

Circuit Architectures for Inference: ***Sensing and analyzing complex physiological signals*** ***in low-power devices***



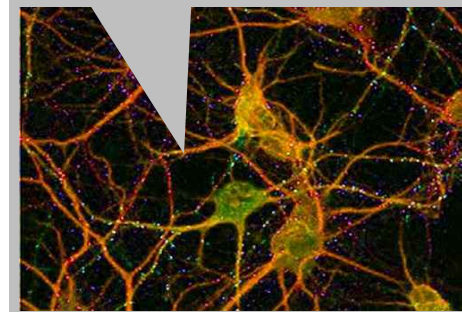
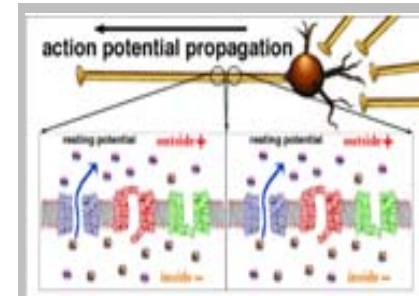
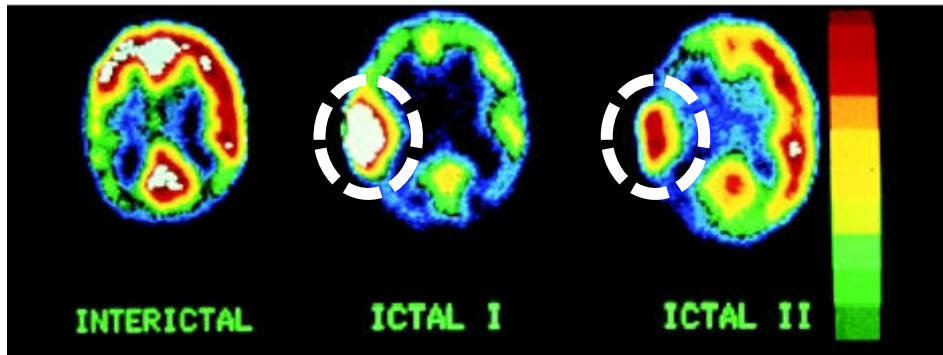
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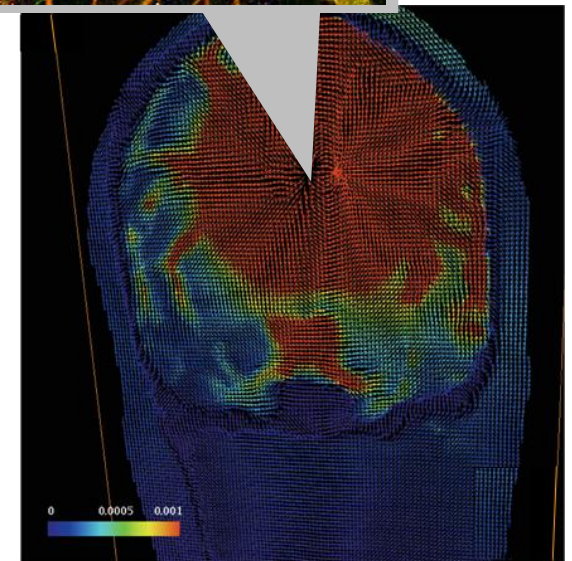
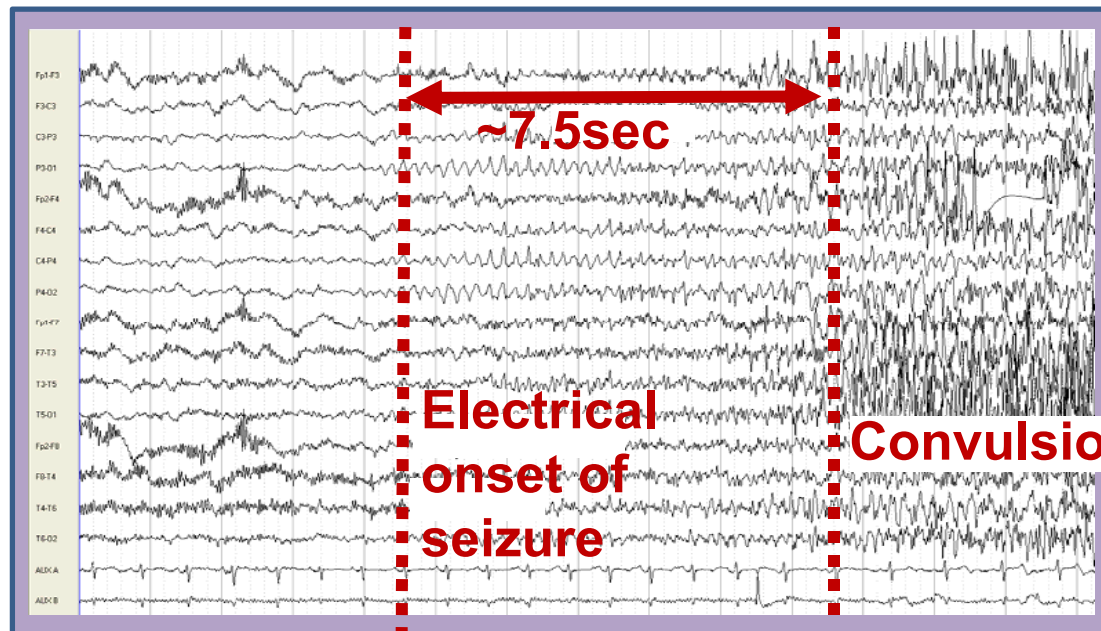
Forum on Integrated Sensors for Cybersystems
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Extracting high-value outputs from LP modalities

SPECT Image:



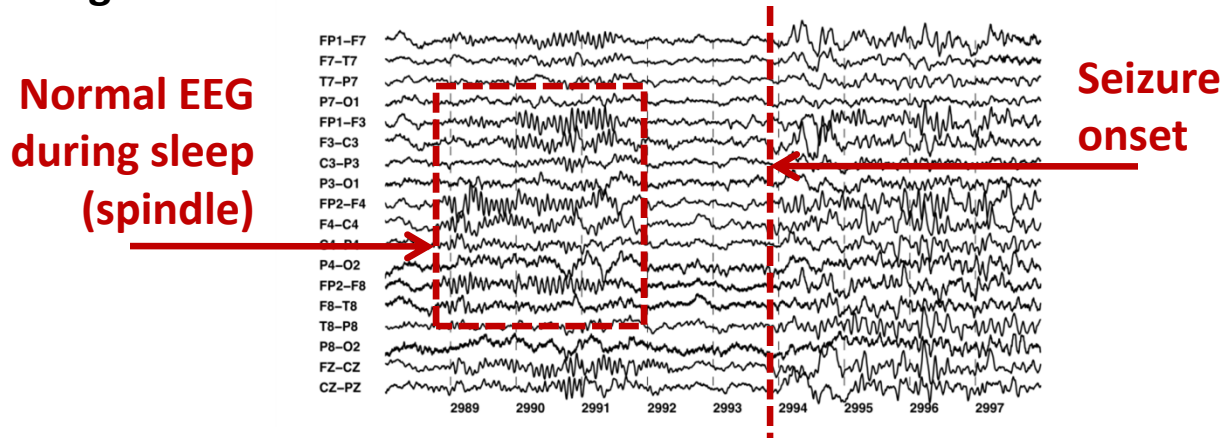
sEEG recording:



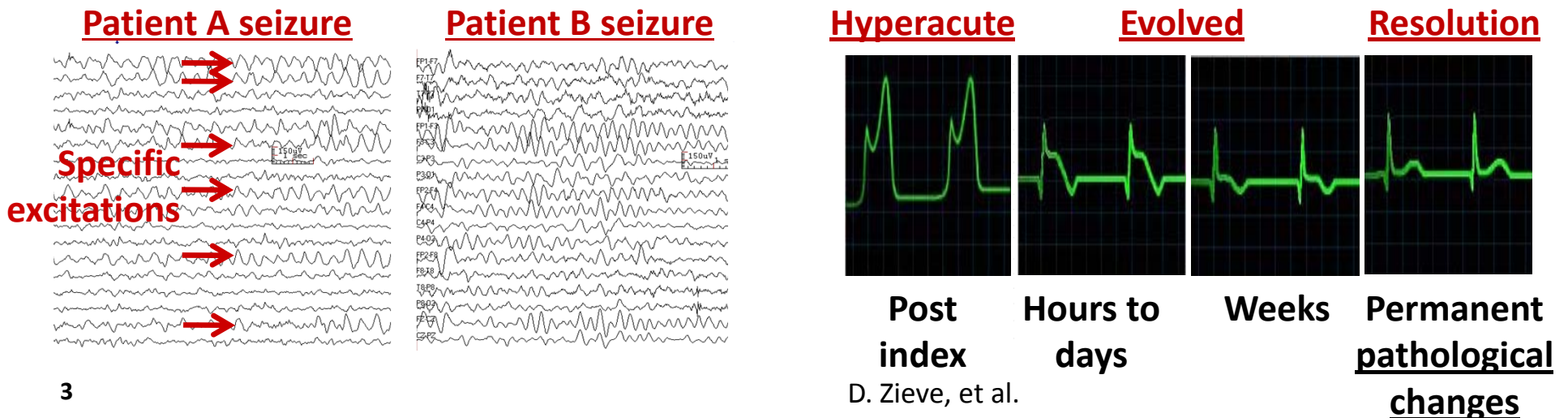
Why is this hard?

A: We don't understand the physical processes to a high-order, and yet...

1) We need high-order models



2) Physical systems are *variable* and *dynamic*



What do we have going for us?

A: DATA!

... sensor network gives us access to more data

... sensor network gives us access to informative data

1) Models for correlation can be based on data

- True variances in the physical signals can be well modeled
- A very wide range of physical processes can be handled

2) Need efficient frameworks for extracting information from data

- Machine learning offers powerful frameworks for inference

3) Need to understand such frameworks from the perspective of low-power platforms

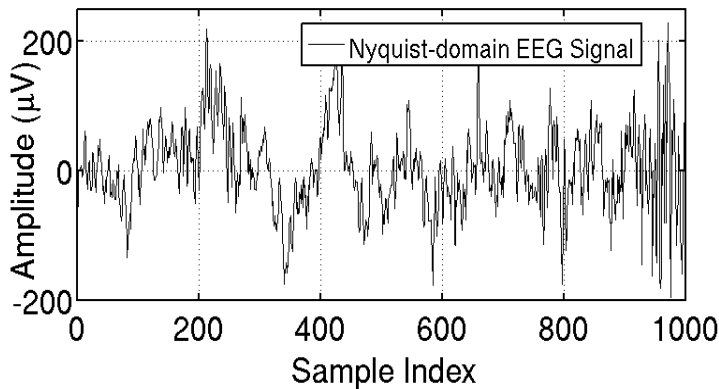
- Energy, memory, bandwidth, SNR, etc.

Data-focused sensing and analysis

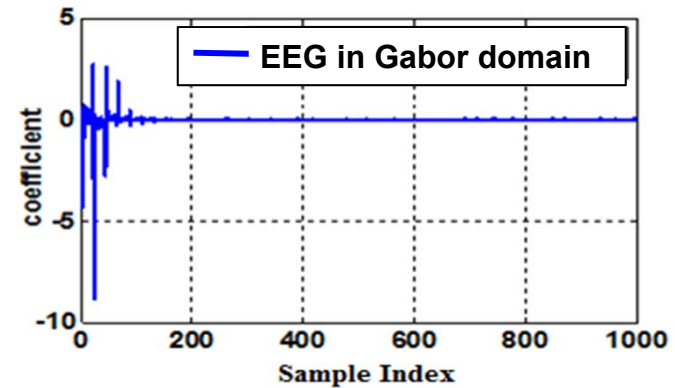
Efficient data representation is likely a key issue;

→sensing frameworks and platforms must be developed around this.

Compressive sensing:

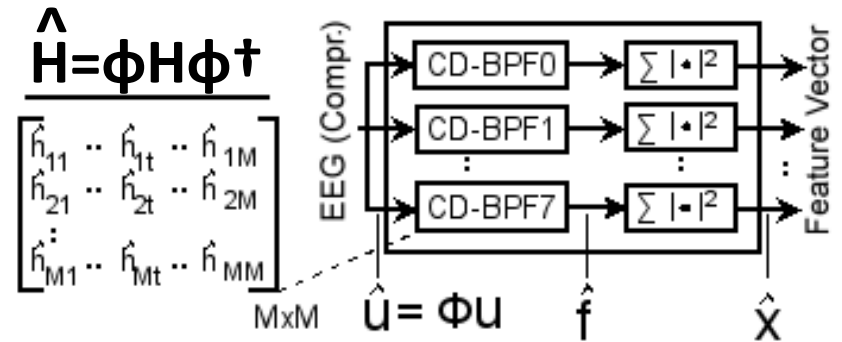
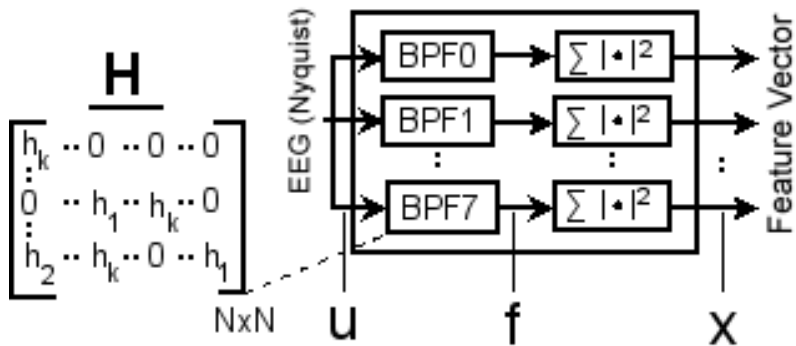


Transform to
sparse basis
(Ψ)



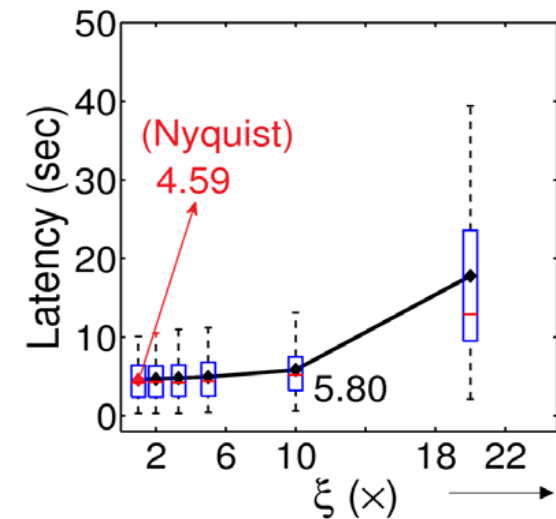
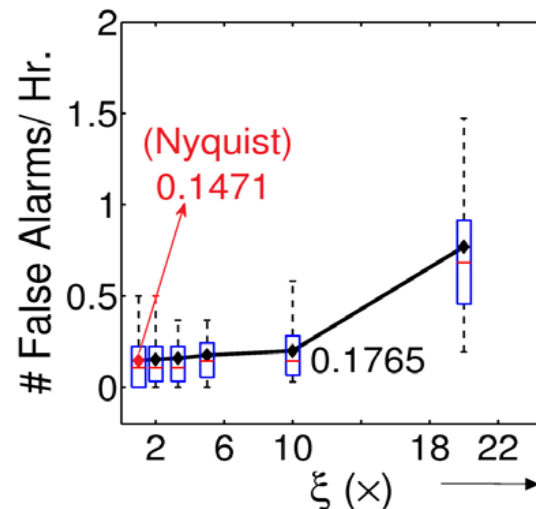
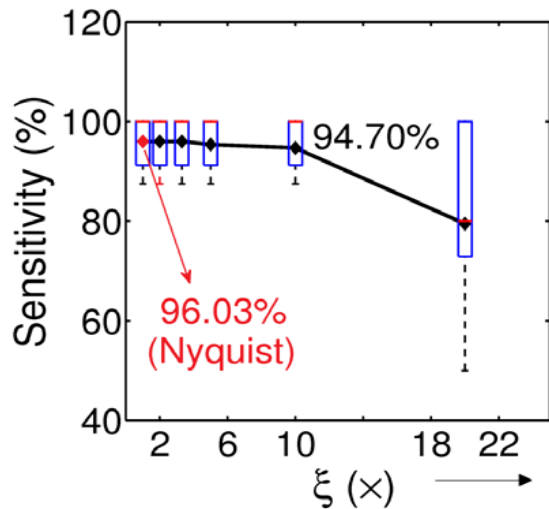
Signal analysis in Nyquist domain

Signal analysis in compressed domain

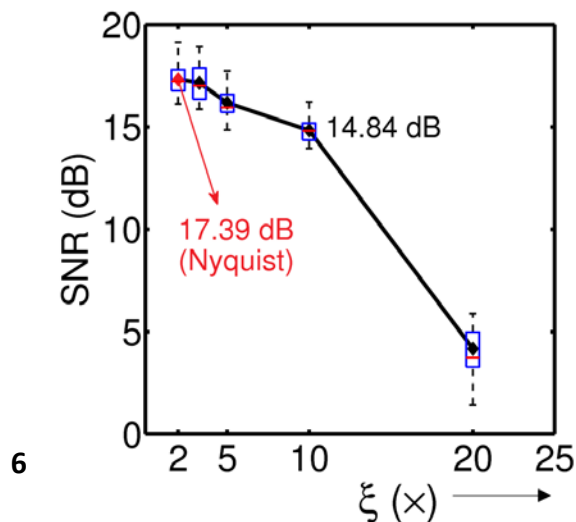


Compressed-domain analysis

Performance of EEG-based seizure detection:



Signal reconstruction performance:



Some questions:

- What are possible methods of representing data?
- How do the data representations change the computational models/methods?
- What power-management opportunities do these give?

Thoughts

Physical signals (of interest) are too complex to model analytically



Sensors give us access to lots of
potentially informative data

Data-driven analysis can allow us to leverage this



What platforms and frameworks are required to exploit data
and enable data-driven analysis



What platforms and systems are required to utilize
physical resources optimally

Acknowledgments

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- Prof. Yann LeCun(NYU)

Students

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- Shoaib Mohammed (Princeton)