

Correlating Extracted and Ground-Truth Harmonic Data in Music Retrieval Tasks

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Problems

- Large-scale retrieval systems limited by **scarcity of ground-truth data**
- For many features, ground-truth **similarity data do not exist**
- **No framework exists** for evaluating similarity-based retrieval systems

Example

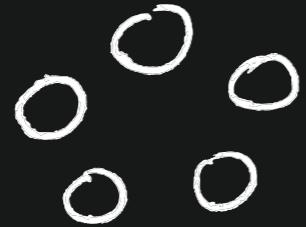
HarmonyQuerifier 2.0  vi - IV - I - V

Found at least 233,477 results:

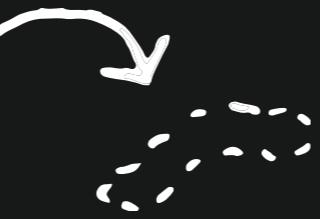
1. The Beatles: Let it Be
2. Adele: Someone Like You
3. Taylor Swift: More songs than you want to know
4. ...

Overview

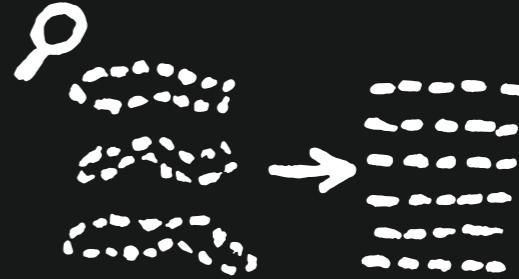




Collection
of Songs



Feature
Extraction
Algorithm

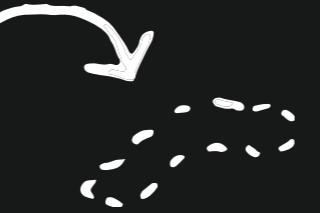


Retrieval
Task

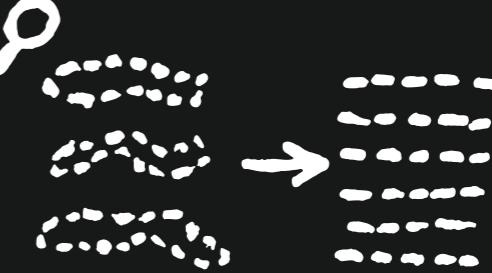
How **similarly** do extracted features and ground-truth features perform at task?



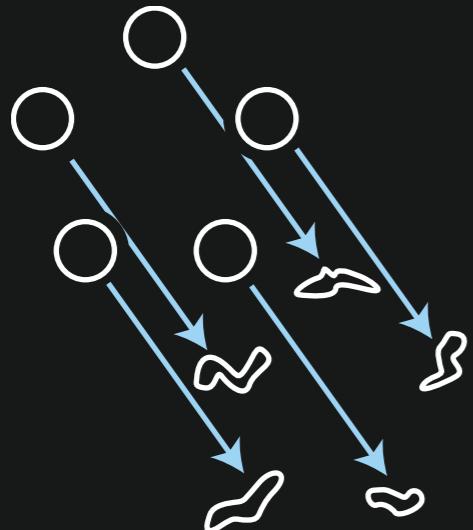
Collection
of Songs



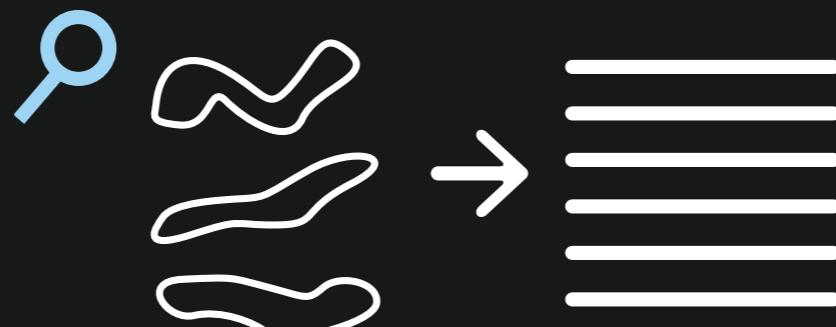
Feature
Extraction
Algorithm



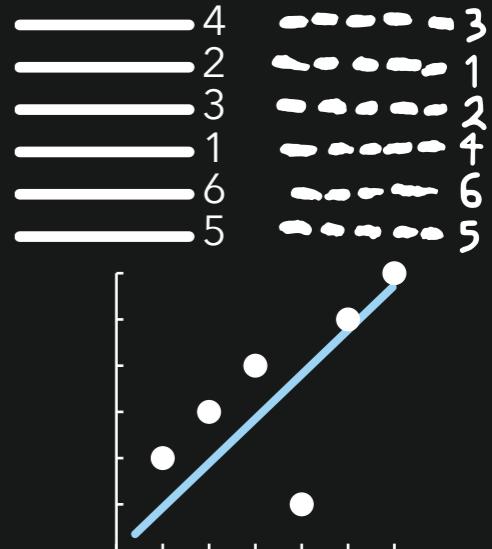
Retrieval
Task



Ground-Truth
Annotations



Retrieval Task
(Ground-Truth)



Rank and
Correlate

Correlational Metrics

- Capture the degree to which **ground-truth and extracted features perform similarly** in retrieval tasks
- A **high correlational metric score suggests the task performs comparably** with extracted features and ground-truth features

Testing with Chord Labeling

- McGill Billboard Annotations: over 500 songs with ground-truth labels
- Use Chordino algorithm to derive extracted features
- Accuracy case study: Let it Be
 - C G Am Am/G Fmaj7 Fmaj6
 - Extracted: C G Am Fmaj7 Fmaj6

A harmonic similarity system

- Alignment algorithms

C G Am Am/G Fmaj7 Fmaj6

C G Am Fmaj7 Fmaj6

A harmonic similarity system

- Alignment algorithms

C	G	Am	Am/G	Fmaj7	Fmaj6	
C	G	Am		Fmaj7	Fmaj6	

A harmonic similarity system

- Alignment algorithms

F C Dm G F C Dm C

F C G F C G Dm C

A harmonic similarity system

- Alignment algorithms

F	C	Dm	G	F	C	*	Dm	C
						Del		
F	C	*	G	F	C	G	Dm	C

A harmonic similarity system

- Alignment algorithms

F	C	Dm	G	F	C	*	Dm	C
						Del		
F	C	*	G	F	C	G	Dm	C

- Localized alignments
- Distance matrix

Alignment Parameters

- Distance function:

- $$\frac{|P_c(c_1) \cap P_c(c_2)|}{|P_c(c_1) \cup P_c(c_2)|}$$

- Tonal Pitch Space

- Gap cost function:

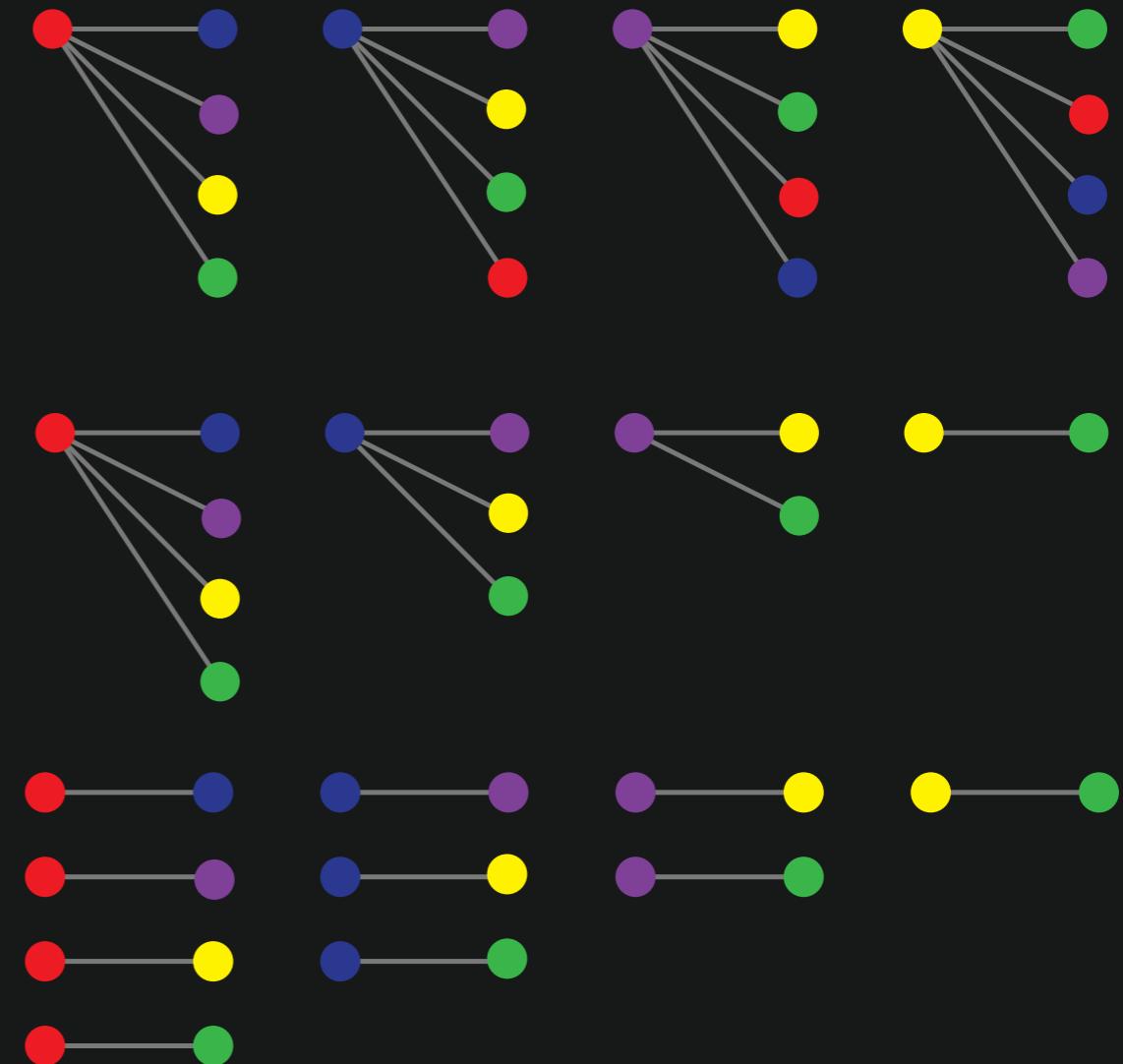
- $$W(i) = -gap_{open} - gap_{extension} \cdot (i - 1)$$

- Alignment normalization:

- $$SW_{norm}(s_1, s_2) = \frac{SW(s_1, s_2)}{\max\{SW(s_1, s_1), SW(s_2, s_2)\}}$$

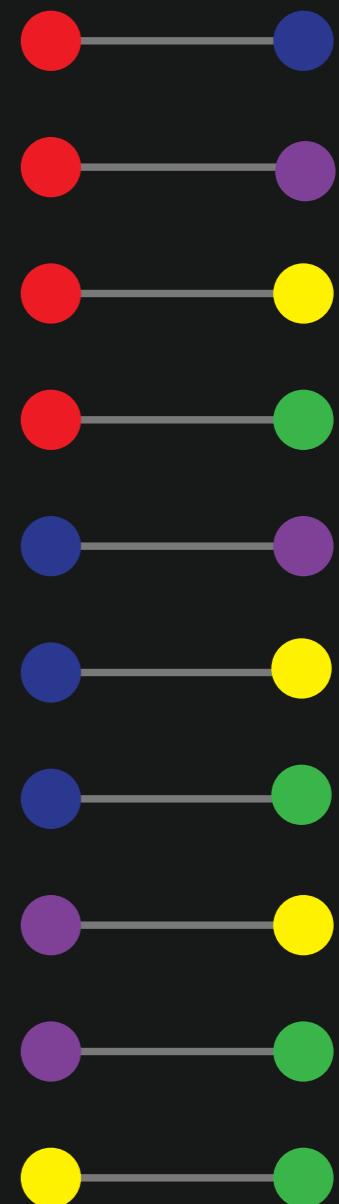
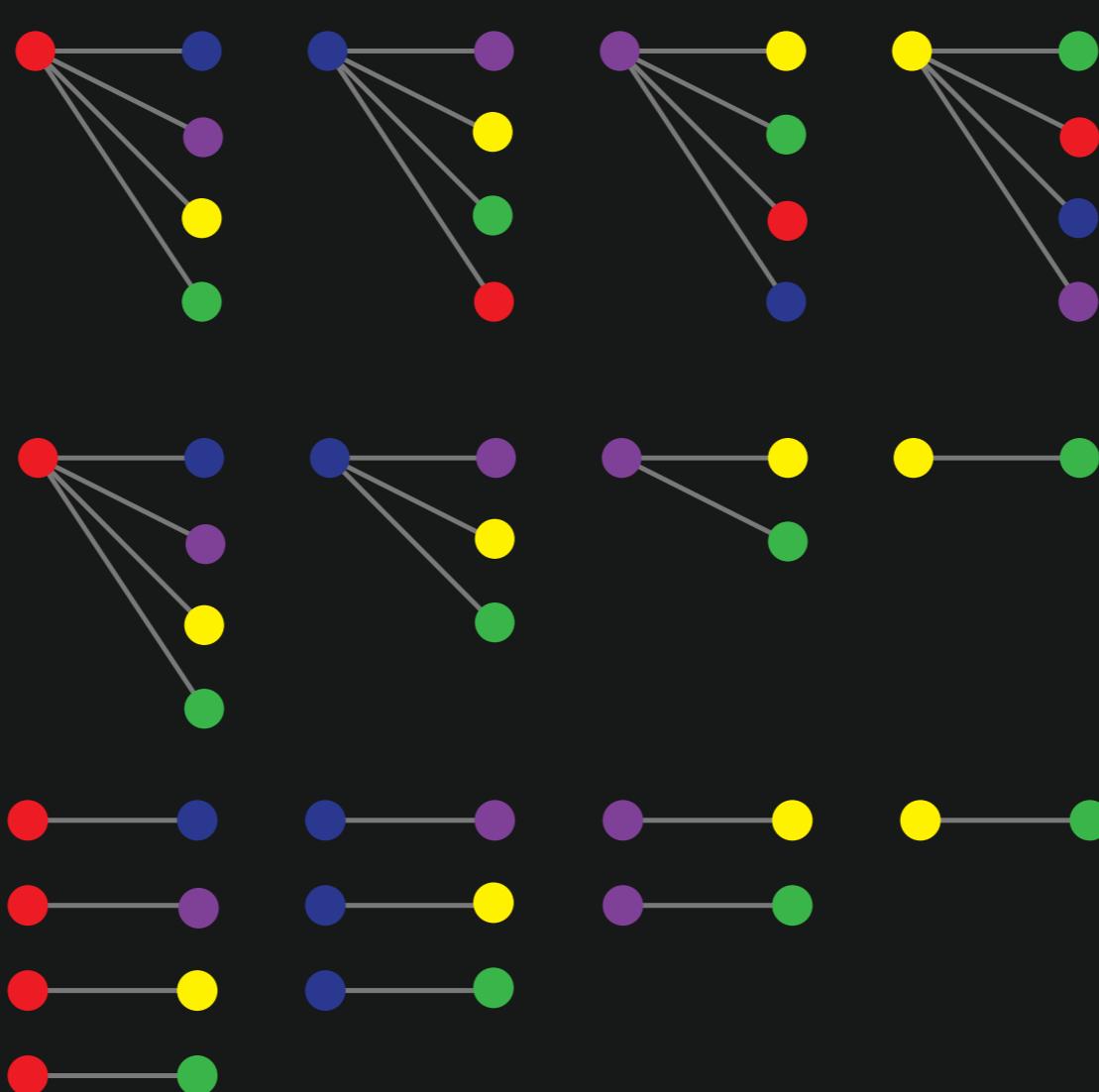
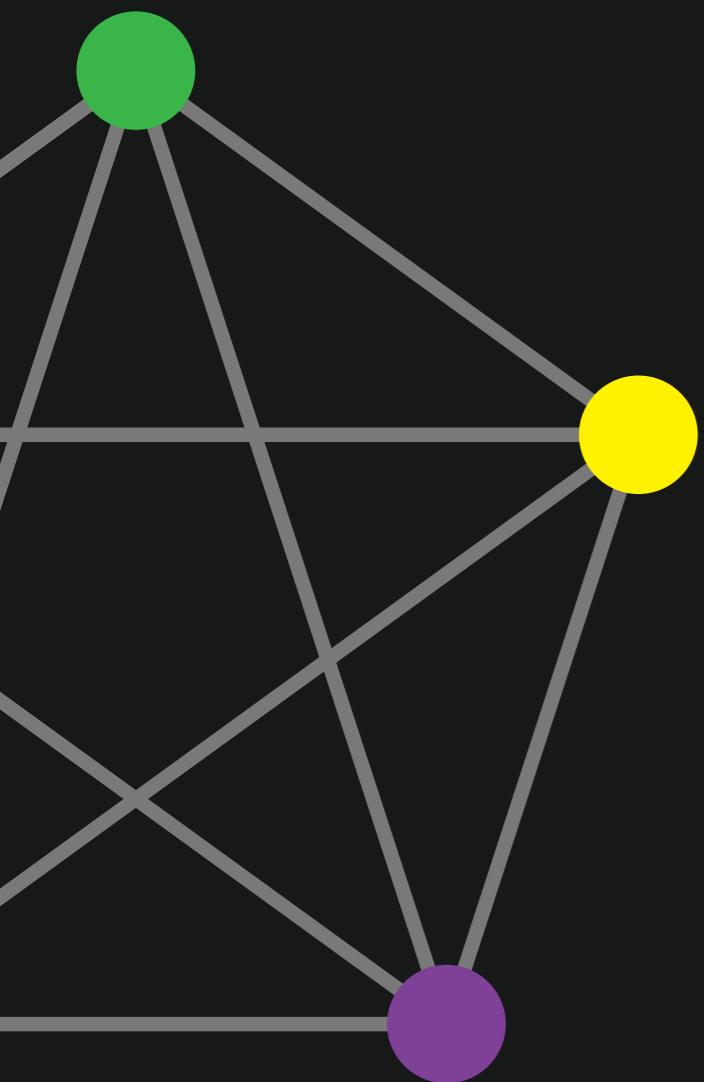
Retrieval Tasks

- Fully Connected Comparison



Retrieval Tasks

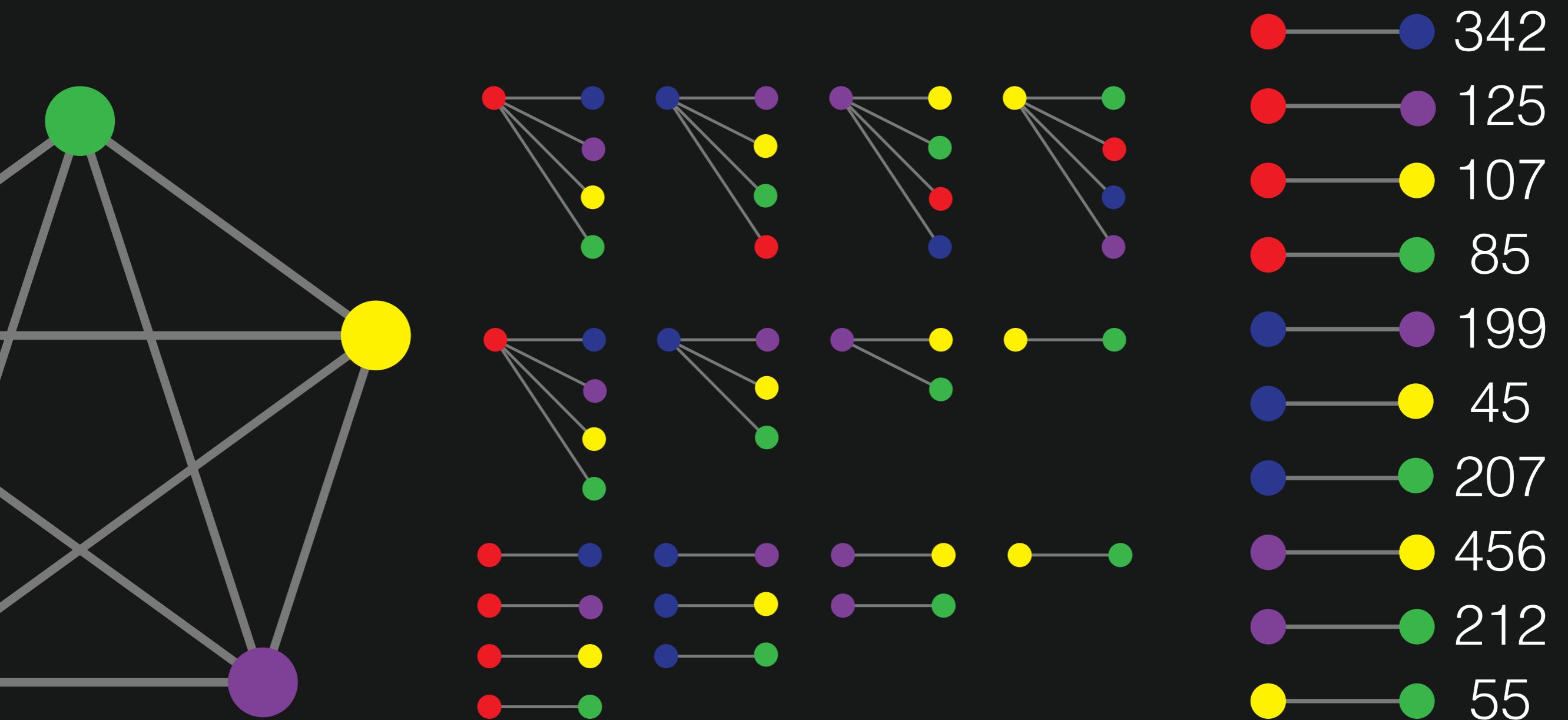
- Fully Connected Comparison



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Retrieval Tasks

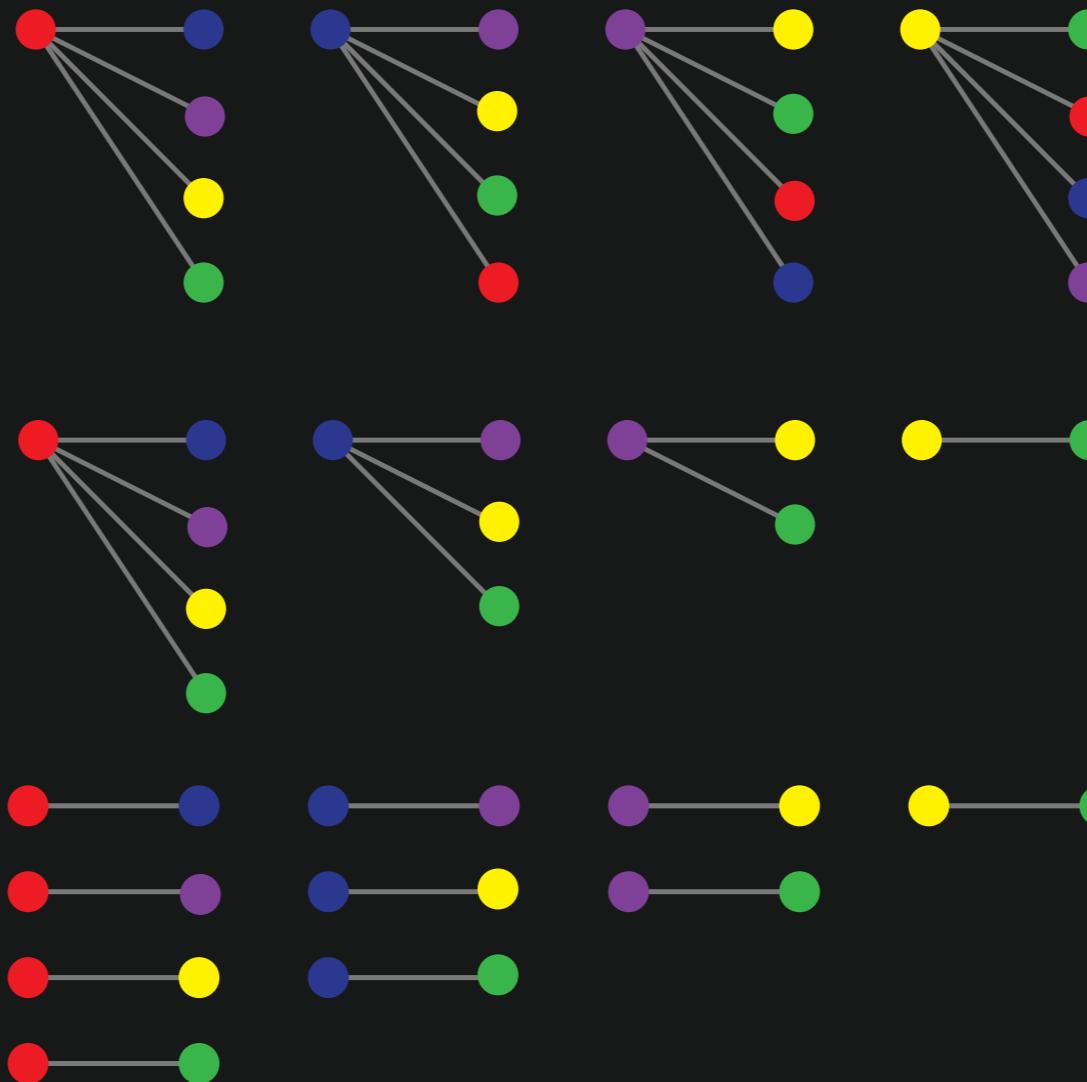
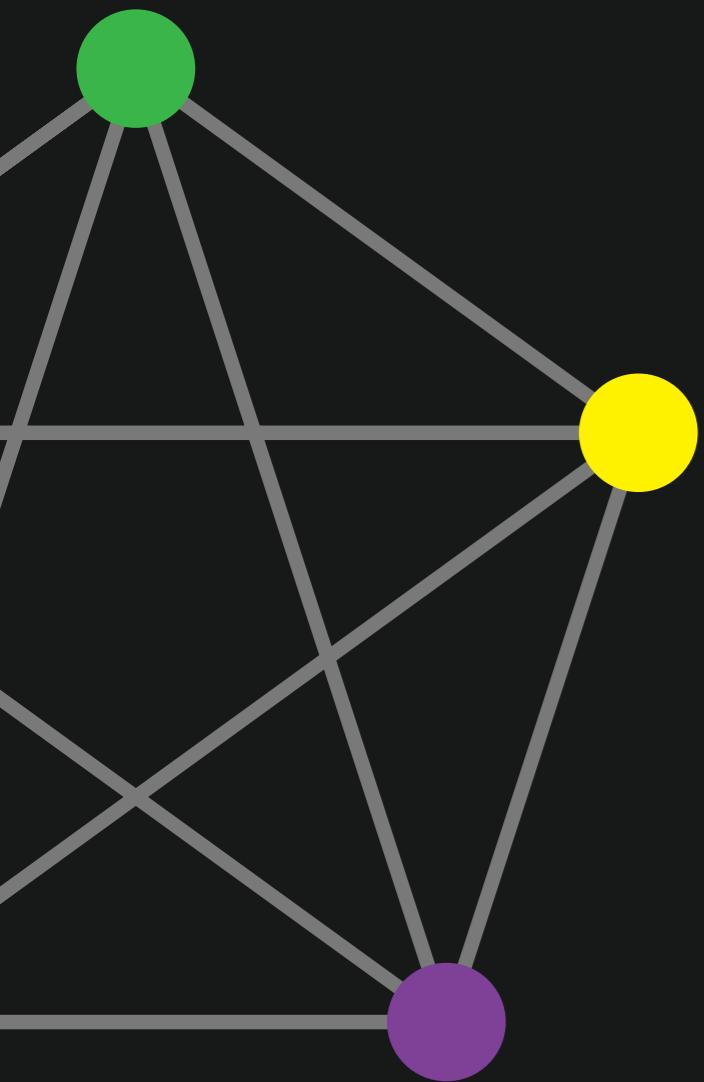
- # • Fully Connected Comparison



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Retrieval Tasks

- Fully Connected Comparison



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Demo

<http://sonority.io>



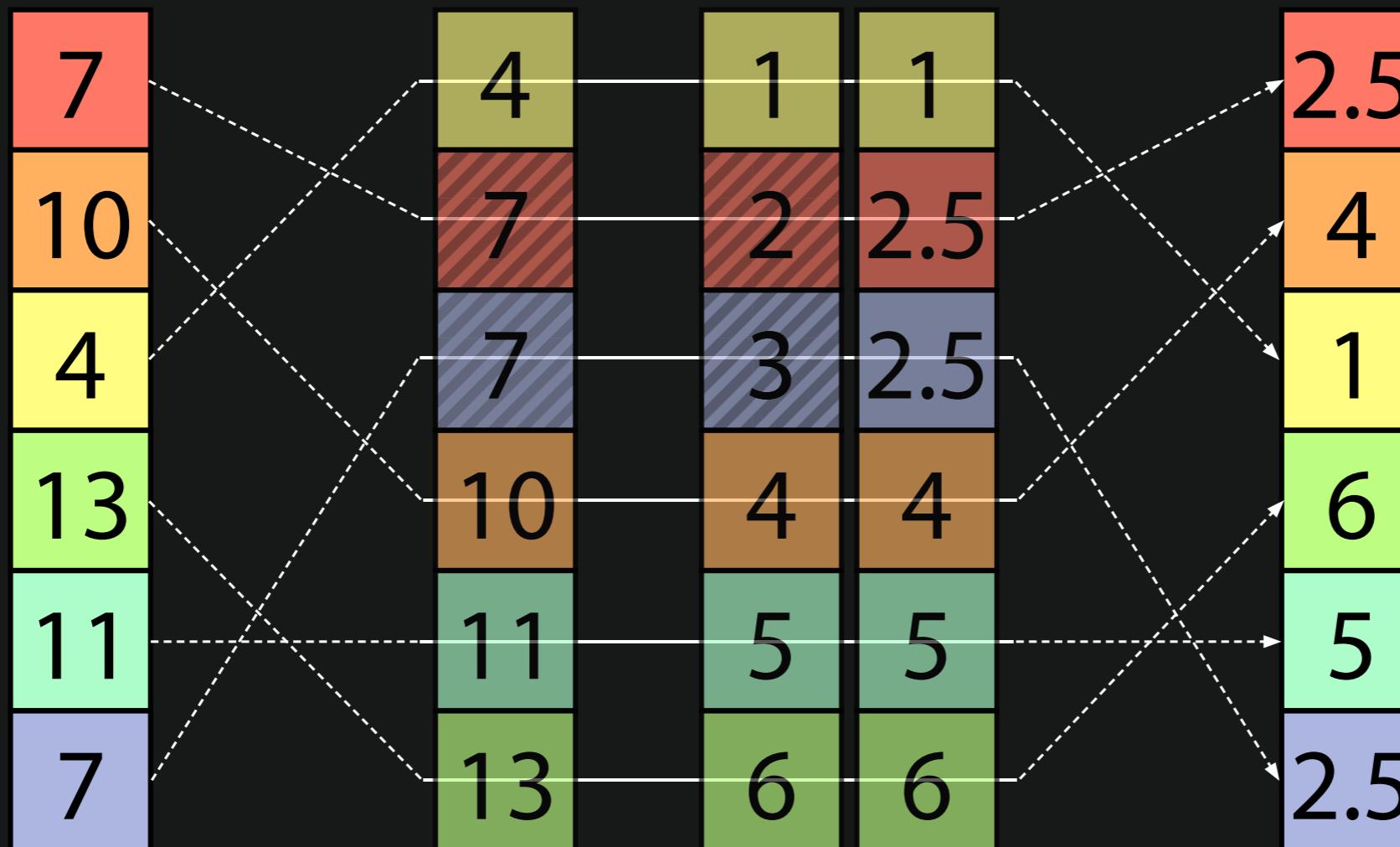
Retrieval Tasks

- **Query by N-Grams**
 - Fabricate 100 query sequences, lengths 4, 8, 16, and 32 chords
 - Pad in length with repetition
 - For each query sequence, compare to every song in collection

Calculating Correlational Metric

- Spearman Rho Coefficient

- $\rho(s_1, s_2) = 1 - \frac{6 \sum_i^n (s_{1i} - s_{2i})^2}{n(n^2 - 1)}$



Optimizing for Correlation

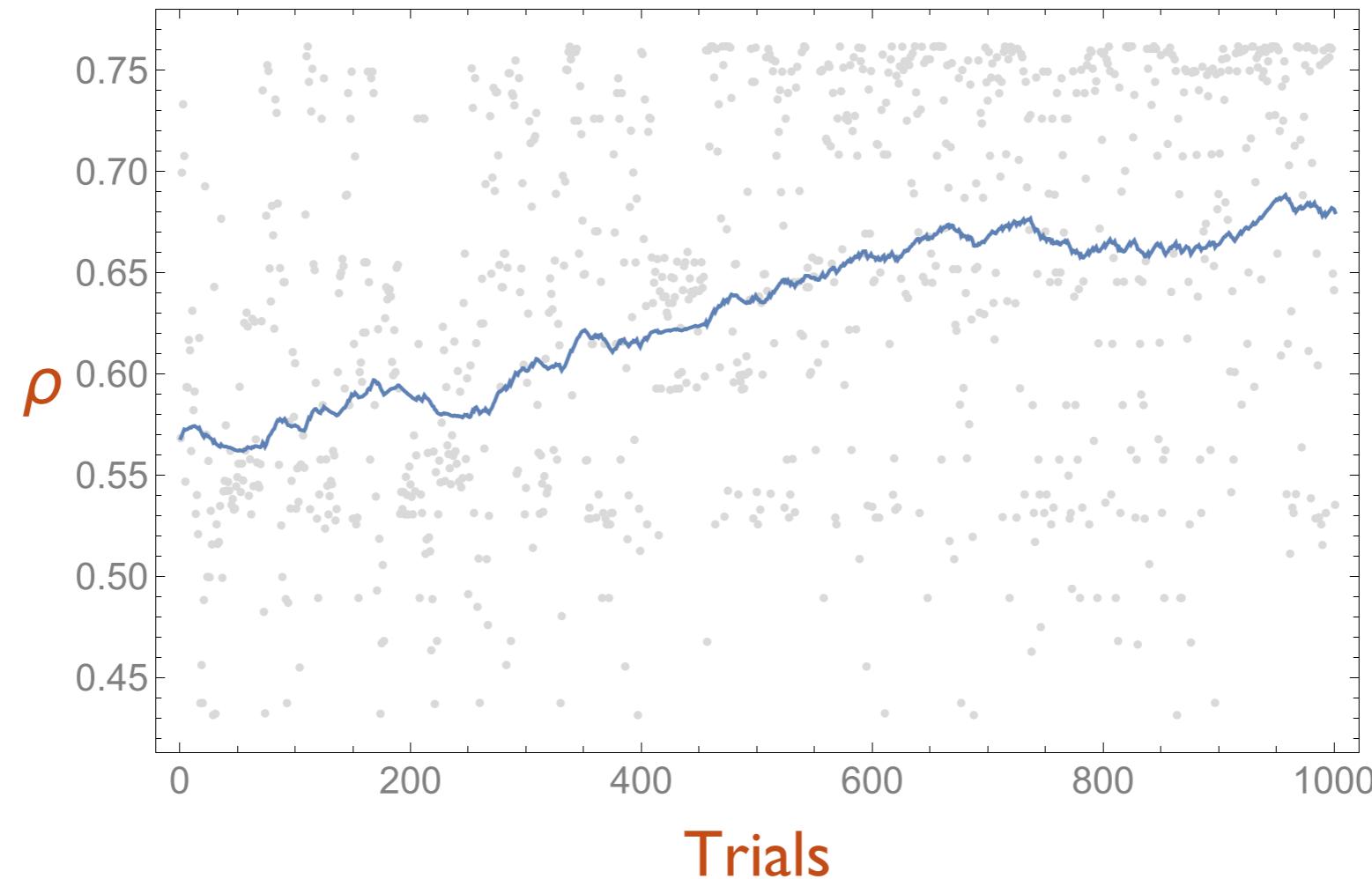
- Run a global optimization algorithm
 - simulated annealing
 - Parameters:

Variable	Notation	Values
Similarity Function	CP_d	$\{SW, SW_{norm}\}$
Gap Open Cost	gap_{open}	$[0, 128]$
Gap Extension Cost	$gap_{extension}$	$[0, 128]$
Chord Distance	C_d	$\{Harte, TPS\}$
Distance Multiplier	m_x	$[1, 30]$
Distance Subtractor	m_s	$[1, 30]$

How did we do?

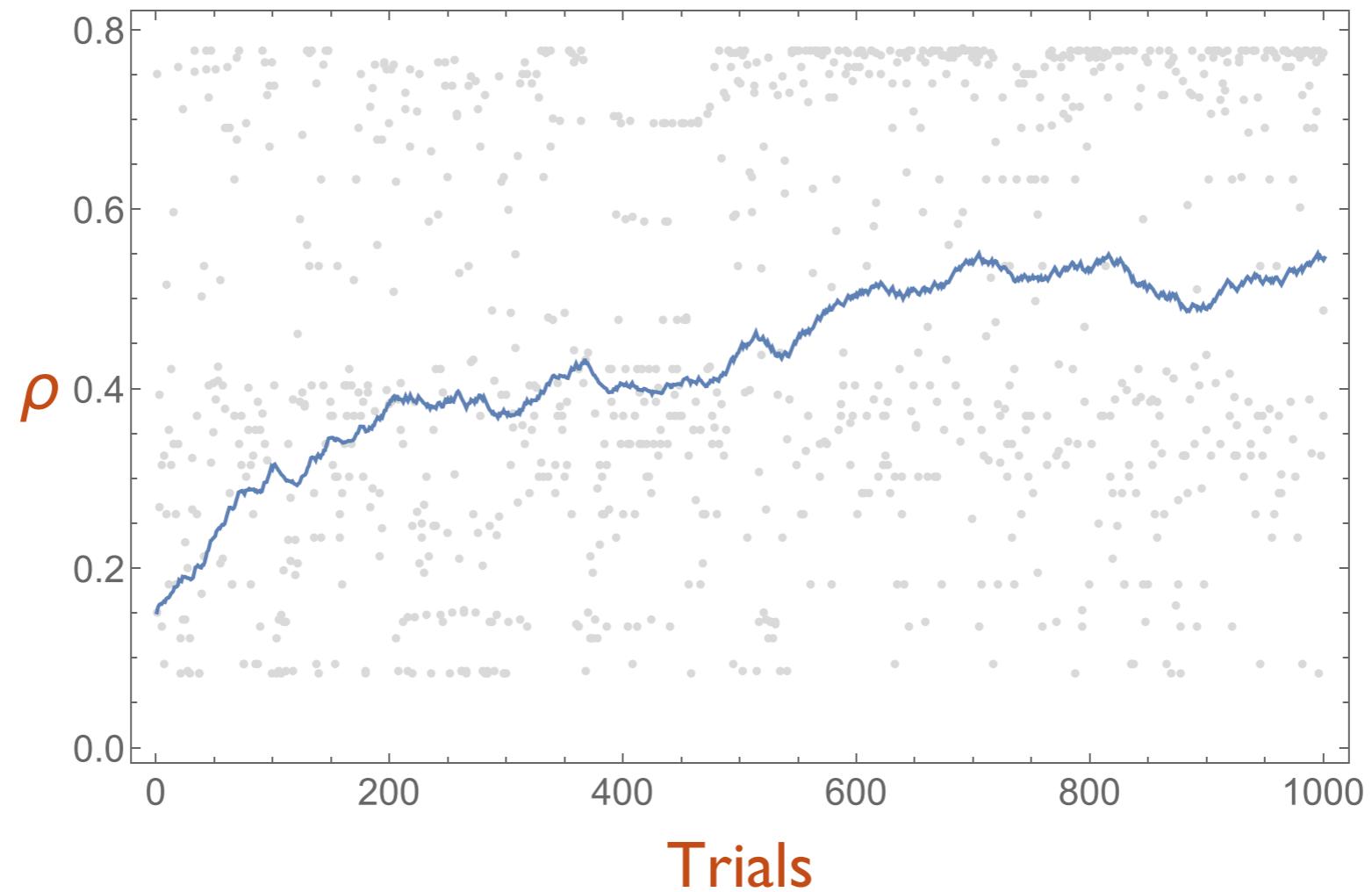
Task	P	ADR
<i>FCC</i>	0.7619	0.7664
<i>QBN</i>	0.7790	0.7900

How did we do?



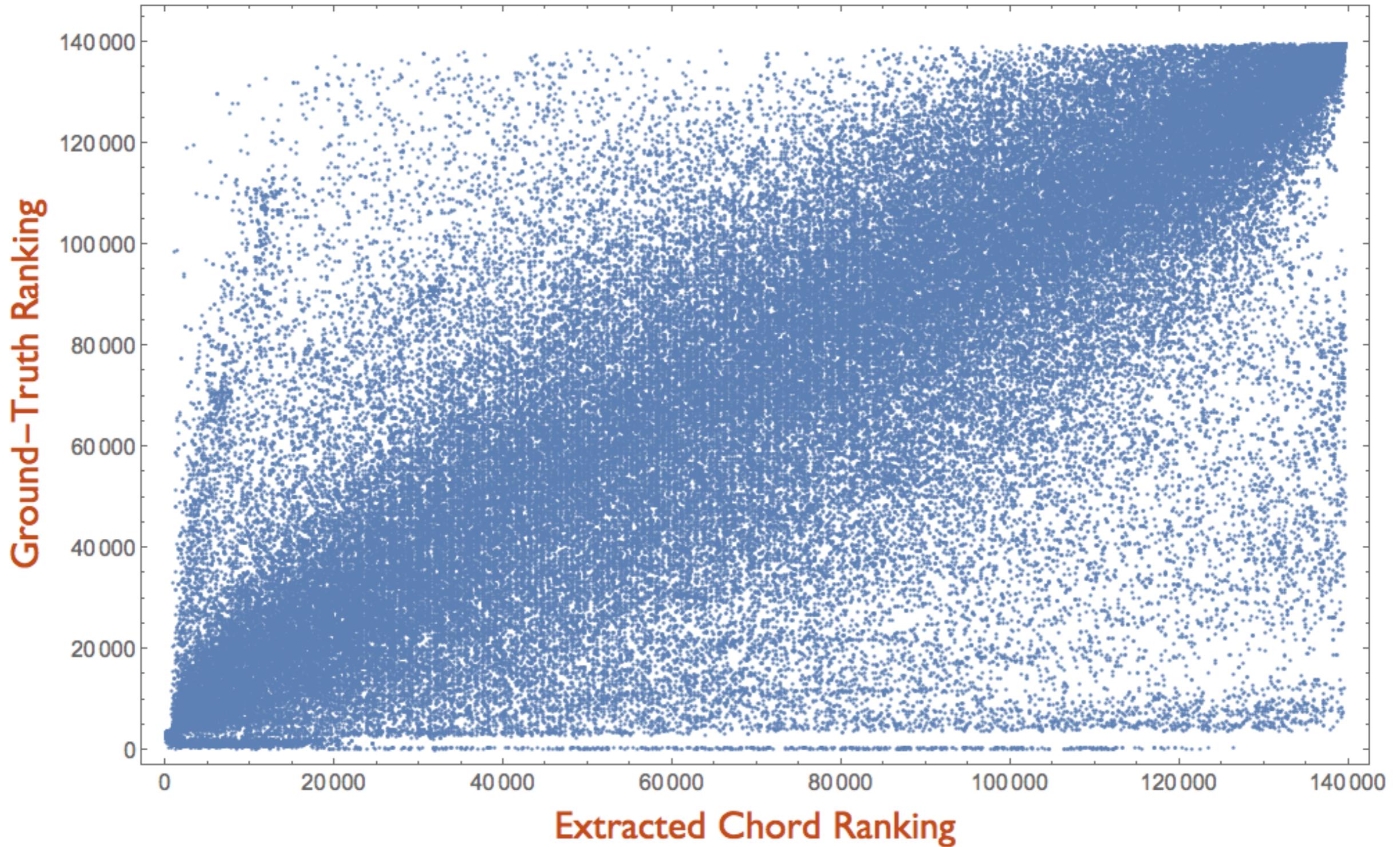
Fully connected comparison

How did we do?

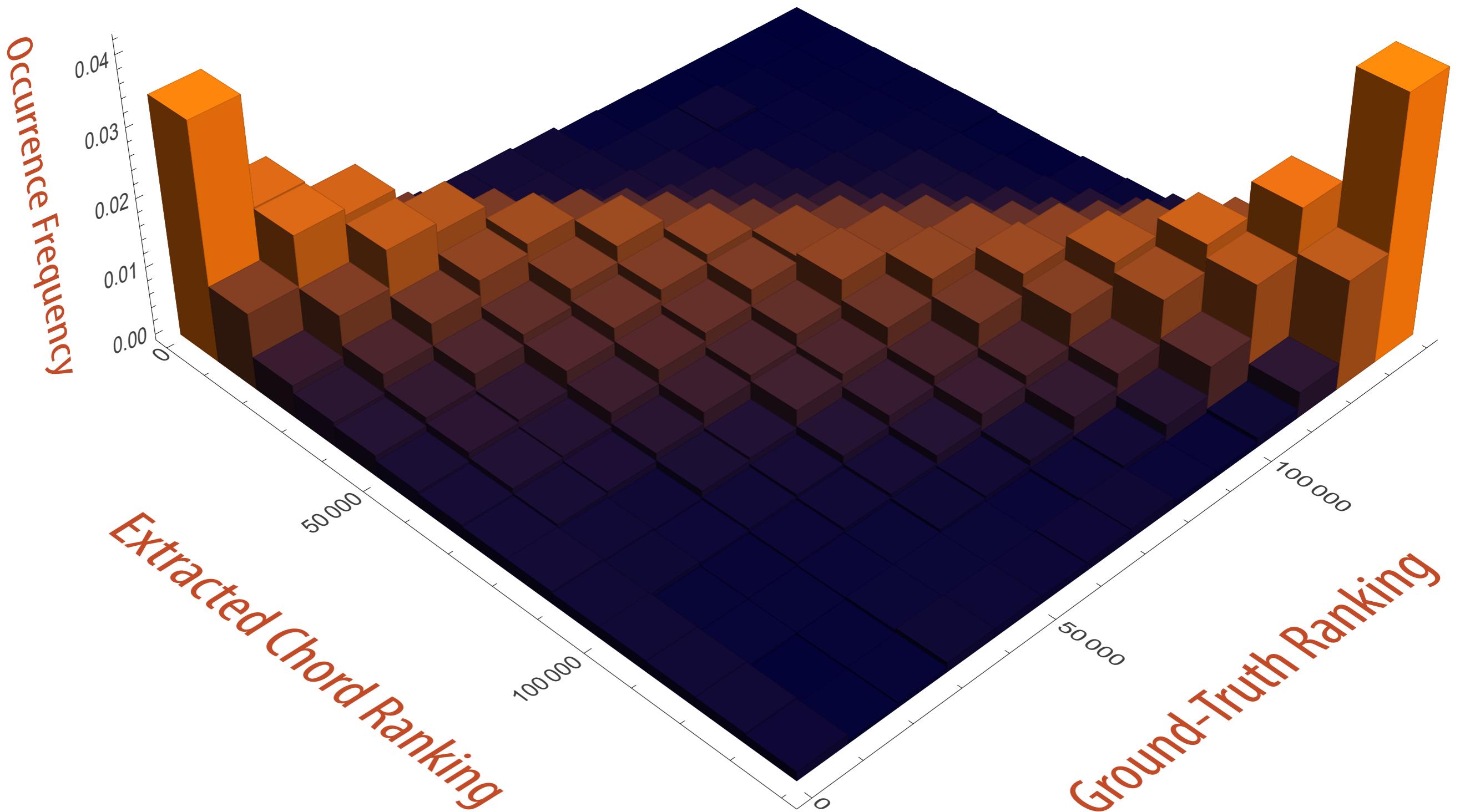


Query by N-Grams

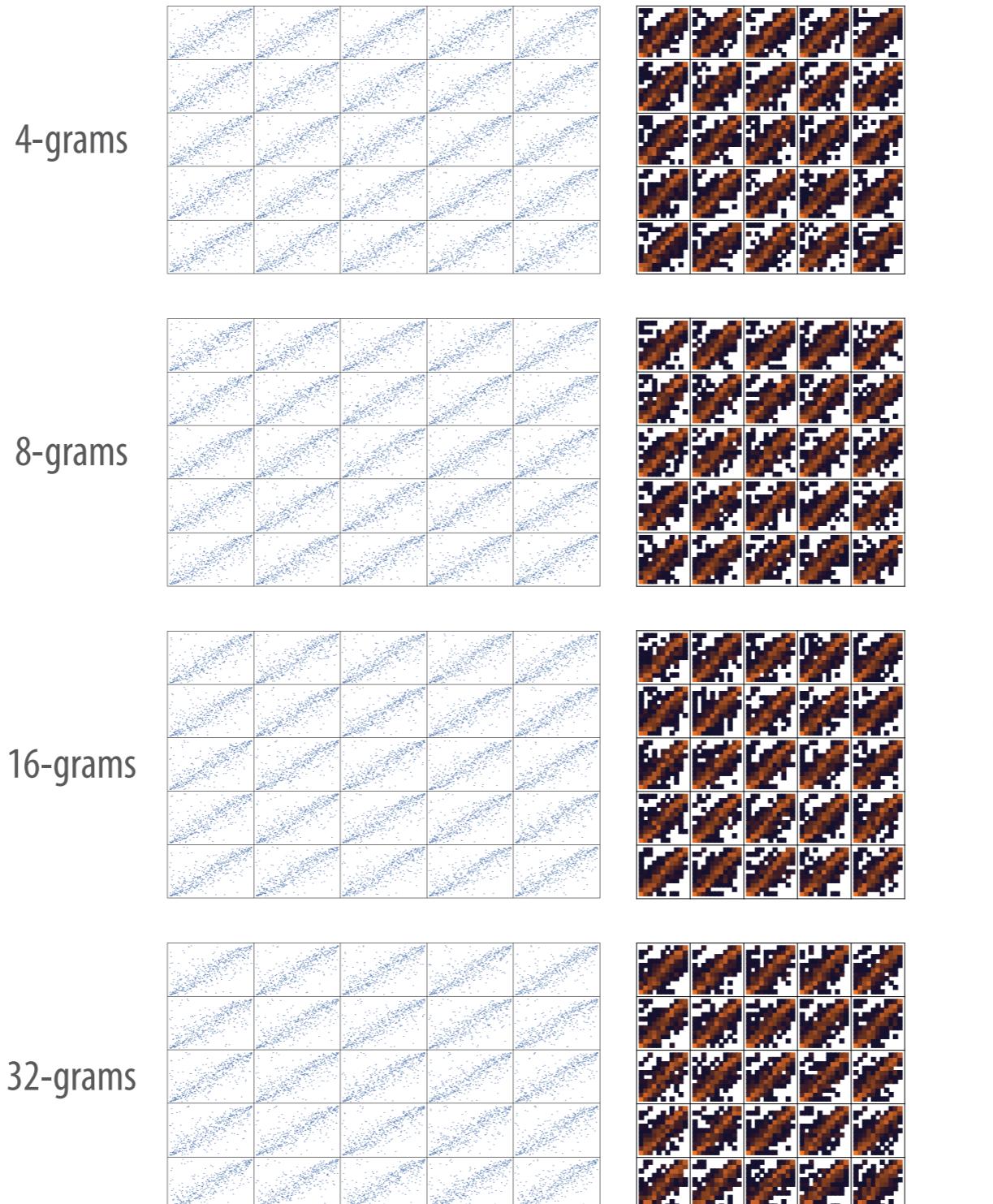
Fully Connected Comparison



Fully Connected Comparison



Query by N-Grams



Occurrence Frequency
0.06
0.04
0.02
0

Discussion

- New class of similarity assessment in MIR: **correlational metrics**
- Shows potential for effective MIR systems to be constructed **without guide of human ground-truthing**
- Benefit from testing other chord algorithms and features

Thank you!

- Slides: <http://sonority.io/slides.pdf>
- Paper: <http://sonority.io/paper.pdf>
- Follow-up: freedmand@gmail.com