

# Advances in the Analysis of Discrete Resonance Spectrograms

Using the DSR for Source Separation and Sequential Prediction

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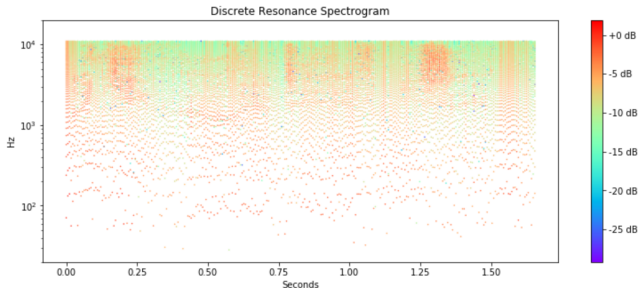


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# SOURCE SEPARATION TO SEQUENTIAL PREDICTION

## From Vertical to Horizontal Analysis

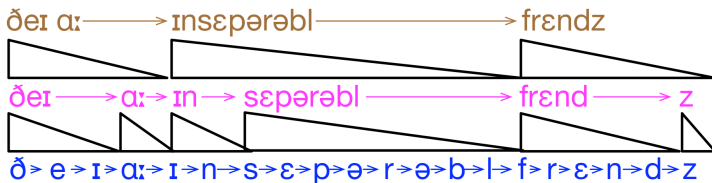
- ▶ Source separation looks at dependencies between frequencies **within a slice**, i.e. vertical analysis.
- ▶ Temporal correlations can be exploited to observe dependencies **between slices**, i.e. horizontal analysis.



# BOUNDARY ENTROPY SEGMENTATION

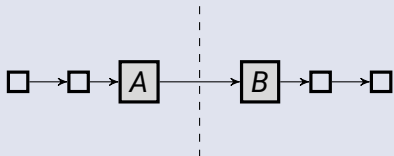
## Boundary Entropy

- ▶ Online chunking according to **pairwise sequential** regularities in order to compress a stream of symbols
- ▶ **Unexpectedness**: current symbol is relatively more rare
- ▶ **Uncertainty**: current symbol has more options to follow



# SEQUENCE VS NETWORK INTERPRETATION OF BES

## Sequence Interpretation



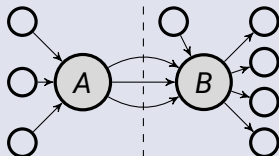
### Information Content

$$h(x) = -\log p(x)$$

### Entropy

$$H(x) = -\sum_{y \in Y} p(y|x) \log p(y|x)$$

## Network Interpretation



### In-Entropy

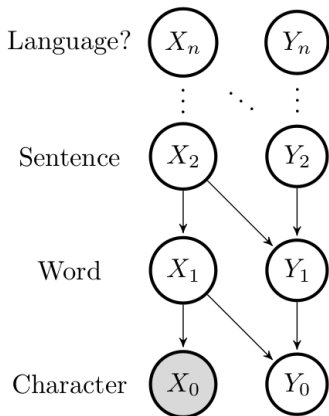
$$H_{in}(x) = -\sum_{y \in In(x)} p(x|y) \log p(x|y)$$

### Out-Entropy

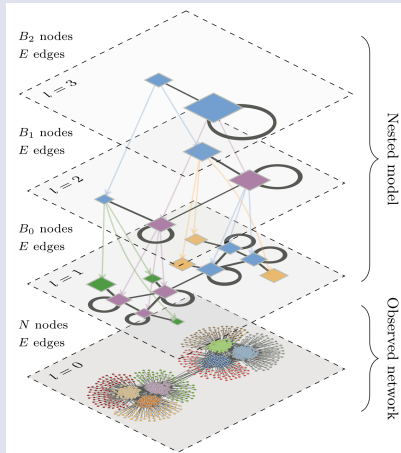
$$H_{out}(x) = -\sum_{y \in Out(x)} p(y|x) \log p(y|x)$$

# HIERARCHICAL STRUCTURE AND DYNAMICS

## Hierarchical Prediction



## Hierarchical Structure



## Memory Consolidation

- ▶ According to the **information efficiency** criterion of IDyOT, online boundary entropy segmentation is likely suboptimal
- ▶ **Offline memory consolidation** can fix some missteps that occurred online by lowering the total entropy of the model

## Minimum Description Length Principle

- ▶  $\Sigma (\text{Description}) = \mathcal{L} (\text{Model}) + \mathcal{S} (\text{Data})$  (in bits)
- ▶ Least complex model that accurately describes the data
- ▶ Used for **model selection** in AIT and complex networks

## PLACEMENT AND NEXT STEPS

### Placement of Research

- ▶ **Online vs offline** community structure detection
- ▶ **Topological vs causal** structure inference in networks
- ▶ **Static vs temporal** system dynamics and link prediction

### Immediate Next Steps

- ▶ Causal network topology **inference** and sequence prediction through boundary entropy segmentation
- ▶ Memory **consolidation** based on MDL principle for networks

# APPLICATIONS AND FUTURE WORK

## Applications



## Future Work





THANK YOU!



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