**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?
- **Danceability**: Is the song danceable?
- **Instrumentalness**: Is the song instrumental?

### Social Features

- **Artist Discovery**: How unexpectedly popular is the artist?
- **Artist Familiarity**: How familiar is the artist?
- **Artist Hottness**: Is the artist currently popular?
- **Song Hotness**: Is the song currently popular?
- **Song Currency**: How recently has it become popular?

### Temporal Echonest Features

Statistics on echorose segments | Described in [22]
---|---
Genre | 183 genre extracted from tags given by LastFM api

**Metadata Features**

- **Genre**: ID3 genre extracted from tags given by LastFM api
- **Artist Hotttnesss**: How recently has it become popular?
- **Artist Familiarity**: How familiar is the artist?
- **Is the song danceable?**: How many spoken words?
- **Is it a “live” recording?**: Is it a “live” recording?
- **Is the song danceable?**: How energetic is the song?
- **Is the song instrumental?**: How energetic is the song?
- **Is the song positive or negative?**: How energetic is the song?
- **How recently has it become popular?**: How energetic is the song?

**RESULTS**

<table>
<thead>
<tr>
<th>Method</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMF</td>
<td>0.248</td>
<td>0.074</td>
</tr>
<tr>
<td>GNMF</td>
<td>0.211</td>
<td>0.146</td>
</tr>
<tr>
<td>Ours 1</td>
<td>0.164</td>
<td>0.074</td>
</tr>
<tr>
<td>Ours 2</td>
<td>0.153</td>
<td>0.074</td>
</tr>
</tbody>
</table>

**OPTIMIZATION**

Convex sub-problems:

\[
\min_{A,B \geq 0} KL(\Omega \circ (CAB)) + \theta_A \| A \|_{TV_A} + \theta_B \| B \|_{TV_B}.
\]

### Fenchel Duality

\[
\min_{B \geq 0} KL(\Omega \circ (CAB)) + \theta_B \| B \|_1 = \max_{Y \succeq 0, Y_1, Y_2} tr(Y^T AB) - \theta_B tr(Y^T B) - \theta_B tr(Y_1^T A B) + \theta_B tr(Y_2^T B).
\]

### Saddle Point Problem

\[
\min_{B \geq 0} \max_{Y \succeq 0, Y_1, Y_2} tr(Y^T AB) - \theta_B tr(Y^T B) - \theta_B tr(Y_1^T A B) + \theta_B tr(Y_2^T B).
\]

### Primal Dual Algorithm

\[
Y_{k+1} = \text{prox}_{s_k \| \cdot \|_1}(Y_k - s_k t AB)
\]

\[
Y_{k+1} = \text{prox}_{s_k \| \cdot \|_1}(Y_k - s_k t K_B B)
\]

\[
B_{k+1} = (B_k - \tau_1 A Y_{k+1}^T - \tau_2 (K_B^T Y_{k+1}^{k+1} T_Y))_2
\]

**SONG RECOMMENDATION**

\[
w_{jj'} = \exp(-\|x_j - x_{j'}\|_1 / \sigma)
\]

**OUR HYBRID SYSTEM**

**PLAYLISTS GRAPH**

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

\[
w_{ij}^A = \gamma_1 \delta_{\text{cat}(i) = \text{cat}(j)} + \gamma_2 \sin(\cos(C_i, C_j))
\]

**RESULTS**

**RECOMMENDATION**

**REPORT**

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

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