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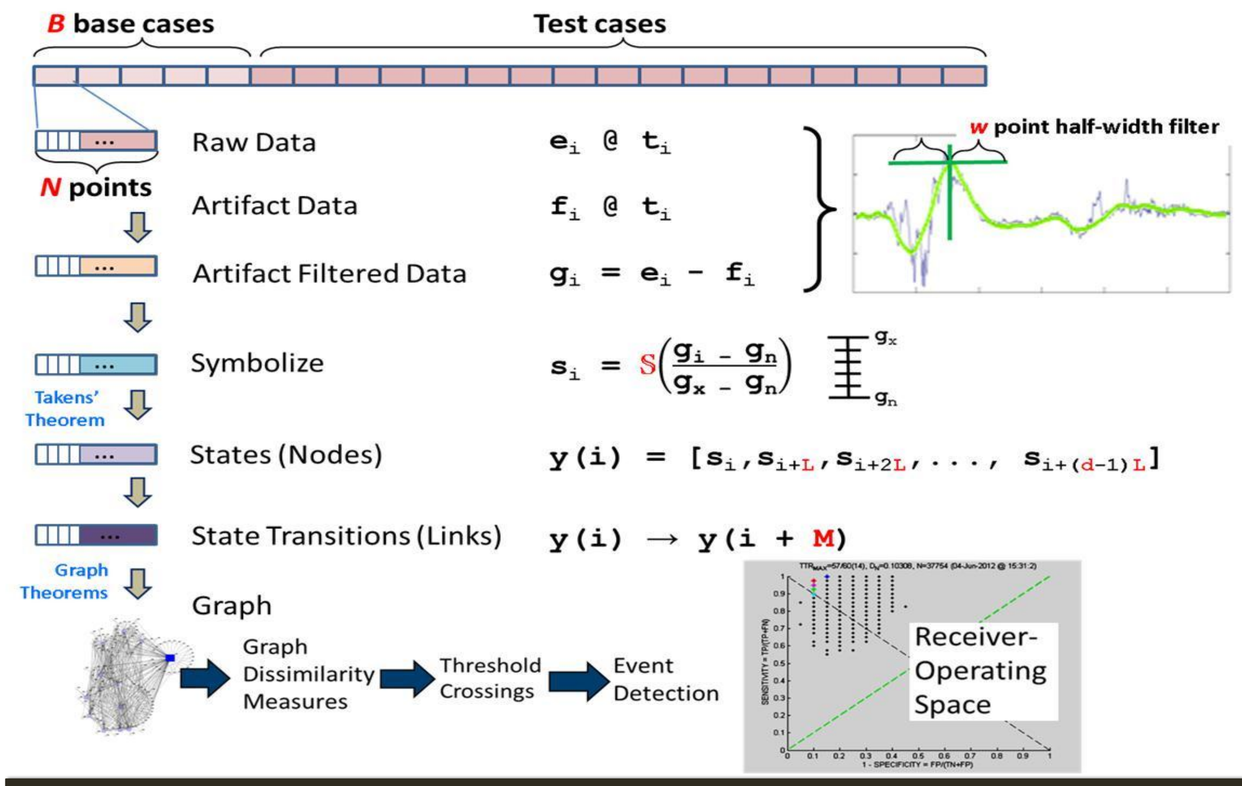
Improving Seizure Forewarning Using Graph Dissimilarity and Layout Analysis

Theorem-based event detection



60 observation data sets (40 event / 20 non-event)

Time-serial data analysis of EEG

Time-delay-embedding theorem produces state vectors

Novel states = nodes

State-to-state transitions = links

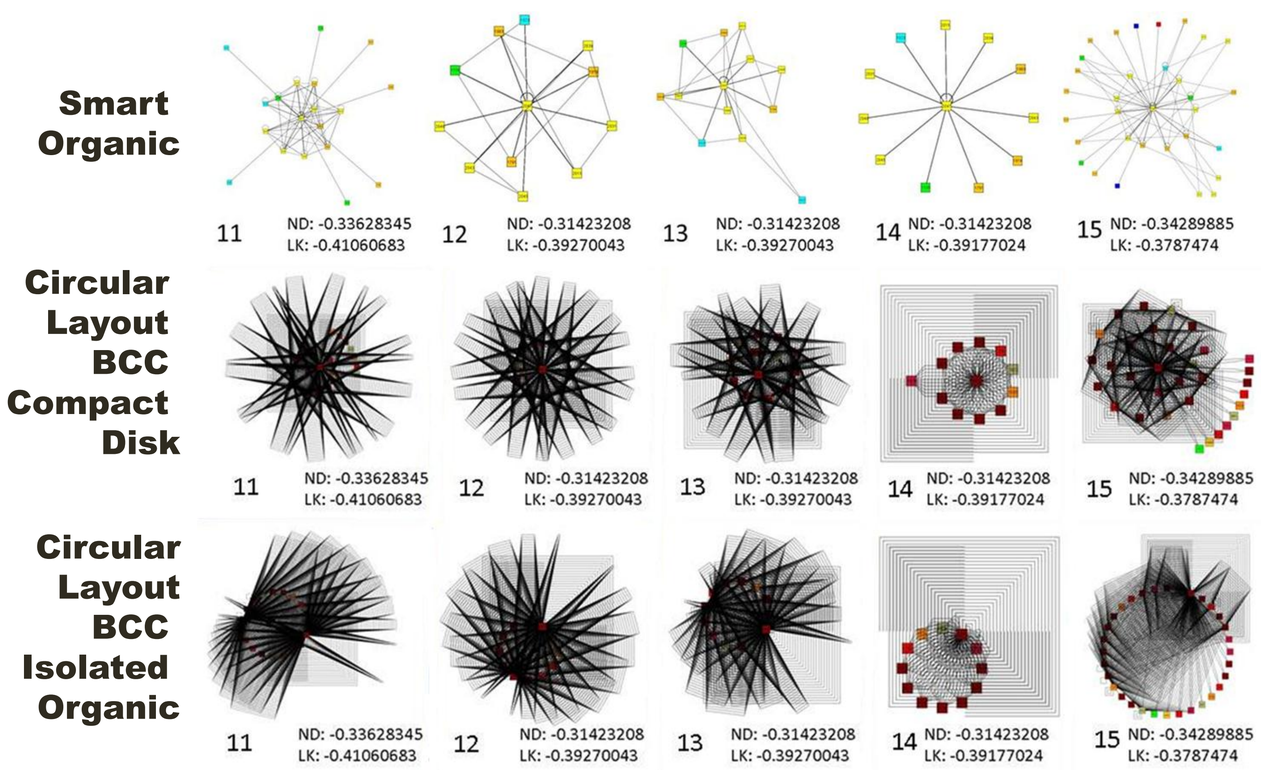
Nodes + Links = mathematical graph

Graph theorems to extract topological measures

Dissimilarity measures for seizure forewarning

Graph properties

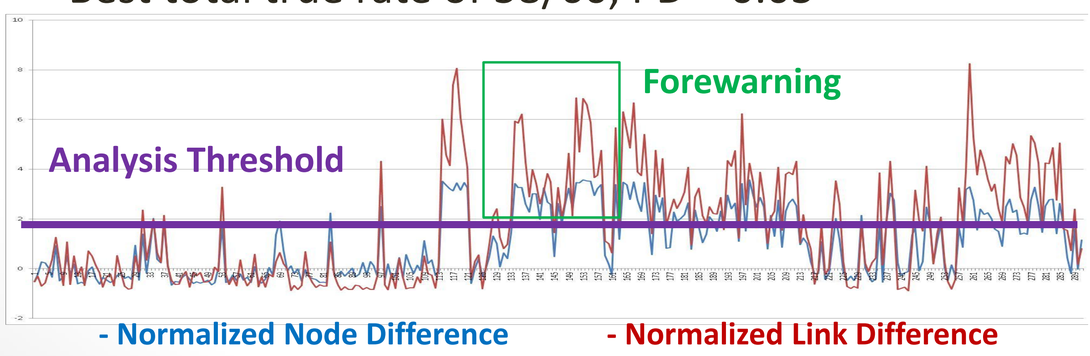
- Graph visualization
- Hundreds to thousands of nodes
- Typically thousands of links
- Pictorial layout: organic, hierarchical, circular
- Graph properties, such as
  - biconnected
  - planar
  - strongly connected
- Graph-theoretic measures as features
  - difference between number of nodes
  - difference between number of links
- Conversion of features into forewarning
  - analysis threshold gives yes (1) or no (0)
  - several successive occurrences give forewarning



Analysis framework

Measures of success in seizure forewarning

- True positive (TP): correct prediction of an event
- True negative (TN): no prediction in non-event data
- False positive (FP): prediction of a seizure in non-event data
- False negative (FN): no prediction of real event
- Balance of TP and TN by prediction distance (PD)
- Best total true rate of 58/60, PD = 0.05

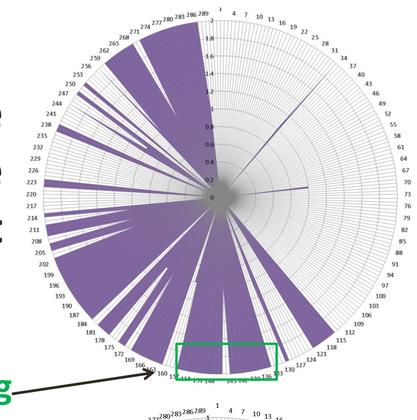


Node and Link difference by cutset for one EEG observation

Observation 45: Example of FP, No event, Forewarning indicated

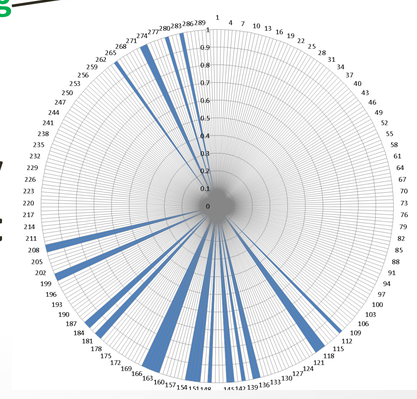
Node/Link difference occurrences above threshold by cutset

Observation 45: FP, No event



Biconnected property by cutset

Observation 45: FP, No event



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