Real-time Epileptic Seizure Detection using Reservoir Computing

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Reservoir Computing (RC)

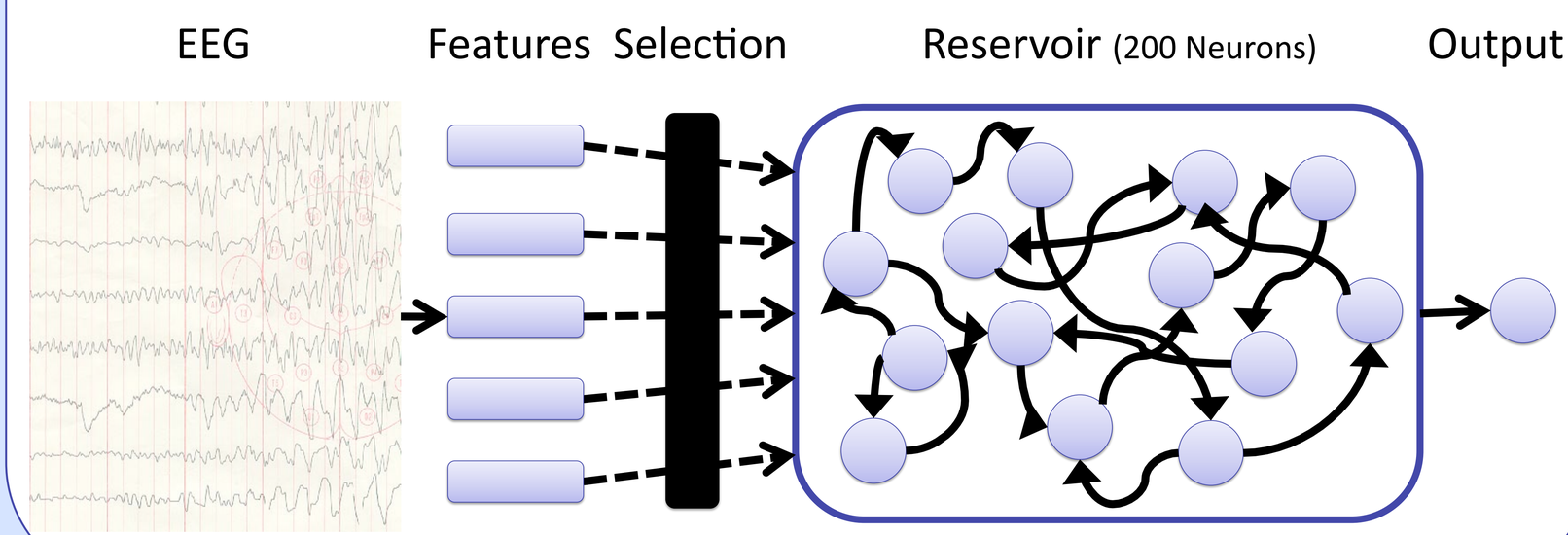
Description:

- Training method for Recurrent Neural Networks (RNN's)
- Random RNN – "reservoir"
- Random input connections
- Only single layer of linear output nodes is trained

Advantages:

- Recurrent network: random processing abilities
- Fast training: one linear neuron per output channel
- No convergence issues
- Works with practically any kind of neurons (analog, spiking, …)

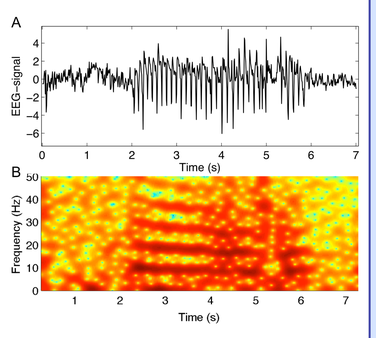
Seizure Detection Setup



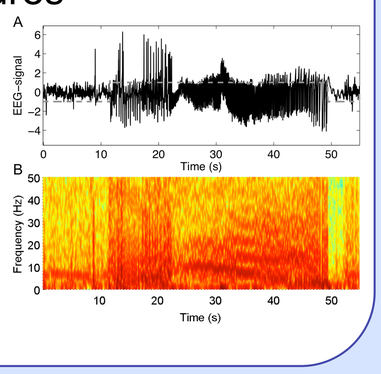
EEG Data

Intracranial data from Rats:

- GAERS
  - Genetic Altered Rats from Strasbourg
  - Absence seizures
  - 1.5 seizures/min
  - Last 8 to 50 s
  - In total:
    15 hours
    17 minutes
  - 10% for training



- Kindling Model
  - Brain stimulation to develop epilepsy
  - Tonic-clonic seizures
  - 2 seizures/h
  - 40s to 4 minutes
  - In total:
    4 hours
    23 minutes
  - 20 % for training



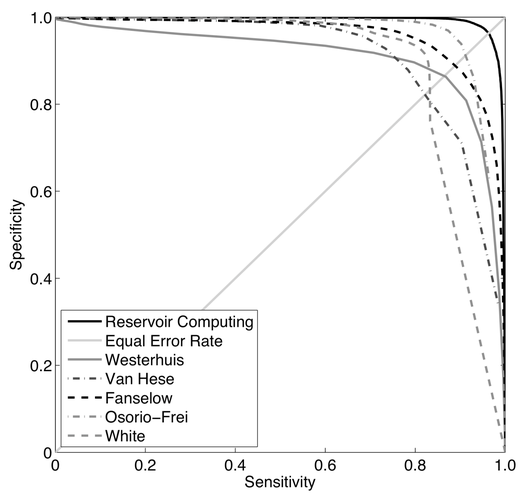
Results

ROC-curves:
- Receiver Operator Characteristics
- Sensitivity versus Specificity
- Area Under Curve (AUC)

Detection delay:
- Delay before seizure is detected
- For threshold of sensitivity = specificity

GAERS:

- AUC:
  - RC = 0.99
  - 2nd best, Faselow and Osorio-Frei = 0.96
- Detection delay:
  - RC = 0.3s
  - Osorio-Frei = 0.9s
  - Fanselow and others > 3s



Kindling:

- AUC:
  - RC = 0.99
  - 2nd best, White = 0.82
  - Osorio-Frei = 0.78
- Detection delay:
  - RC = 1.5s
  - Osorio-Frei = 1.8s
  - White and others > 2.5s

Conclusion

- Epileptic seizure detection is possible with Reservoir Computing
- It renders good results on intracranial rat data
- It results in a small detection delay

Further Work

More rat data
- Results are on a small dataset
- Currently extending results

Human (scalp) EEG
- Human data has different patterns
- Scalp EEG contains artefacts and noise
- Preliminary results promising

More features
- Currently small set of features
- Adapt features from literature

Accelerometry, ECG and others
- Use features from different sources

Compare with more methods
- Gotman,…

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