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NETWORKS

Can one hear the position of nodes?

Learning node centrality from audible waveforms

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Spectral analysis

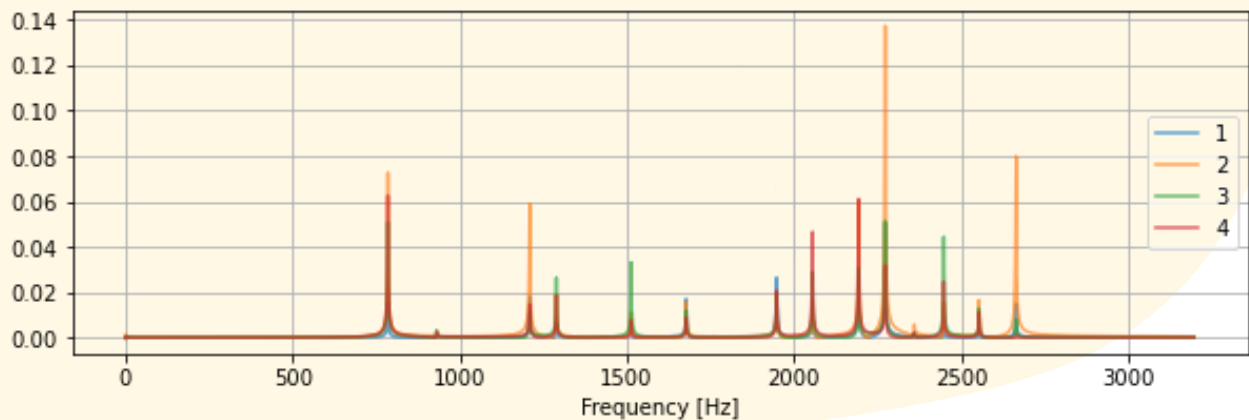
Adjacency spectra

Laplacian spectra

Signless Laplacian spectra



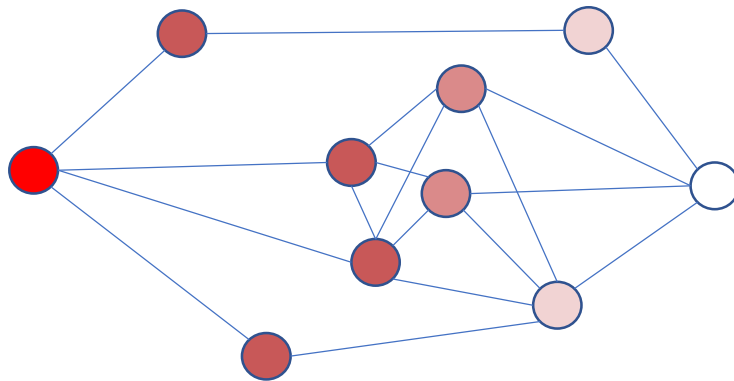
Florentine Families Network



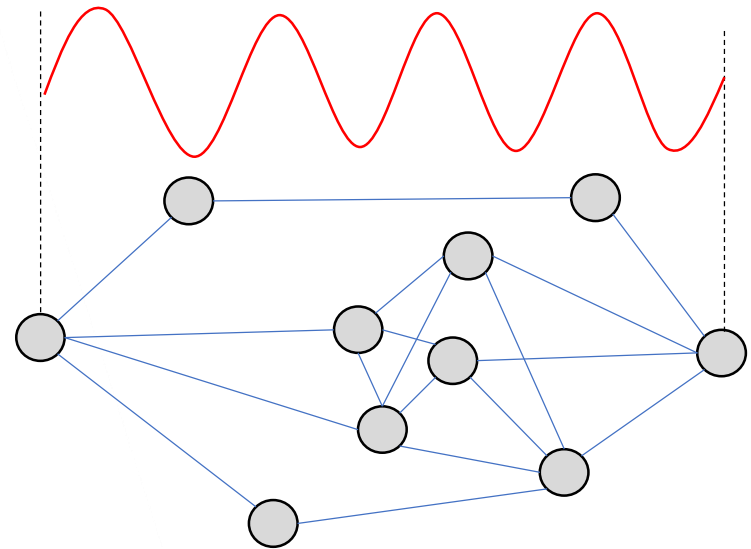


Spectrum of what?

Heat propagation



Wave propagation

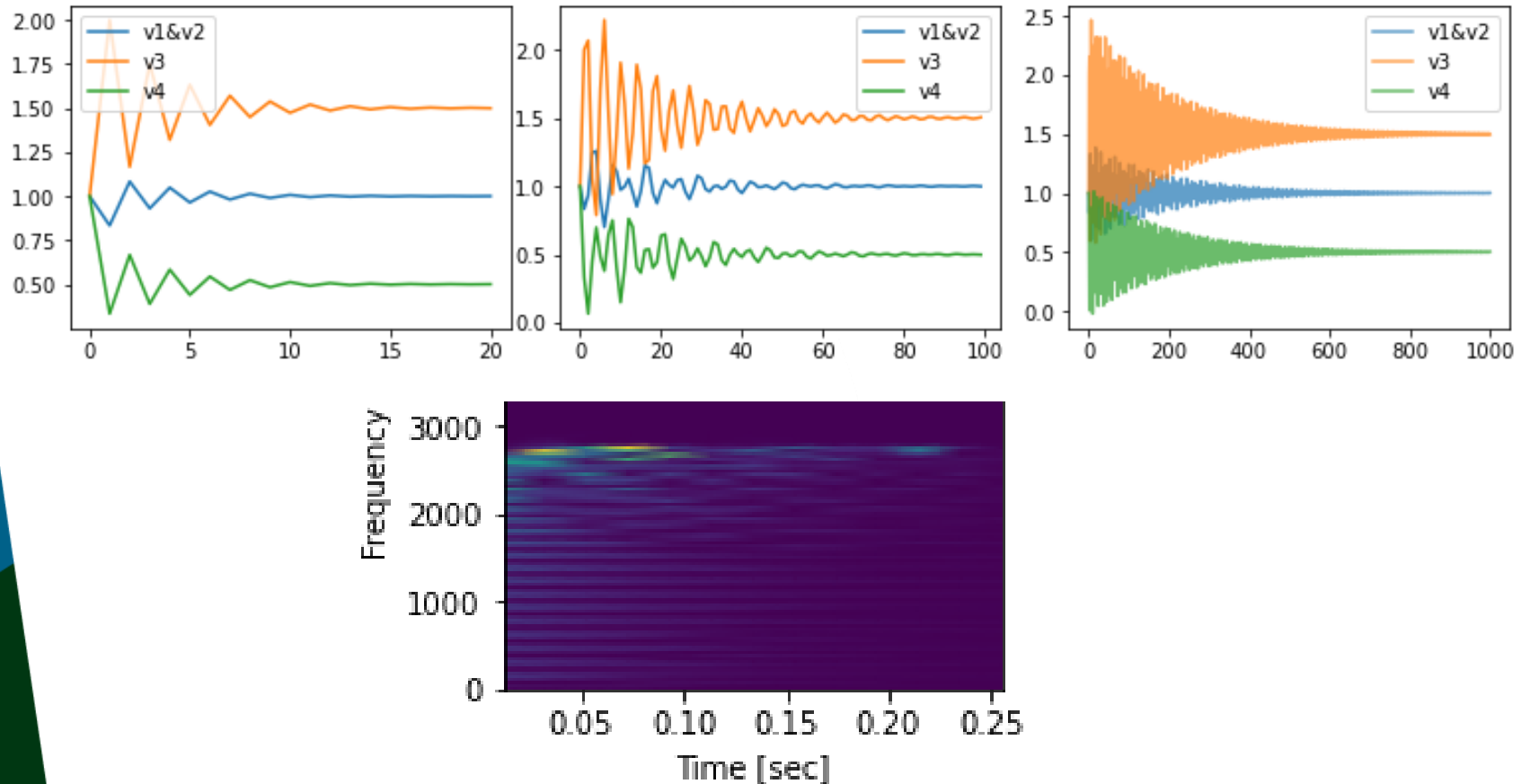




How do the waveforms look like?



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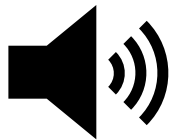
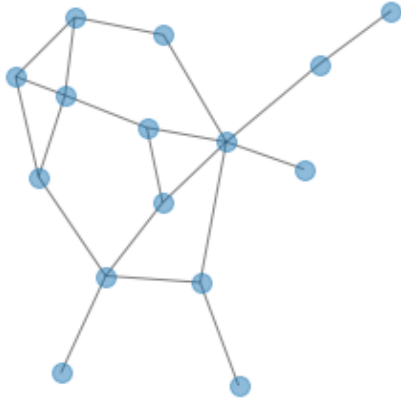


Listening to the nodes

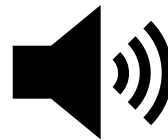
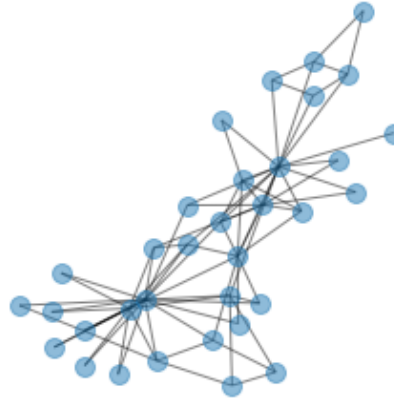


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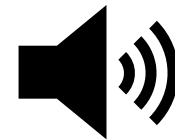
Florentine Families



Karate Club



A Line

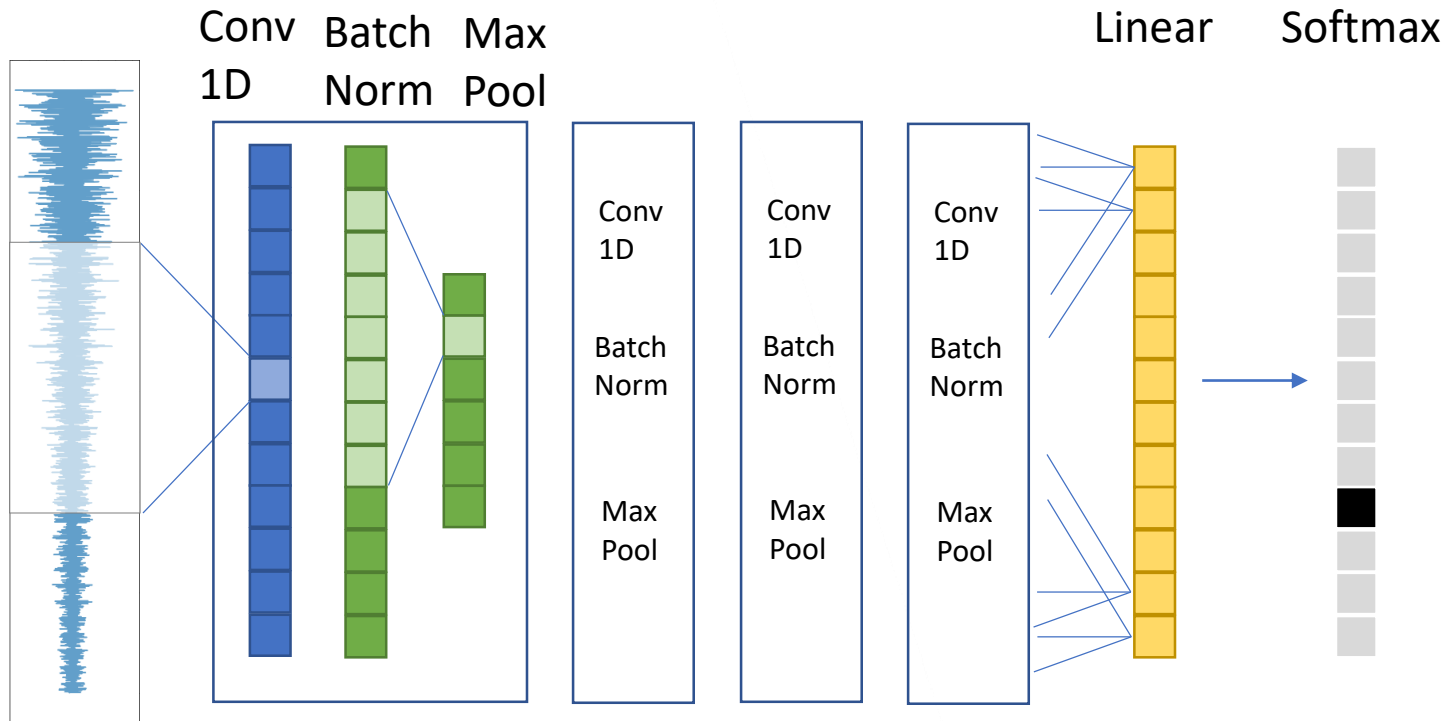




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Recognizing the sounds

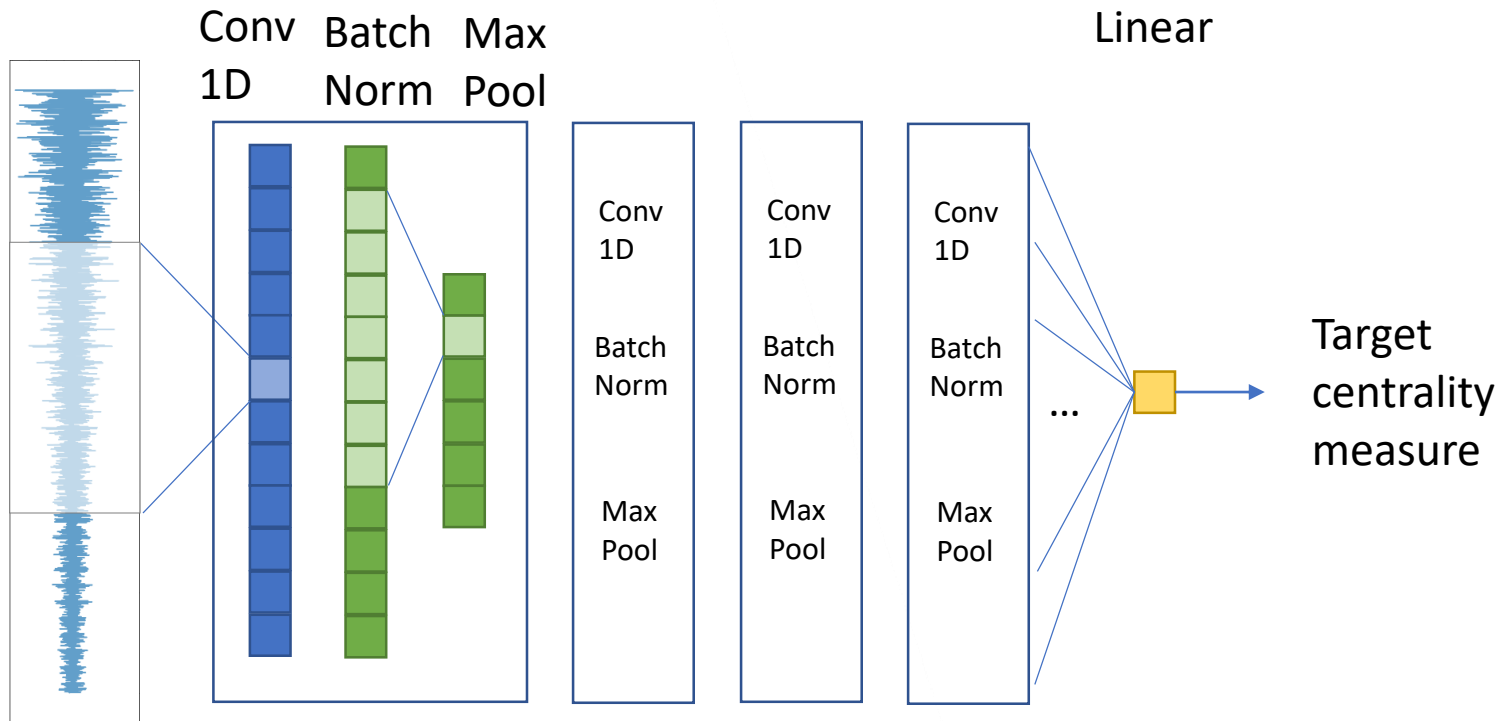
- Very deep convolutional neural networks for raw waveforms (Dai et al. 2017)





Learning centrality

Learning arbitrary centrality measures from node waveforms





Results



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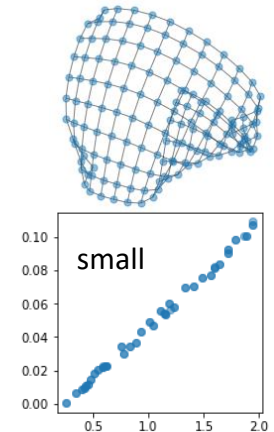
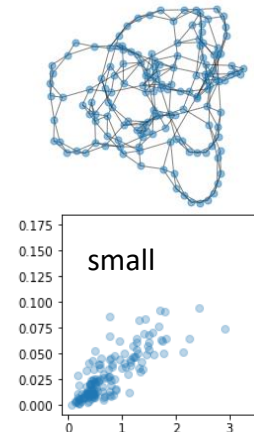
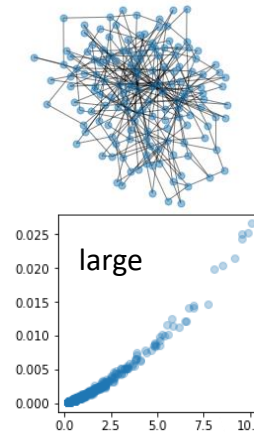
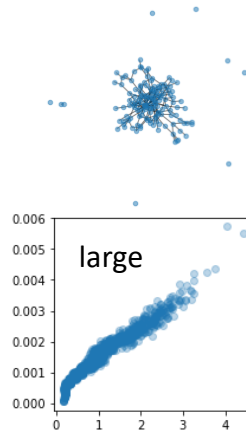
Erdos-Renyi

Barabasi-Albert

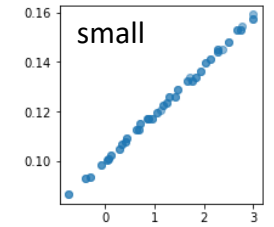
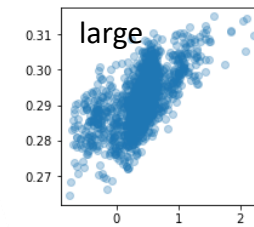
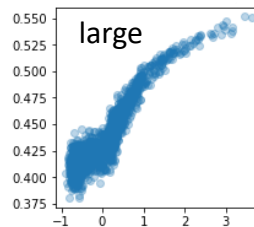
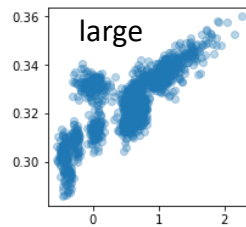
Watts-Strogatz

Grid

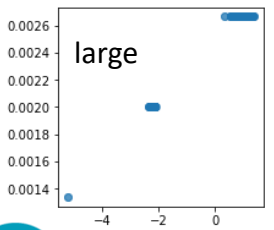
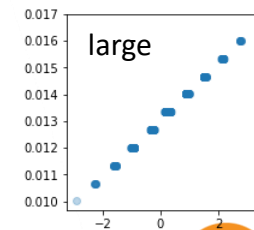
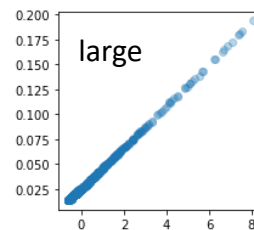
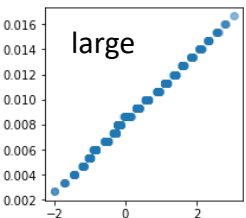
Betweenness



Closeness



Degree





Key take-aways



- Dynamics of network processes may tell us more than the steady state
- Combining technologies
 - Graph neural networks + sound neural networks
- Designing musical instruments using network topologies and propagation rules