FILTERING OF EEG SIGNAL ENSEMBLES USING GRAPH SIGNAL PROCESSING THEORY

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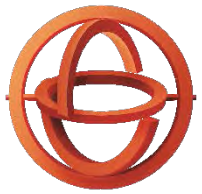

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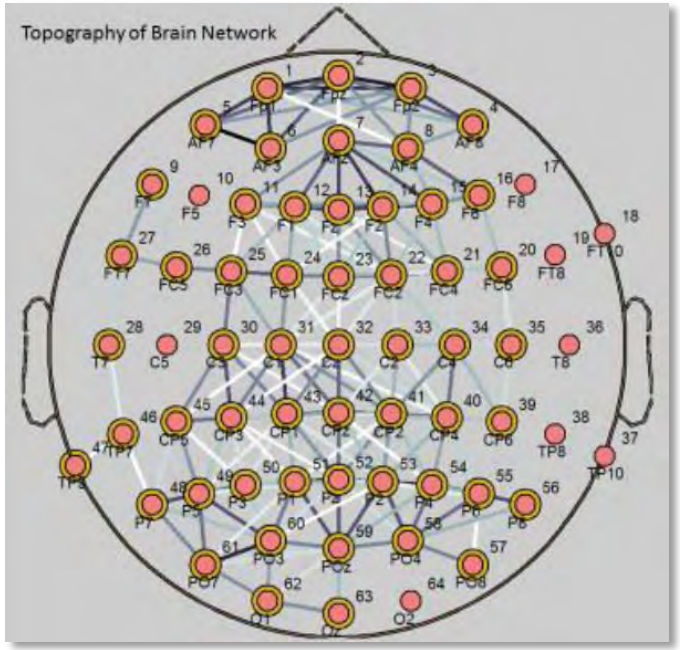
GRAPH SIGNAL PROCESSING (GSP)

- **Aim to:** Investigate the conventional Graph Signal Processing (GSP) Filtering on α-stable noisy EEG signal.
- Advantages:
  - Exploits signal correlations.
  - Works better for irregular signal structures.
- Disadvantages: Gaussian noise
- Main procedure: Filtering
- Necessary operators:
  - Adjacency (A)
  - Laplacian (L)
- Important operation:
  - Graph Fourier Transform
    - Eigendecomposition (A or L)

Dataset/Graph Description

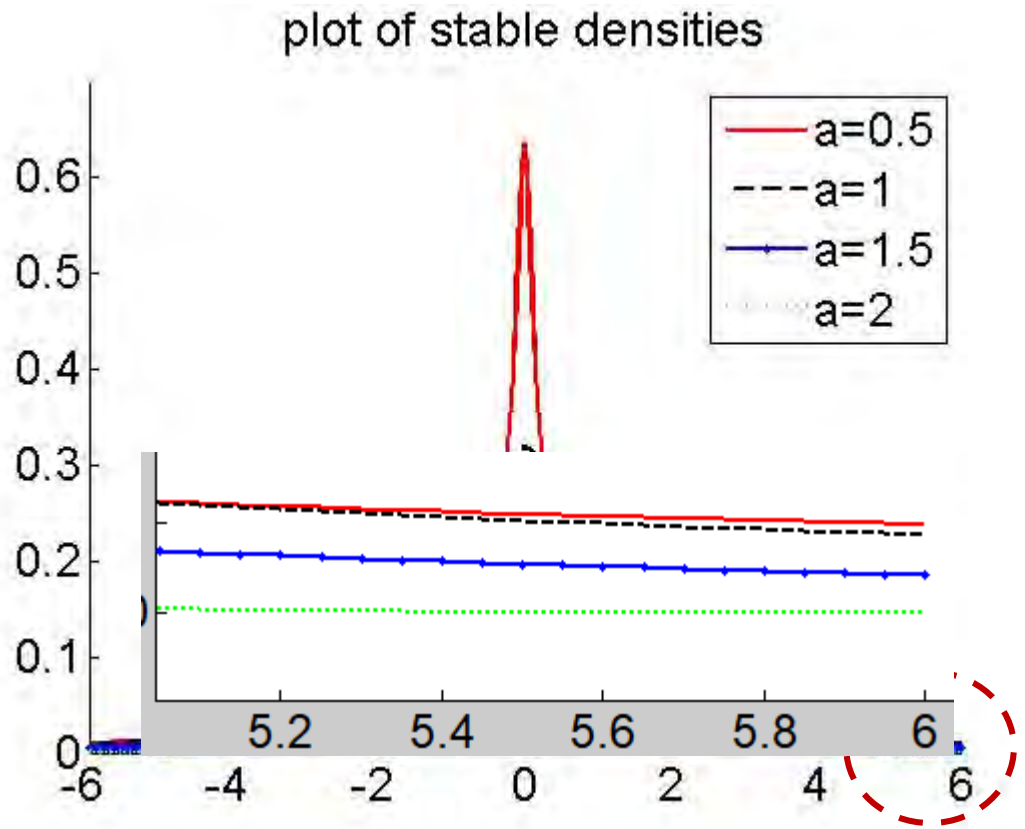


ALPHA-STABLE

- Generalized family of distributions
  - Includes specific distributions (based on α) e.g. the Gaussian & Cauchy
- α-stable Advantages:
  - More natural noise representance
  - Big Fluctuations

- Attributes:
  - Heavy-tailed nature
  - Parameters:
    - **S** (α,β,γ,δ;parametrization)

heaviness symmetry dispersion location



Plot of α-stable distributions. If α=1 or α=2, this family reduces to the Cauchy and Gaussian distributions, respectively. In zoom, the tails of the four cases are presented, showing that for smaller α's the distribution becomes heavier.

Experimental Results & Future Work

Observations

- As α increases to 2 (Gaussian distribution), the GSP filtering is better than the α-stable per signal filtering.
- Denoising: NMSE decreases as α increases in GSP case.

FUTURE WORK

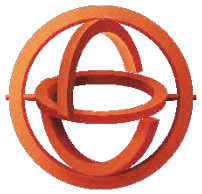
What if the noise is non-Gaussian?

Challenge: Create an α-stable GSP filter

	Adjacency		
	α=1	α=1.5	α=2
γ=0.01	1.02E-04	3.73E-08	0.00E+00
γ=0.1	1.00E+00	9.71E-05	1.44E-07
γ=1.5	6.56E-01	1.17E-03	2.51E-05
	Laplacian		
γ=0.01	3.08E-07	1.10E-10	0.00E+00
γ=0.1	6.96E-03	1.08E-08	3.30E-10
γ=1.5	1.00E+00	1.14E-05	1.09E-07
	α-stable		
γ=0.01	1.57E-05	6.49E-09	0.00E+00
γ=0.1	7.17E-04	5.94E-07	1.74E-08
γ=1.5	1.00E+00	3.26E-04	3.97E-06

Normalized Mean Square Error (NMSE) between original & denoised signals.

THANK YOU



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