Giang Nguyen

Gianghn2@illinois.edu

Tech review: Application of topic model in music industry

## 1. Introduction

Text mining has been proven to be crucial in many different fields. Topic model is one of the most popular method for mining topics and their distribution from text data. It has been extended and employed in numerous fields of science such as biology, medical, and education. However, the application of topic model in music industry has not been widely mentioned. This technology review aims to provide an overview of the current application of topic model in music industry as well as its benefits and drawbacks.

## 2. Classic topic modeling methods

In data science, topic model is one of the most effective ways to represent text documents. It also plays a significant role to extract topic from documents and the distribution of those topics within a document. Obviously, topic model can be applied in lyrics analysis and genre mining. There are many research and applications taking that approach. Song lyrics are often represented by probabilistic latent semantic analysis (PLSA) and latent Dirichlet allocation (LDA). After that, topics are determined by combining the distribution in those models and the metadata of the songs. A thesis published by Lucas Sterckx in 2013 contains one of the most completed discussion for this approach. The paper examined LDA for analyzing song lyrics [1]. Moreover, different part of the songs such as metadata, lyrics, and title are taken into account to retrieve more accurate and meaningful information. Numerous applications are proposed in the thesis. For instance, this model can be applied in automatic playlist generation or artist recommendation systems [1].

## 3. Topic model for melodic sequences

However, topic model is also extended in much mor interesting ways. As music contains both lyrics and instrumental components, analyzing lyrics alone is obviously not enough. Therefore, another extension of topic model is developed. Instead of representing text data, PLSA, LDA, and dynamic topic model are used to analyze audio data as well. Audio signals are captured and separated into small chunk of data and then treated as worlds as mentioned in the paper of Paris Smaragdis and Madhusudana Shashanka Bhiksha Raj [2].

Depend on specific purposes, disparate methods are used to build “words” out of an audio track.

### 3.1. Modeling musical influences

Thanks to this extension of topic model, numerous information is extracted from songs. Music influence is one of them. This application is studied by Uri Shalit, Daphna Weinshall, and Gal Chechik to discover the influence of a song on musical topics or genre [3]. In this research, the audio data of 24941 songs from 1920 to 2010 are represented by dynamic topic model (DTM) to capture influence over time periods and document influence model (DIM) to measure influence of songs. A classic topic model is used to represent songs in a specific period. Time dependent model then be applied to denote the changes in the chosen timeline. The influence factor then be used to recognize influential songs. An influential song is the one having effect on the musical language of the others in its genres. In addition to song influence, artist influence and the relationship between influence and music innovation can also be captured by this method [3].

### 3.2. Genre visualization

Another helpful application of topic model is studied by Swaroop Panda, Vinay P. Namboodiri, and Shatarupa Thakurta Roy in 2021 [4]. In the paper, topic model is used to support music genre visualization. Similar to the above research, audio data is divided into small segments which are represented by Mel frequency cepstral coefficients (MFCC) features [4]. These segments are treated as musical words. K-mean clustering is used to form the dictionary to group the words to specific K genres. The genres are retrieved from the genre annotation of the songs and are separated into multiple groups. As musical words are audio signal, cluster means and genre’s probability are then used to form topics. LDA is then used for building associated matrices such as topic-document and topic-word association. From the information provided by LDA, the genre distribution of a song can be recognized. Furthermore, the genre proportion in small segments of a song can be recognized from the topic-word proportion matrix [4].

## 4. Other extension

Besides, other extensions of classic topic models also attract numerous researchers. One of them is the variable-gram topic model for audio data [5]. The model is an extension of LDA by applying Dirichlet Variable- Length Markov model (Dirichlet-VMM). In the model, the conditional probability of generating a musical word given a context with variable length.

This length is chosen based on the frequency of the context [5]. In contrast to LDA, topics are represented by this new distribution instead of the probability over words. The detailed algorithms are mentioned in the reference article [5]. This model aims to solve the difficulties of representing complex melodic music data. As music are constructed by numerous audio tracks and signal based on complex musical components and their relationship, classic models such as LDA cannot capture enough crucial information [5].

## 5. Conclusion

Topic model plays a certain role in music analysis. It provides an efficient way to represent both lyrics and instrumental contents of musical pieces. It also helpful for finding relationship between music components, visualizing topics and genres, and supporting recommendation and inference systems. The combination of multiple extensions and applications can be studied further to create robust systems. However, topic model also has several drawbacks. At the moment, it is not sophisticate enough to cope with the complexity of music. Besides, it can also provide incorrect information if the contexts are not accurately chosen or when there are not enough contexts.

## 6. References

[1] Lucas Sterckx, “Topic Detection in a Million Songs”, 2013, https://libstore.ugent.be/fulltxt/RUG01/002/033/229/RUG01-002033229_2013_0001_AC.pdf

[2] Paris Smaragdis and Madhusudana Shashanka Bhiksha Raj, “Topic Models for Audio Mixture Analysis”, http://mlsp.cs.cmu.edu/publications/pdfs/nipsworkshop09.pdf

[3] Uri Shalit, Daphna Weinshall, and Gal Chechik, “Modeling Musical Influence with Topic Models”, https://proceedings.mlr.press/v28/shalit13.pdf

[4] Swaroop Panda, Vinay P. Namboodiri, and Shatarupa Thakurta Roy, “Visualizing Music Genres using a Topic Model”, 2021, https://arxiv.org/pdf/2103.00127

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