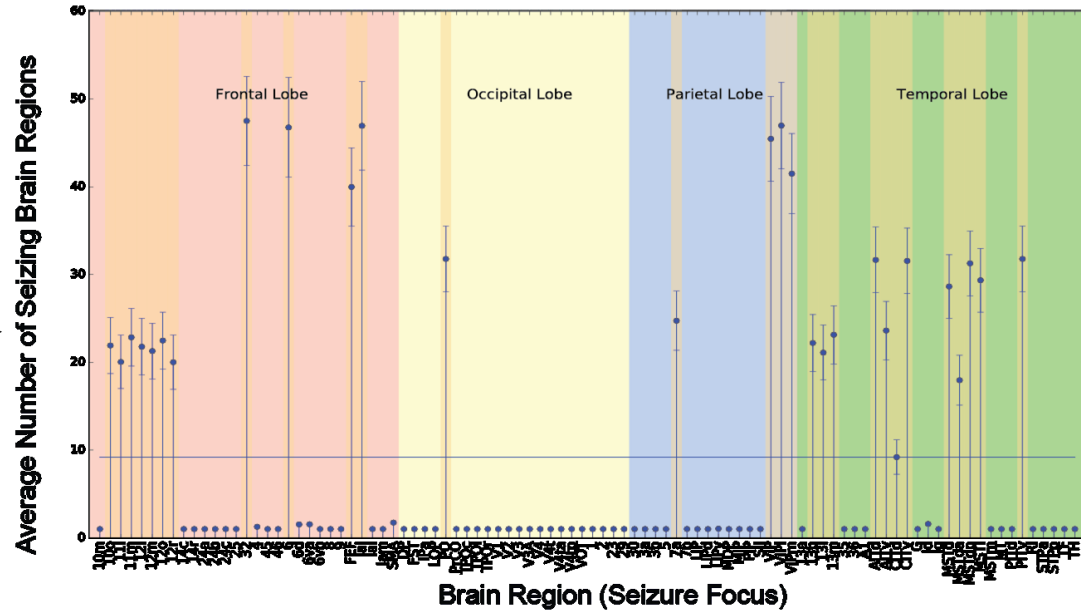
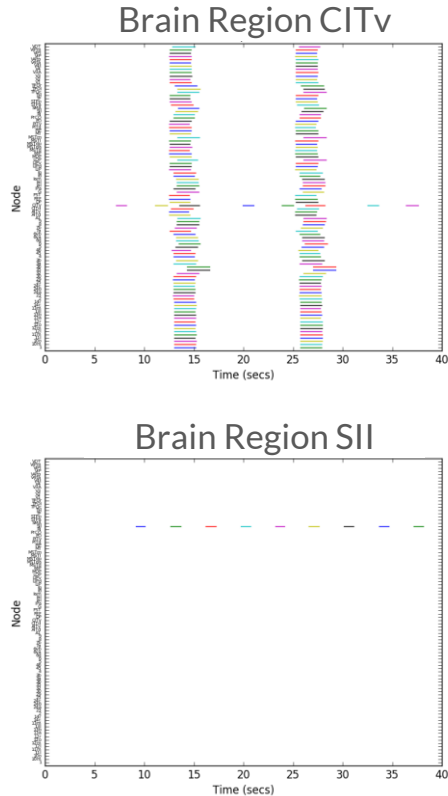
Seizures can be modeled mathematically



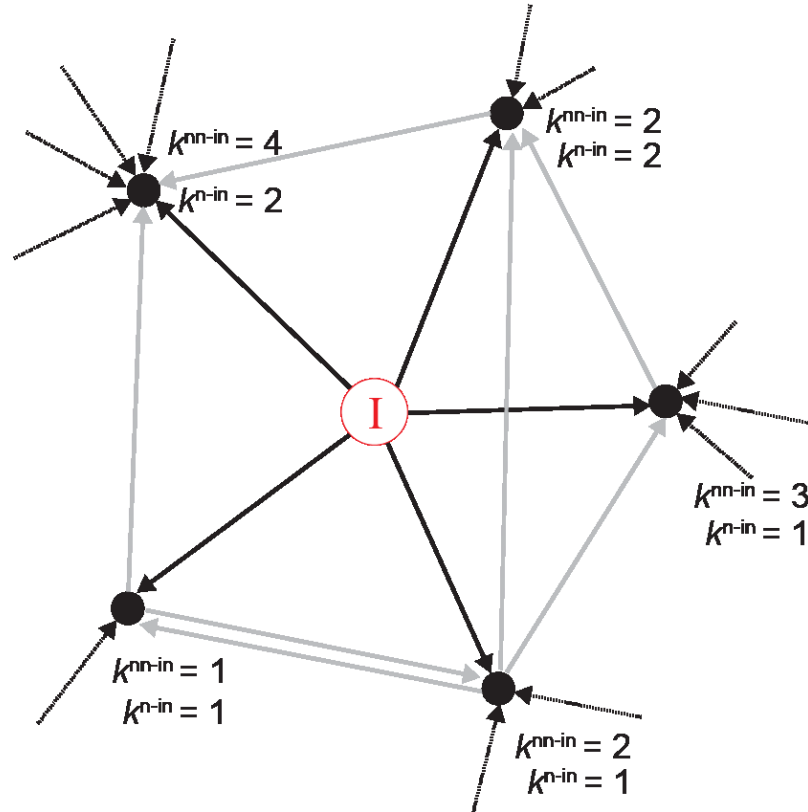
Macaque Connectome



# Quantifying Seizure Propagation



# Relevant Network Feature

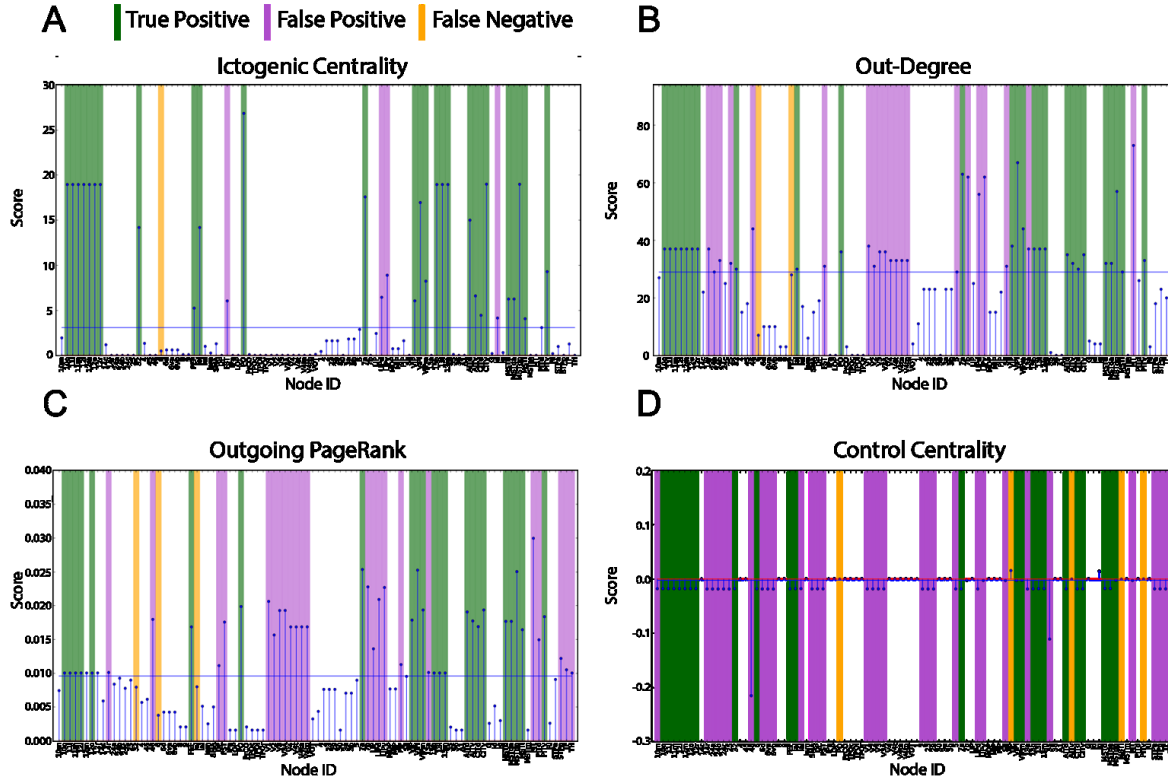


Neighboring Indegree

Neighboring Centrality

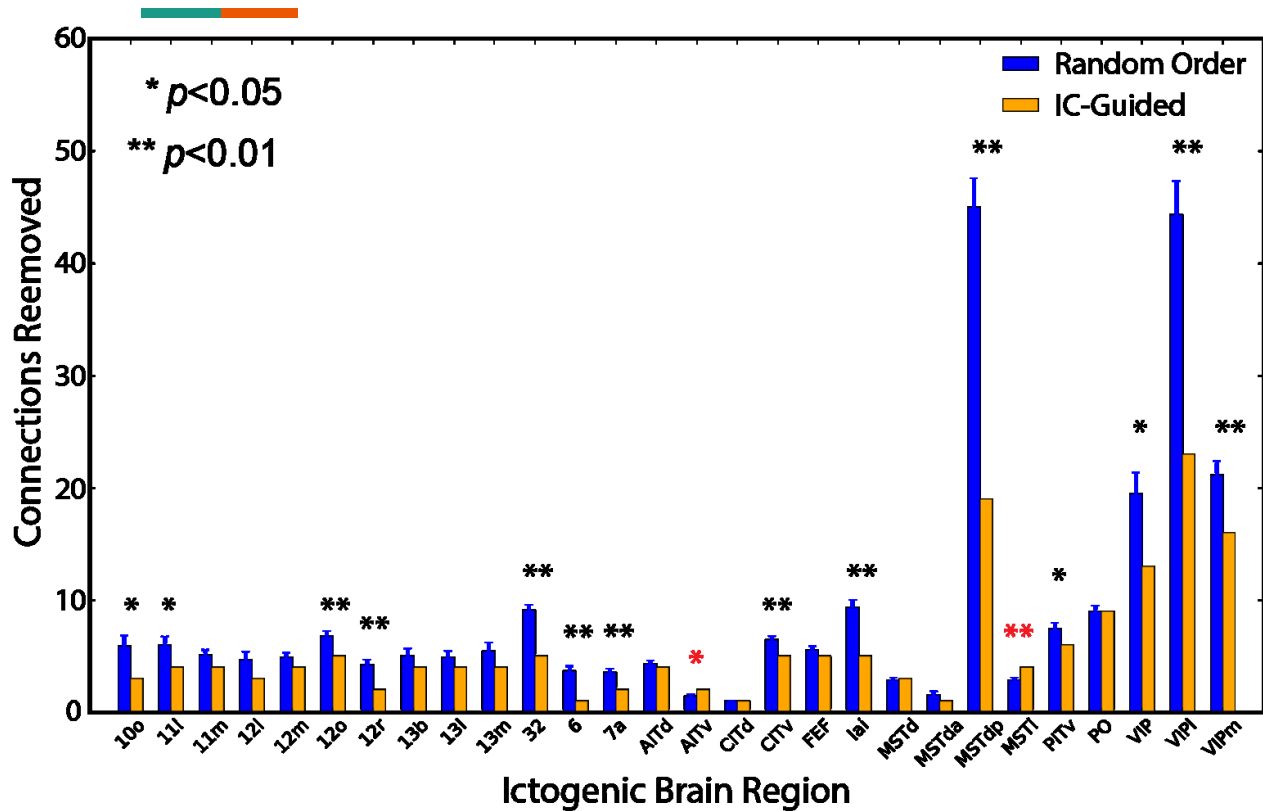


# Performance of Ictogenic Centrality



Ictogenic Centrality  
outperforms all other  
measures

# Simulated Interventions

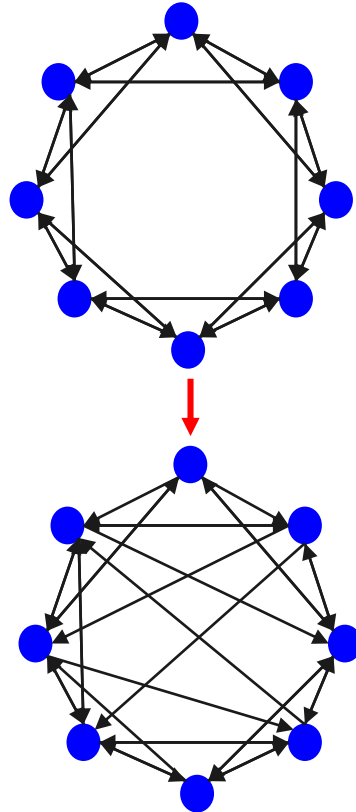


Ictogenic Centrality improved efficiency of selective structural intervention

# Artificially Generated Networks



Citation network from <https://www.r-bloggers.com/coauthorship-and-citation-networks/>



Ictogenic Centrality is robust,  
even working to predict  
influential nodes in **non-brain  
networks**

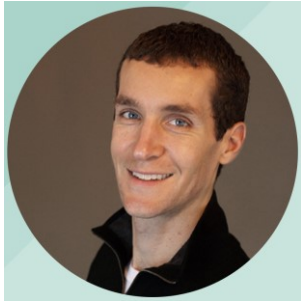
# Conclusions and Applications

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- Ictogenic centrality is a **simple, high-performing network centrality measure for epilepsy**
- Simulations demonstrate ictogenic centrality's potential to improve **efficiency in interventions**
- Surgeons may one day use **individualized connectomes** to determine the best course for surgical intervention. Network measures like ictogenic centrality may help foster **more effective surgical interventions.**

# Acknowledgements

## Co-Authors



Dr. Christian Fink  
- Principle  
Investigator

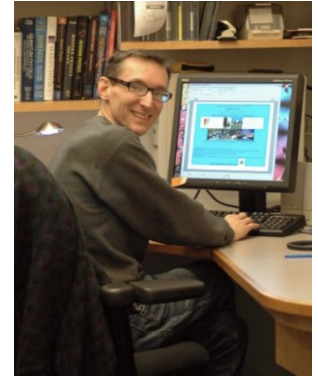


Momi Afelin



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## Senior Research Advisor



Dr. Brad Trees

National Institute of Health  
[Grant R01-NS094399]

National Science Foundation  
[Grant 1560061]

OWU Summer Science Research

