Music recommendation System - Spotify

Collaborative Filtering and Feedback System

Mithun Madathil
Table of contents

- Introduction
- Methods of recommendation
- Collaborative Filtering in Spotify
- Feedback System
- Conclusion
- References
The ideal music recommender

- maximize user’s satisfaction
- Recommend songs to hit top songs of user’s favourite list
- Nowadays streaming music provides best services such as Soundcloud, Deezer, Spotify
Spotify

- Uses various ways of recommendation
- 100 mio. monthly active users with millions of songs and playlists
- Three main services for recommendation and a feedback system

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Spotify track

1. Starboy
   Daft Punk
   3:50

2. Party Monster
   4:09

3. False Alarm
   3:40

4. Reminder
   3:38

5. Rockin'
   3:52

6. Secrets
   4:25

7. True Colors
   3:26

8. Stargirl Interlude
   Lana Del Rey
   1:51

9. Sidewalks
   Kendrick Lamar
   3:51

10. Six Feet Under
    3:57
Spotify track

```json
{
    "danceability" : 0.560,
    "energy" : 0.527,
    "key" : 2,
    "loudness" : -9.783,
    "mode" : 1,
    "speechiness" : 0.0374,
    "acousticness" : 0.516,
    "instrumentalness" : 0.0000240,
    "liveness" : 0.156,
    "valence" : 0.336,
    "tempo" : 93.441,
    "type" : "audio_features",
    "id" : "2z7D7kbprCvEdT71tdiNQ",
    "uri" : "spotify:track:2z7D7kbprCvEdT71tdiNQ",
    "track_href" : "https://api.spotify.com/v1/tracks/2z7D7kbprCvEdT71tdiNQ",
    "analysis_url" : "http://echonest-analysis.s3.amazonaws.com/TR/-ENytQjtFbuv9XJtXVpEI2tp9PXqI7k",
    "duration_ms" : 168720,
    "time_signature" : 4
}
```

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1. Content-based recommendation

- Without user’s evaluation or ratings
- Uses machine language to acquire information
- Algorithms: decision trees, neural networks and vector-based methods
2. Knowledge-based recommendation

- Based on demands and preferences of user
- Predictions decided by functions and features of objects
3. Collaborative Filtering - KNN

- Uses K-nearest neighbour (KNN) technique
- Music taste of users calculates distance between different users
- Search for neighbour users who share similar interest in music and recommend content
- Daily life: friend’s recommendation
### Categories:

<table>
<thead>
<tr>
<th>Memory-based</th>
<th>Model-based</th>
<th>Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predict items based on previous ratings</td>
<td>Uses algorithms and models preferences</td>
<td>Combining both models and outperforms them</td>
</tr>
</tbody>
</table>

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Collaborative Filtering - Flowchart

1. Users
2. User's evaluation
3. Find user's neighbor
4. Evaluate for item without comment
5. IB-CF Process
6. Find nearest neighbor
7. Recommend the item with highest comment
Collaborative Filtering - Approach (1)

Neighborhood Models:

\[ \hat{r}_{ui} = \frac{\sum_{j \in S^k(i;u)} S_{ij} r_{uj}}{\sum_{j \in S^k(i;u)} S_{ij}} \]  

[4]

Minimize cost function:

\[ \min_{x^*,y^*} \sum_{u,i} c_{ui} (p_{ui} - x_u^T y_i)^2 + \lambda \left( \sum_u \|x_u\|^2 + \sum_i \|y_i\|^2 \right) \]  

[4]

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Collaborative Filtering – Approach (2)

1. Initialize user & item vectors
2. Fix item vectors and solve for optimal user vectors
3. Fix user vectors and solve for optimal item vectors
4. Repeat till convergence

\[ x_u = (Y^T C^u Y + \lambda I)^{-1} Y^T C^u p(u) \]
\[ y_i = (X^T C^i X + \lambda I)^{-1} X^T C^i p(i) \]

[4]

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In Spotify: Discover Weekly Playlist

You listen to and save songs  

Develops your "taste profile"  

Spotify users create billions of playlists  

Spotify identifies similar songs that appear on those playlists  

Spotify finds songs that fit your profile, but that you haven't listened to  

Discover Weekly

1
2
3
4
5
6
7
8

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My discover weekly playlist

1. Mon ami
   Still Fresh - Mon ami
   3:15

2. All The Way Up (Remix)
   Fat Joe, Remy Ma, JAY Z, French Montana, Infared - All The Way Up (Remix) (feat. French Montana...
   4:44

3. Need Somebody
   Zolo, Tory Lanez - Need Somebody
   3:31

4. Say Less
   Dillon Francis, G-Eazy - Say Less
   3:24

5. Tupac Shakur
   Lil Cezer - Tupac Shakur
   4:26

6. Childish (feat. Yg)
   Bobo Norco, YG - Childish (feat. Yg)
   3:55

7. Kronan
   Blizzy - Djunglebå
   3:12

8. Askungen
   Ozzy - Askungen
   3:39

9. Mamacita
   KESI, Benny Jamz - Mamacita
   3:39
Feedback System

Theory of general feedback system [1]
Results in Spotify

Frequency of pressing „like“ when users find songs matching their taste [1]

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## Conclusion – Collaborative Filtering

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluates information that is difficult to be analysed</td>
<td>Cold-start problem</td>
</tr>
<tr>
<td>Avoids low accuracy by matching items with neighbourhood users</td>
<td>Unusual taste leads to poor recommendations</td>
</tr>
<tr>
<td>Provides users with not similar recommendations but based on taste</td>
<td>Personalization weakened with popular songs recommended</td>
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<td></td>
<td>Big amount of data needed</td>
</tr>
</tbody>
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Conclusion – feedback system improvements

- Time delay of correcting measures
- Requirements, features and development for every system
- Users moods are not important which leads into the inaccuracy problem
Papers

- [1]: Exploring drawbacks in music recommendation systems
- [2]: A survey of music recommendation systems and future perspectives
- [3]: A model-based music recommendation system for individual users and implicit user groups
- [4]: Collaborative Filtering for implicit feedbacks

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Sources


Time for your questions!