

Musical Influence Network Analysis and Rank of Sample-Based Music



Nicholas J. Bryan and Ge Wang

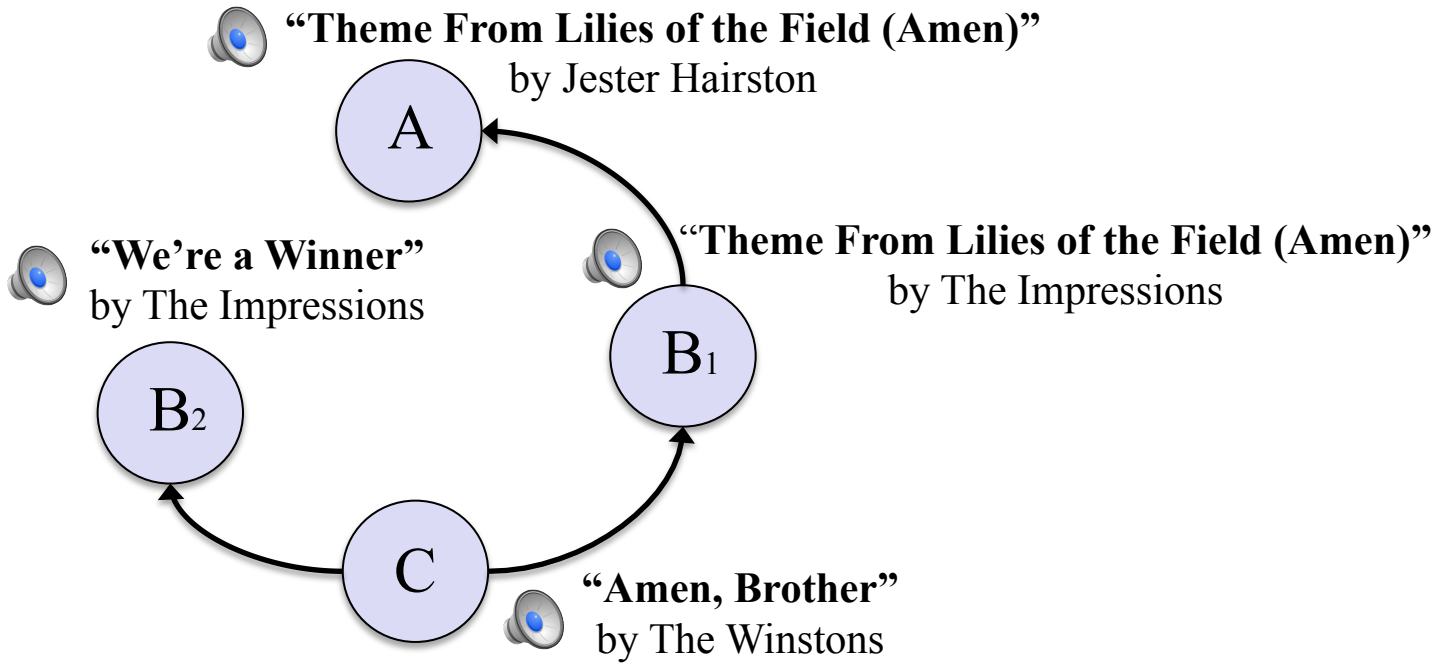
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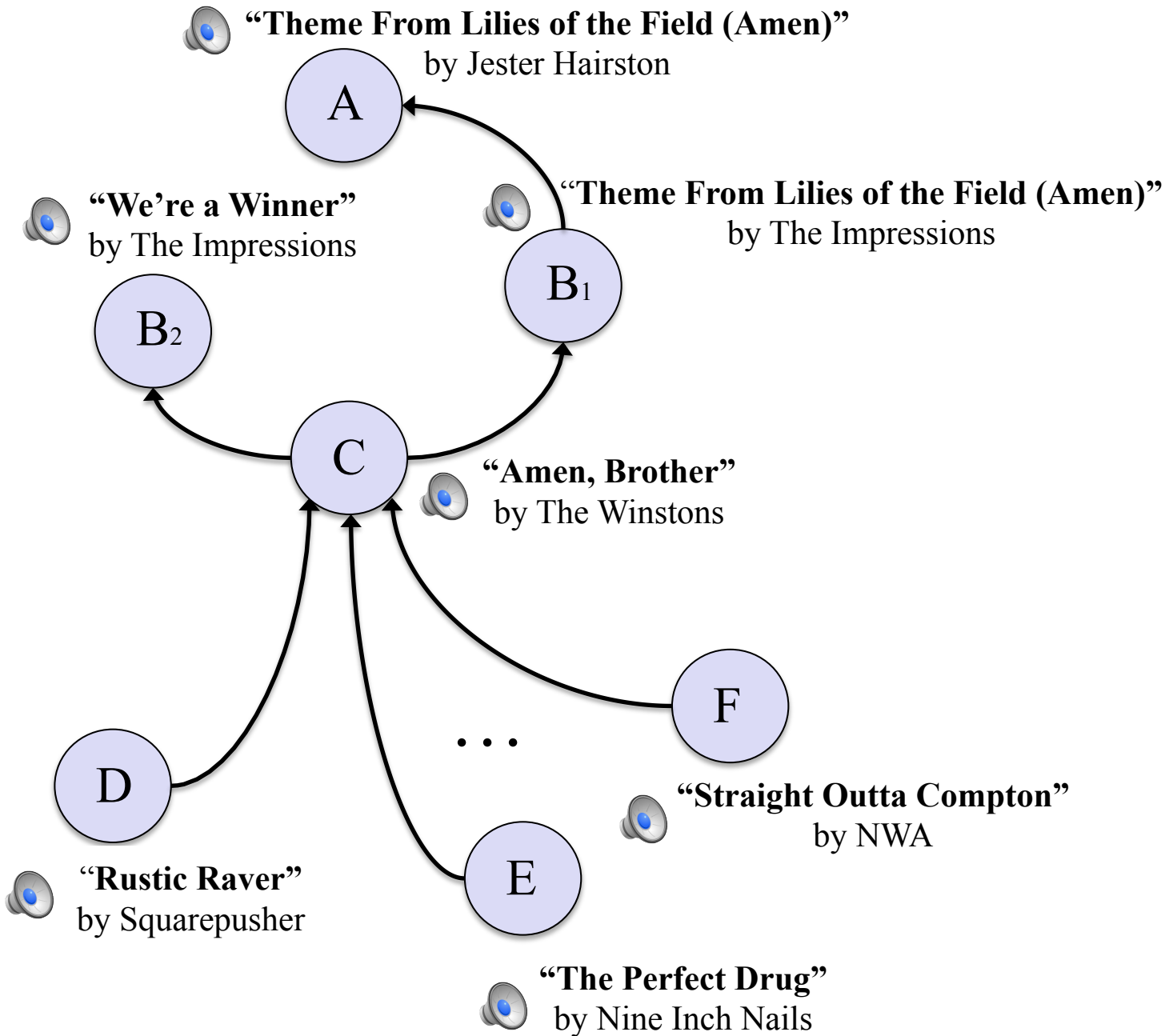
Introduction

- Influence Network Analysis and Rank
 - Understand how songs, artist, and genres interact within the musical practice of sample-based music
- Sampled-Based Music
 - A musical work that borrows material from another source, whether it be direct manipulation of a recorded sound or less direct transcribed material as decided from a user community

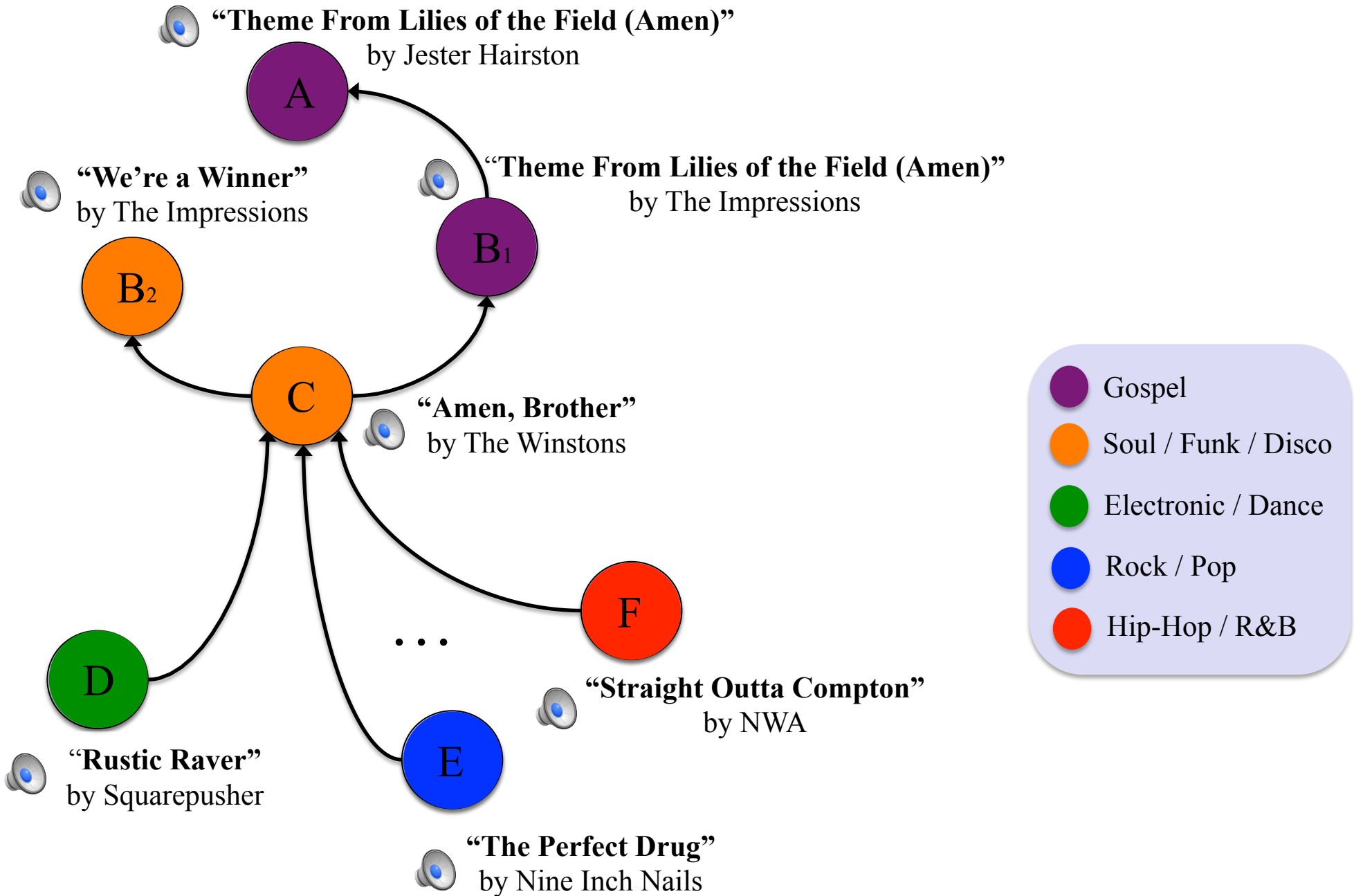
“Amen Break”



“Amen Break”



“Amen Break”



Today

- Unique Dataset
 - User community generated sample-based music data
 - Initial analysis and trends
- Network Analysis
 - Degree centrality & distribution
 - Song-, Artist-, and Genre-level influence networks

Unique Dataset

- Whosampled.com Dataset
 - 42,447 user-generated records of sampling
 - *Destination and Source*
 - Song, artist, year, genre, part-sampled
 - collaborating artist(s), featured artist(s), producer(s)

hip-hop/R&B (H)

electronic dance (E)

country (C)

world (W)

spoken word (K)

soundtrack (S)

other (O)

rock/pop (P)

soul/funk/disco (F)

jazz/blues (J)

classical (L)

easy listening (Y)

gospel (G)

reggae (R)

drum loop (D)

vocals (V)

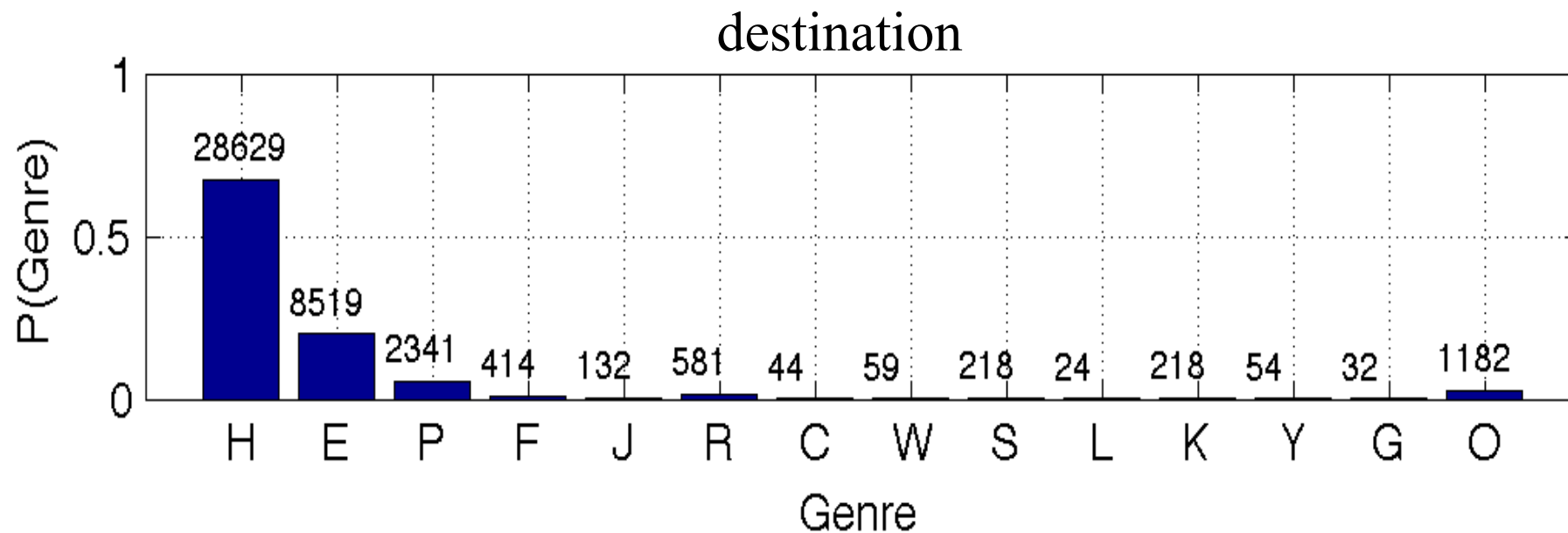
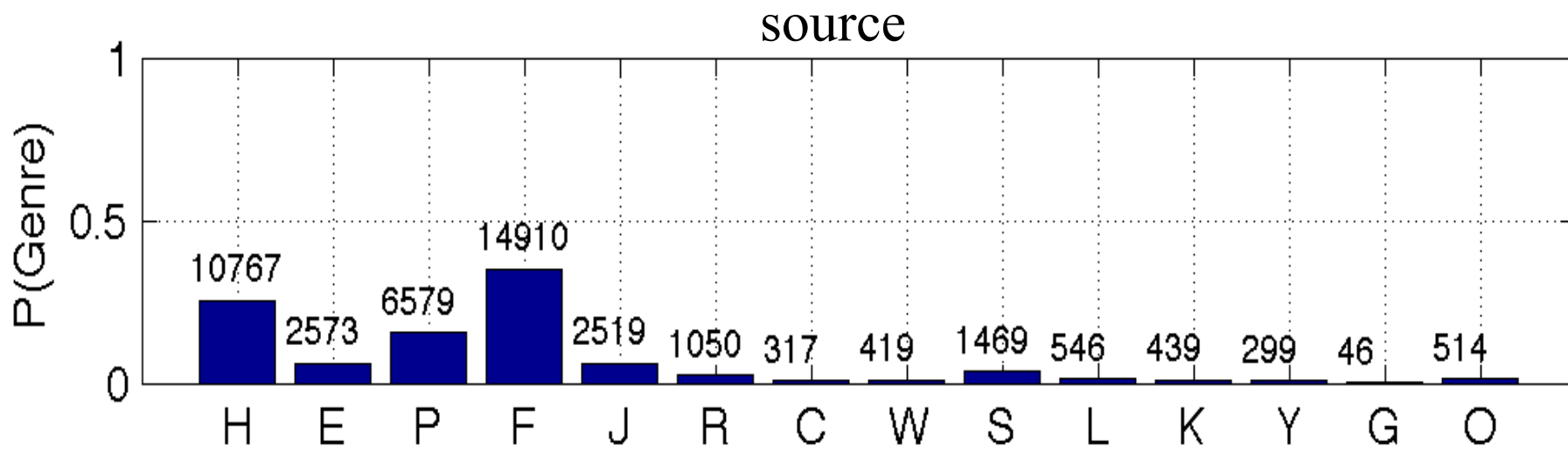
bass line (B)

hook (H)

other (O)

whole track (W)

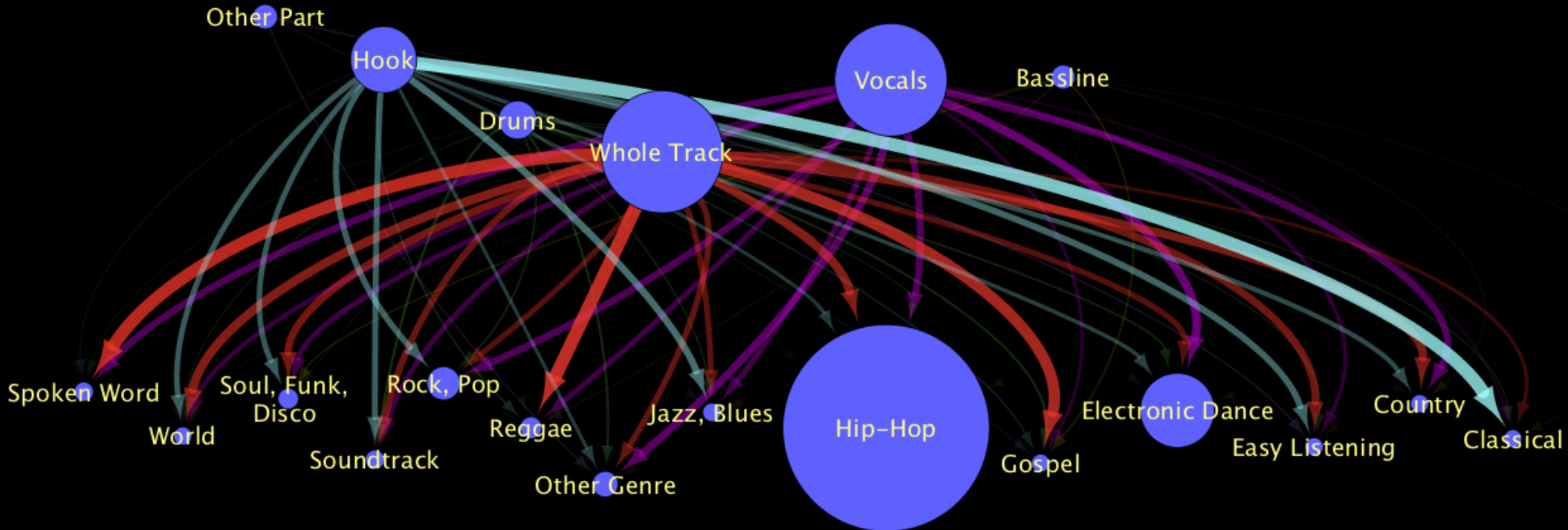
Genre & Part-Sampled Trends I



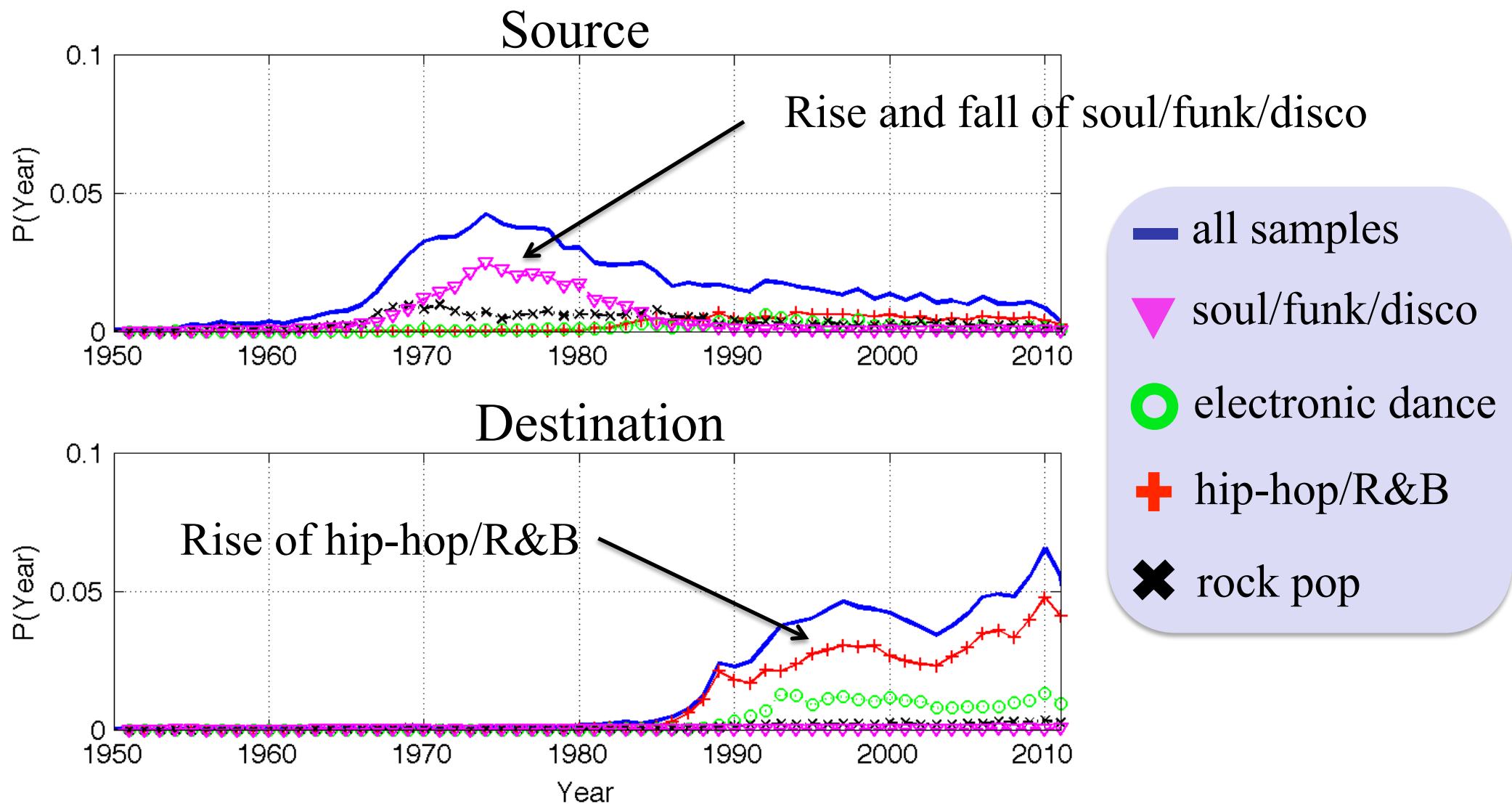
Genre Visualization



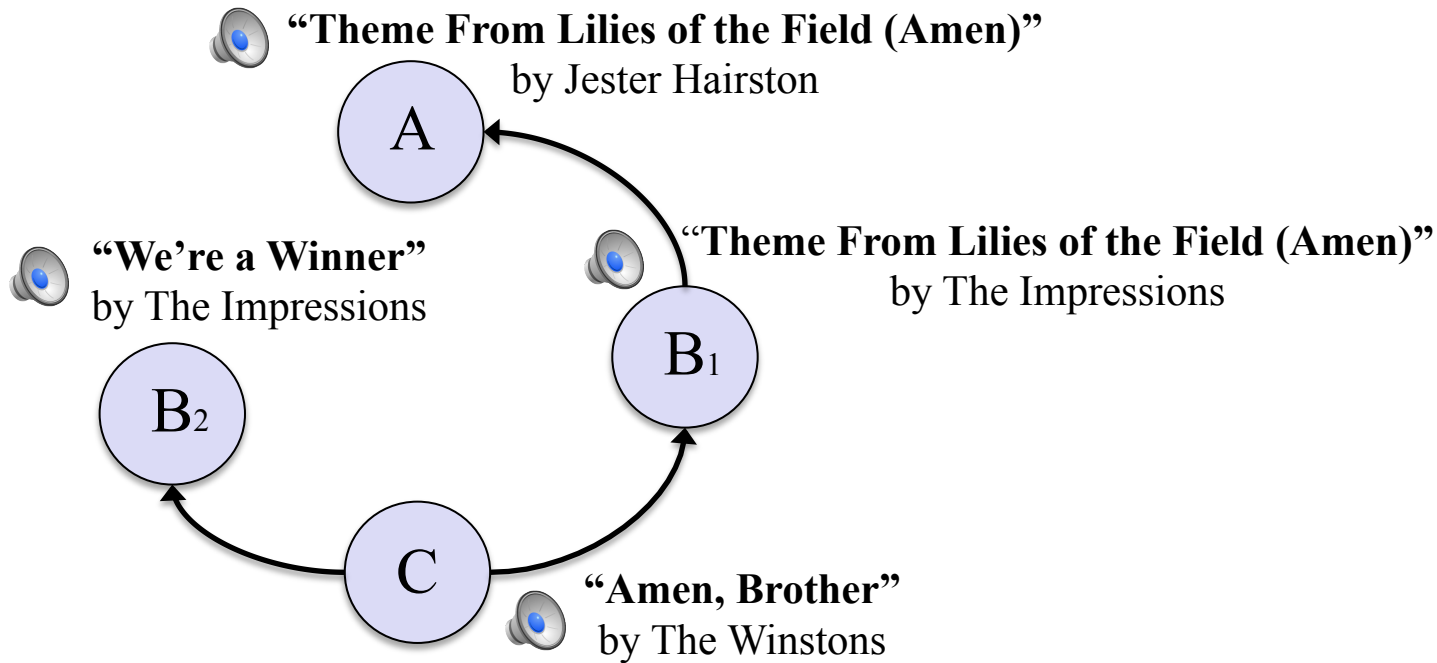
Part-Sampled Visualization



Time-Based Trends

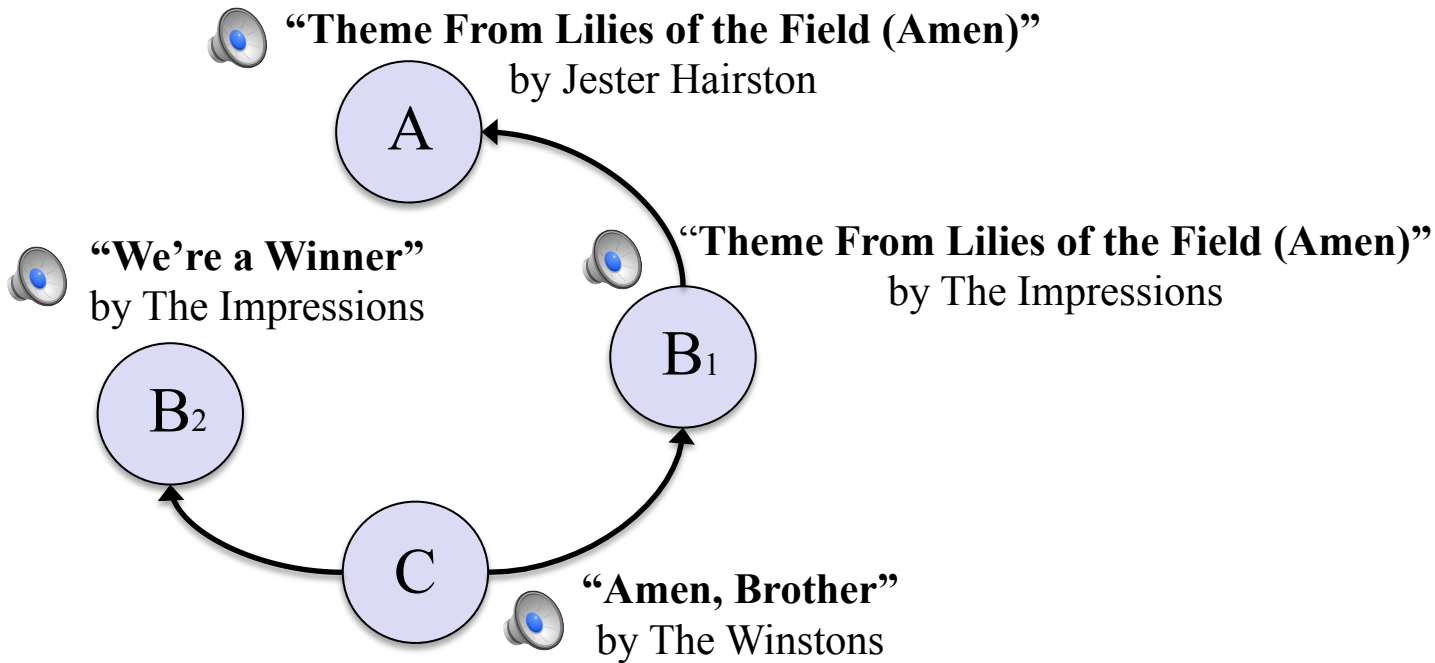


Network Analysis



- Song, artist, and genre-level networks
- Focus on song-level network and musical sampling

Network Analysis II



$$G = (N, E) \longleftrightarrow A$$

		destination			
		A	B ₁	B ₂	C
source	A		1		
	B ₁				1
	B ₂				1
	C				

Degree Centrality & Influence

- Degree Centrality (In/Out)
 - In-Degree (# of derived samples)
 - Out-Degree (# of used samples)

		destination				In-Degree
		A	B ₁	B ₂	C	
source	A		1			1
	B ₁				1	1
	B ₂				1	1
	C					

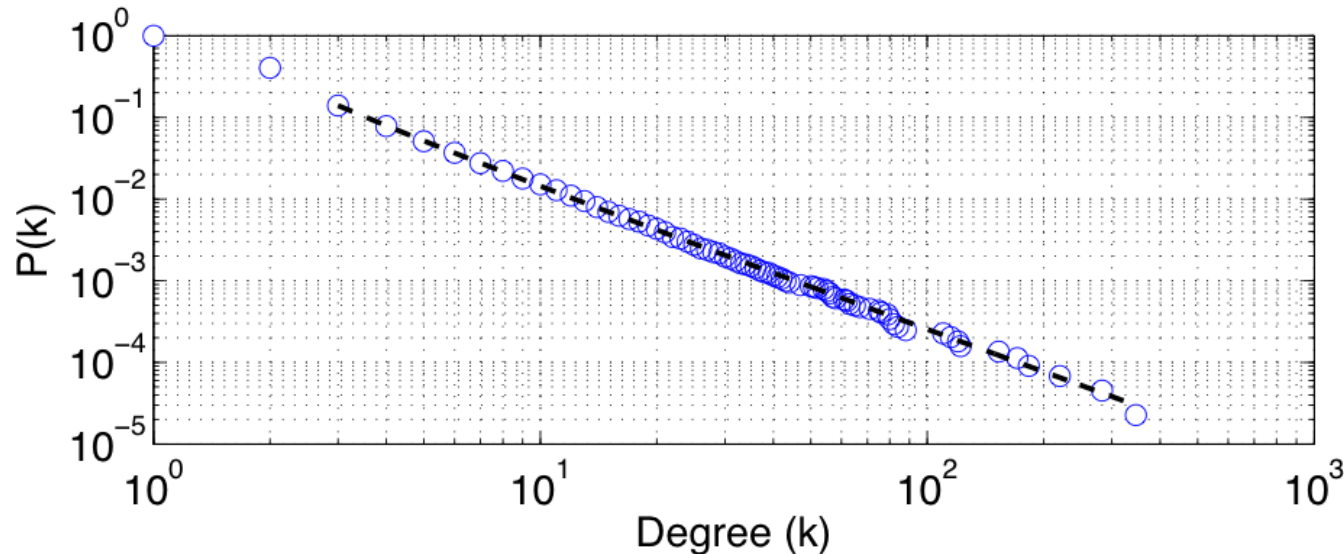
Out-Degree

	1		2
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- Sample chains
 - Desirable to capture direct and indirect influence
 - Need more!!!

Degree Distributions

- Power-law distribution, $f(k) \propto k^{-\gamma}$
 - Preferential attachment and scale-free networks
 - Popular musical samples will be popular
- Hypothesis
 - Build unweighted acyclic song-level network
 - Maximum likelihood fit [Clauset 2009]



$$k \geq 3$$

$$\gamma = 2.72$$

$$\text{p-value} = .16$$

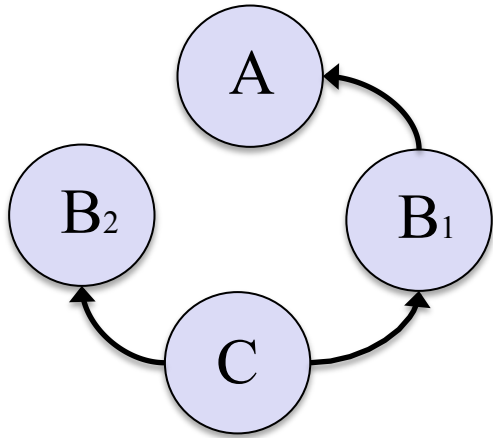
Katz Influence

- Weighted sum of the powers of adjacency matrix \mathbf{A}

$$\begin{aligned}\mathbf{I}_K &= (\mathbf{I} - \alpha\mathbf{A})^{-1} - \mathbf{I} \\ &= \alpha\mathbf{A} + \alpha^2\mathbf{A}^2 + \dots + \alpha^k\mathbf{A}^k + \dots,\end{aligned}$$

- If $\mathbf{A}_{ij} = 0$ or 1 , \mathbf{A}^k have elements representing the number of sample chains of corresponding length k
[Katz 1953]
- Captures sample chains in a straightforward manner

Katz Influence Example I



$$\begin{aligned} \mathbf{I}_K &= (\mathbf{I} - \alpha \mathbf{A})^{-1} - \mathbf{I} \\ &= \alpha \mathbf{A} + \alpha^2 \mathbf{A}^2 + \dots + \alpha^k \mathbf{A}^k + \dots, \end{aligned}$$

\mathbf{A}

\mathbf{A}^2

$$\mathbf{I}_S = \alpha$$

	A	B ₁	B ₂	C
A		1		
B ₁				1
B ₂				1
C				

$$+ \alpha^2$$

	A	B ₁	B ₂	C
A				1
B ₁				
B ₂				
C				

$$+ \mathbf{0} \dots$$

Katz Influence Example II

$$\alpha = 0.0$$

		destination			
		A	B ₁	B ₂	C
source	A		1		0
	B ₁				1
	B ₂				1
	C				

$$\alpha = 0.5$$

		destination			
		A	B ₁	B ₂	C
source	A		1		.5
	B ₁				1
	B ₂				1
	C				

$$\alpha = 1.0$$

		destination			
		A	B ₁	B ₂	C
source	A		1		1
	B ₁				1
	B ₂				1
	C				

- Rank—sum rows or columns
- View Column—“Who influenced the given song”
- View Row— “Who the given song influenced”

Katz Influence Computation

- Compute using expanded form
 - Eliminates any restrictions on α
 - Song-level network is *very* sparse
 - Sample-chains are limited length

- Rescale

$$\tilde{\mathbf{I}}_K = \mathbf{A} + \alpha^1 \mathbf{A}^2 + \dots + \alpha^{k-1} \mathbf{A}^k + \dots,$$

- $\alpha = 0$, only direct influence
- $\alpha > 0$, direct + indirect influence
- $\alpha = 1$, equal weighting of direct and indirect influence

Collapse-and-Sum Influence I

- Derived artist- and genre-level influence from song-level

$$\mathbf{I}_S \longrightarrow \mathbf{I}_A \longrightarrow \mathbf{I}_G$$
$$\mathbf{I}_S \longrightarrow \mathbf{I}_G$$

- Collapse-and-sum the rows and columns of \mathbf{I}_S based on song-artist and song-genre relations
 - e.g. sum all song-level influence of an artist together
 - e.g. sum all song-level influence of a genre together

Collapse-and-Sum Influence II

- Song-to-Artist, $\mathbf{I}_S \longrightarrow \mathbf{I}_A$, $\alpha = 0.5$

		destination			
		A	B ₁	B ₂	C
source	A		1		.5
	B ₁				1
	B ₂				1
	C				

		destination		
		A	B	C
source	A		1	.5
	B ₁			1
	B ₂			1
	C			

		destination		
		A	B	C
source	A		1	.5
	B			2
	C			

- A) Jester Hairston
- B) The Impressions
- C) The Winstons

- Rank—sum rows or columns
- View Column—“Who influenced the given artist”
- View Row—“Who the given artist influenced”

Relating Influence Levels

- \mathbf{I}_S vs. \mathbf{I}_A











		destination			
		A	B ₁	B ₂	C
source	A		1		.5
	B ₁				1
	B ₂				1
	C				

		destination		
		A	B	C
source	A		1	.5
	B			2
	C			











- Compute influence of song for artist
 - i.e. $B_1 / B = 50\%$ influence from song B₁
 - i.e. $B_2 / B = 50\%$ influence from song B₂

Song Influence

$\alpha = 0.0$

 Change the Beat (Female Version) by Fab 5 Freddy (1.0)
 Amen, Brother by The Winstons (0.82)
 Funky Drummer by James Brown (0.63)
 La Di Da Di by Doug E. Fresh (0.53)
 Think (About It) by Lyn Collins (0.49)
 Impeach the President by The Honey Drippers (0.44)
 Funky President by James Brown (0.35)
 Here We Go (Live at the Funhouse) by Run-DMC (0.34)
 Bring the Noise by Public Enemy (0.33)
 Synthetic Substitution by Melvin Bliss (0.32)

$\alpha = 0.2$

 Change the Beat (Female Version) by Fab 5 Freddy (1.0)
 Amen, Brother by The Winstons (0.74)
 Funky Drummer by James Brown (0.71)
 La Di Da Di by Doug E. Fresh (0.51)
 Impeach the President by The Honey Drippers (0.49)
 Think (About It) by Lyn Collins (0.45)
 Funky President by James Brown (0.37)
 Synthetic Substitution by Melvin Bliss (0.36)
 Here We Go (Live at the Funhouse) by Run-DMC (0.34)
 Bring the Noise by Public Enemy (0.32)

$\alpha = 1.0$

 Change the Beat (Female Version) by Fab 5 Freddy (1.0)
 Funky Drummer by James Brown (0.84)
 Impeach the President by The Honey Drippers (0.62)
 Synthetic Substitution by Melvin Bliss (0.55)
 Get Up, Get Into It, Get Involved by James Brown (0.54)
 The Big Beat by Billy Squier (0.51)
 Scratchin' by The Magic Disco Machine (0.50)
 We're a Winner by The Impressions (0.46)
 Assembly Line by Commodores (0.46)
 Amen by Jester Hairston (0.46)

Artist Influence

Top Artist Sample-Based Influence

James Brown (1.0)	James Brown (1.0)	James Brown (1.0)
Dr. Dre (0.34)	Dr. Dre (0.28)	Run-DMC (0.25)
Marley Marl (0.29)	George Clinton (0.25)	Fab 5 Freddy (0.23) ⁴
George Clinton (0.28)	Marley Marl (0.25)	George Clinton (0.22)
Public Enemy (0.27)	Public Enemy (0.23)	Russell Simmons (0.19)
Rick Rubin (0.25)	Rick Rubin (0.22)	Kool & the Gang (0.19)
DJ Premier (0.25)	Fab 5 Freddy (0.22)	Marley Marl (0.18)
Material (0.24)	Material (0.21)	Rick Rubin (0.17)
Fab 5 Freddy (0.24)	Run-DMC (0.21)	Public Enemy (0.17)
Hank Shocklee (0.23)	DJ Premier (0.21)	Larry Smith (0.16)

$\alpha = 0.0$

$\alpha = 0.2$

$\alpha = 1.0$

Top Influential and Influenced Artists of Jay-Z

Influential ($\alpha = 0.2$)	Influenced ($\alpha = 0.2$)
The Notorious B.I.G. (0.97)	Girl Talk (1.0)
Dr. Dre (0.91)	Lil Wayne (0.80)
Puff Daddy (0.53)	The Game (0.53)
Nas (0.5)	DJ Premier (0.40)
James Brown (0.42)	Linkin Park (0.39)

Genre Influence

- Top influential genres
 - Soul/funk/disco
 - Hip-hip/R&B
 - Rock/Pop
 - Jazz/Blues
 - Electronic/Dance
- Top influenced genres
 - Hip-hop/R&B
 - Electronic/Dance
 - Rock/Pop
 - Reggae

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