Sandpiles on Epileptic Brain

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January 22, 2014

Introduction

Motivation

- Epileptic episodes are characterized by cascading process.
  - Chain reactions triggered by a small fraction of a system.
- Graphs from ictal phase shows a high number of a specific motifs.

Hypothesis

Something in the graph topology may be behind the genesis and propagation of the cascading phenomenon.

Introduction

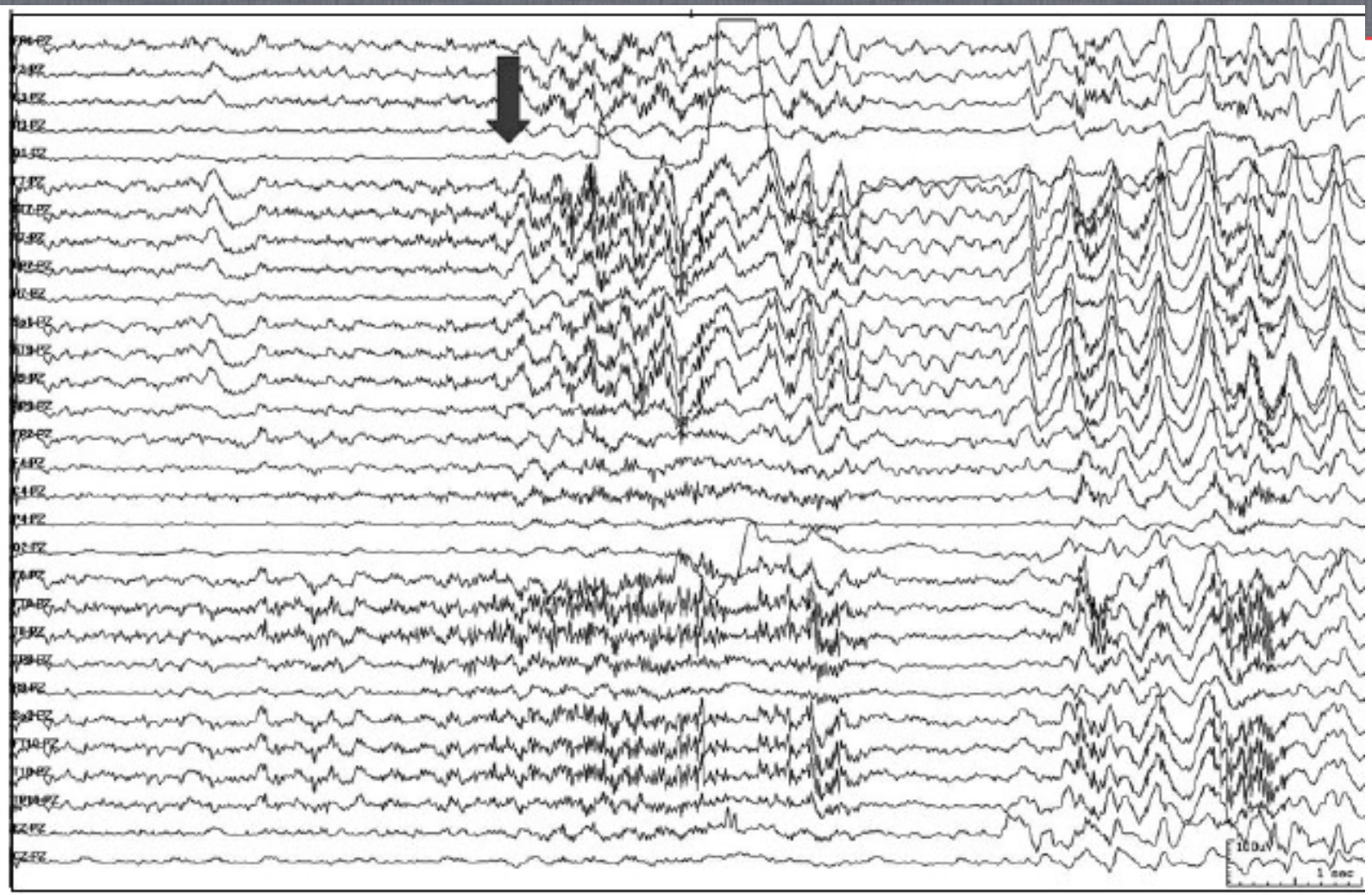


Figure : The arrow points to the start of the ictal period, where the seizures happens.

Introduction

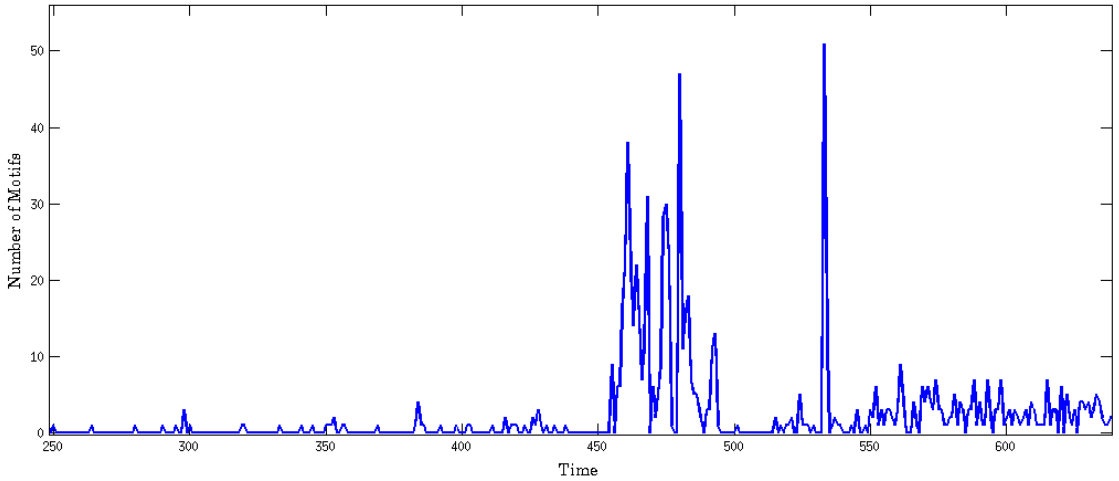


Figure : Number of motifs along time.

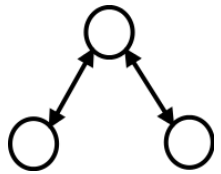


Figure : This kind of motif has well know synchronization features.

Objective

Goals

- Investigate the susceptibility of **ictal** graph to the genesis of cascading behavior (avalanches)
- Identify the role of the motifs on the cascading process.

Methodology

- Simulate the cascading process using a dynamic model (Sandpile) and a static model (graph)
- Comparisons between:
  - Ictal versus inter-ictal networks
  - Ictal versus randomly generated networks
- Ictal and inter-ictal graphs are calculated from the EEG signals using a Granger causality test.
  - Directed, binary graphs

Sandpile Model

Characteristics

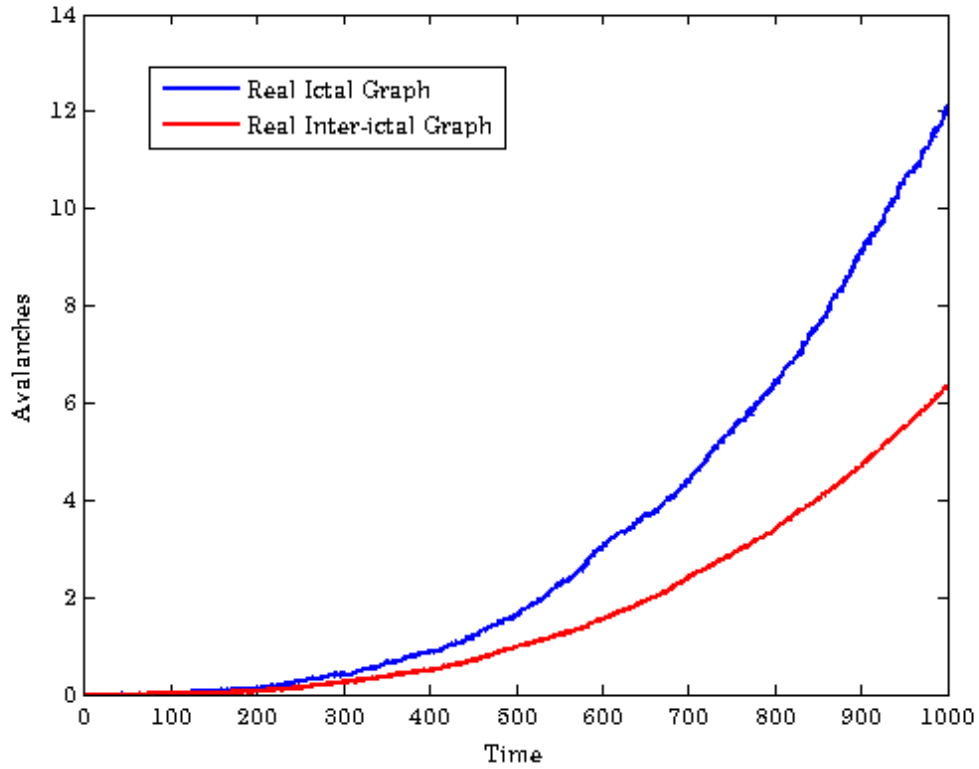
- Describe situations of cascading failures:
  - Breakdown of a electrical system.
  - Colapse of a communication network.
  - Unexpected epidemic spread of diseases.

Algorithm

- Each node starts with 0 "grains".
- On every iteration one grain is added to a randomly selected node
- If the number of grains is greater than a threshold, they are transferred to neighbor nodes.
- The neighbor can also overflow and initiate the cascading phenomenon.

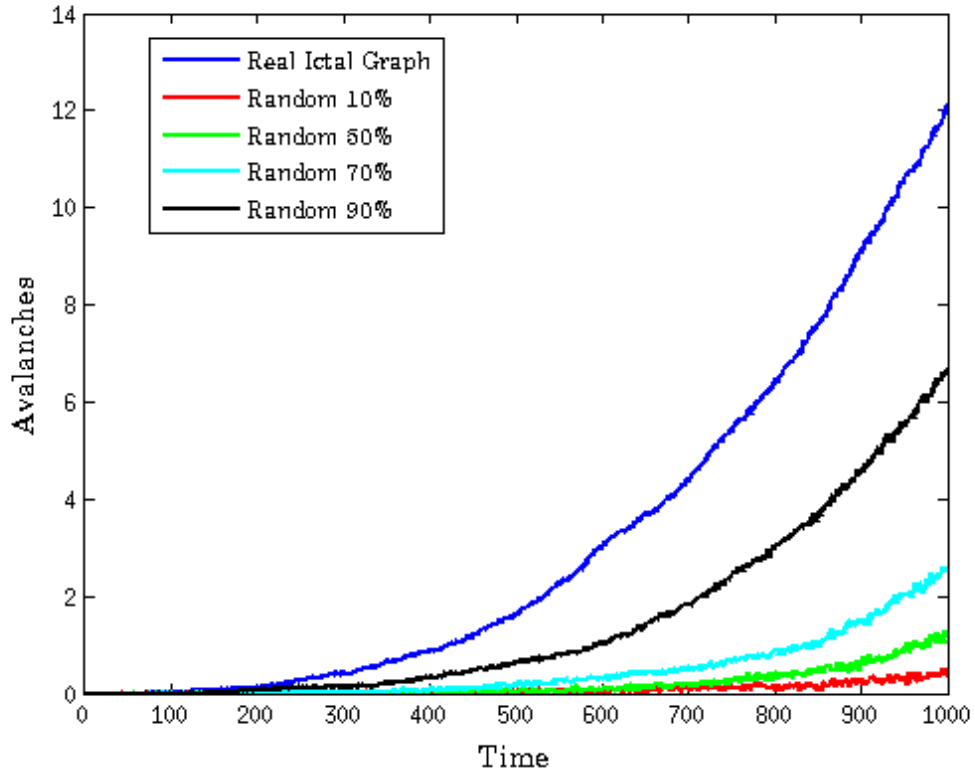
Results

First simulation: Ictal graph x Inter-Ictal, different number of connections.



Results

Second simulation: Ictal x Random graphs, same number of connections.



Conclusions

- Ictal networks shows higher number avalanches than inter-ictal networks.
- It is not only the number of edges that influences the genesis of avalanches.
- Random graphs that are closer to the ictal graphs shows similar number of avalanches

Next Steps

- Check others avalanches characteristics: size, duration.
- Sandpiles on other types of motifs

Thank You!