Song recommendation with Non-Negative Matrix factorization and graph total variation

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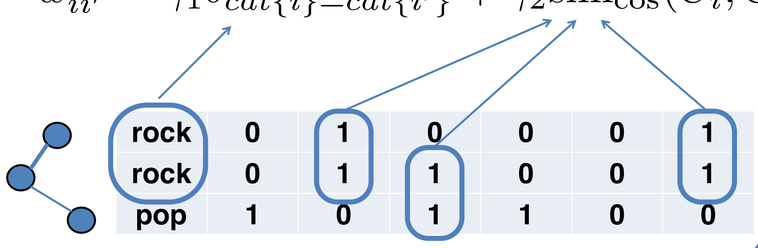
PLAYLISTS GRAPH

- 101,343 playlists (Art of the Mix)
- 30+ playlist categories

$$w^A_{ii'} = \gamma_1 \delta_{cat\{i\}=cat\{i'\}} + \gamma_2 \mathrm{sim}_{\cos}(C_i, C_{i'})$$



SONGS GRAPH

High Level Features

acousticness	Acoustic or electric?
valence	Is the song positive or negative?
energy	How energetic is the song?
liveness	Is it a "live" recording?
speechiness	How many spoken words?
danceability	Is the song danceable?
tempo	Normalized BPM.
instrumentalness	Is the song instrumental?

Social Features

artist discovery	How unexpectedly popular is the artist?
artist familiarity	How familiar is the artist?
artist hotttnesss	Is the artist currently popular?
song hotttnesss	Is the song currently popular?
song currency	How recently has it become popular?

Temporal Echonest Features

statistics on echonest segments	Described in [22]

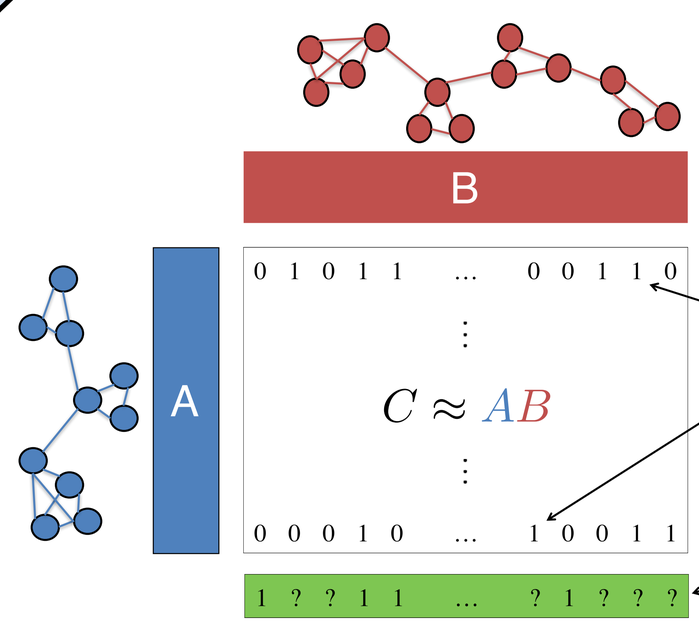
Metadata Features

genre	ID3 genre extracted from tags given by LastFM api

Improve features: Large Margin NN

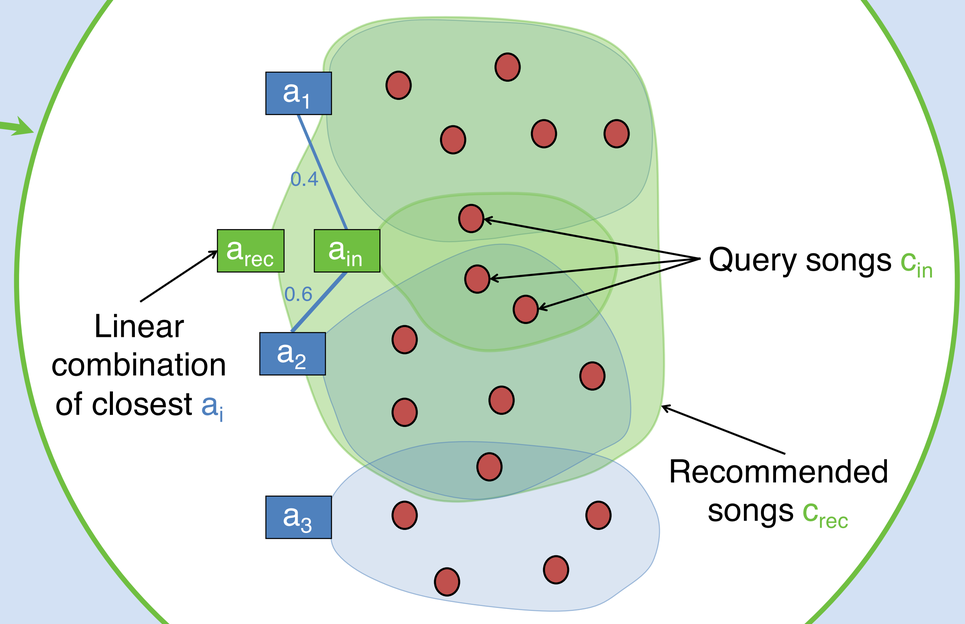
$$w^B_{jj'} = \exp(-\|x_j - x_{j'}\|_1 / \sigma)$$

OUR HYBRID SYSTEM



$$\min_{A,B \geq 0} \mathrm{KL}\big(\Omega \circ (C \| AB)\big) + \theta_A \|A\|_{TV_A} + \theta_B \|B\|_{TV_B}$$

RECOMMENDATION



OPTIMIZATION

Convex sub-problems:

$$\min_{B \geq 0} \quad \underbrace{\mathrm{KL}\big(\Omega \circ (C \| AB)\big)}_{F(AB)} + \underbrace{\theta_B \|K_B B\|_1}_{G(K_B B)}$$

Fenchel duality:

$$\min_B F(AB) = \max_Y \mathrm{tr}\left(Y^\top AB\right) - F^*(Y)$$

Dual variable

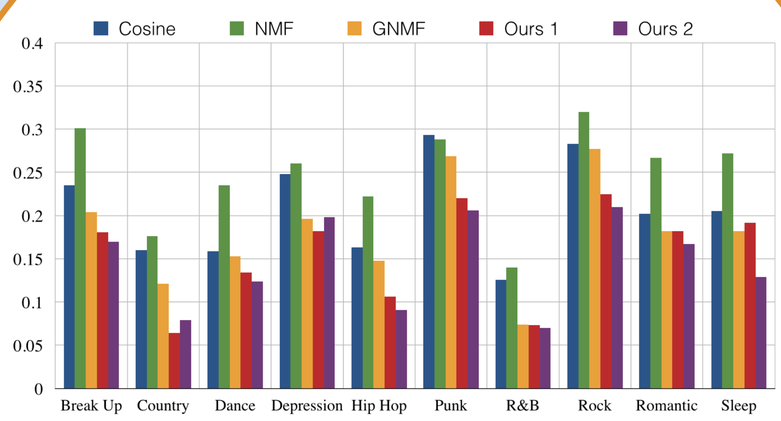
Saddle point problem:

$$\min_{B \geq 0} \max_{Y_1, Y_2} \mathrm{tr}\left(Y_1{}^\top AB\right) - F^*(Y_1) + \mathrm{tr}\left(Y_1{}^\top K_B B\right) - G^*(Y_2)$$

Primal dual algorithm:

$$Y_1^{k+1} = \mathrm{prox}_{\sigma_1 F^\star}(Y_1^k + \sigma_1 A B^k)$$
$$Y_2^{k+1} = \mathrm{prox}_{\sigma_2 G^\star}(Y_2^k + \sigma_2 K_B B^k)$$
$$B^{k+1} = (B^k - \tau_1 A^T Y_1^{k+1} - \tau_2 (K_B^T Y_2^{k+1})^T)_+$$

RESULTS



	Cosine only	NMF [16]	GNMF [10]	$\gamma_1 = 0$ $\gamma_2 = 1$	$\gamma_1 = 0.3$ $\gamma_2 = 0.7$
Test	0.208	0.248	0.181	0.153	**0.146**
Sampled	0.226	0.319	0.211	0.164	**0.074**

$$MPR = \frac{\sum_{p,s} R_{p,s} rank_{p,s}}{\sum_{p,s} R_{p,s}}$$

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