KV Multimedia Search and Retrieval

Exercise 1 Group E

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ABSTRACT

In this paper a rudimentary text-based retrieval system is being developed. Multiple different algorithms for computing the similarity between two songs are tested and compared with a random baseline. For calculating this similarity measure only text-features are used. This paper compares the cos-sim-similarity based on the tf-idf and word2vec respectively. This is contrasted with a measure using the transformer-based BERT.

1 Introduction

The increasing availability of digital libraries has paved the way for a new generation of music recommender systems. Music recommendation systems play a pivotal role in helping users discover new tracks, artists, and genres and thus drive customer satisfaction in a significant way.

The purpose of this paper is to evaluate and compare 4 different approaches to music retrieval systems. Within the scope of this paper all features are going to be text-based.

Concretely, the effectiveness of cos-sim-similarity based on both tf-idf and word2vec are compared to BERT.

The resulting recommendations will be evaluated qualitatively according to the similarity to the queried song.

The data set used for testing the 4 retrieval systems is a subset of the Music4All-Onion dataset which was kindly provided by the university.

2 Methodology

For implementing the assignment, the programming language Python is used as it has the most support for data analysis and data science purposes. The coding environment used is Jupyter Notebook as it supports the programming language python. We also used the libraries NumPy and pandas as well as Scikit-learn which provides us with different similarity functions. The code repository is hosted on the platform Github. The coordination and integration of code contributions of each team member is therefore ensured using Git.

To ensure that new functionality as well as new algorithms can easily be added the text-based music recommender system in the future a large focus is set on making the code modular.

The input of the query is the name of the song as well as the name of the corresponding artist. The recommender system should output a list of songs with the title and the artist-

To be better able to analyze the results of the recommender system this output of the script is saved in a dictionary.

To keep the code modular and make it reusable we first implemented some basic functions in a separated python file. First, we defined a function to get the information about the artist and song name from the IDs. The function takes a list of ids as input and gives us the list of the songs and artist as the output. After that we implemented a function, which can be used for all text based analysis. The function itself is also called text\_based. It takes as input parameters the id of the query song, the representation of the lyrics for example the tf-idf, the number of tracks that want to be retrieved as well as the similarity function for example cosine similarity or Euclidean similarity. This way we are completely flexible and can use the same function for many different use cases. Then we imported the functions into the main file where they can be used with different input parameters.

2.1 The dataset

Music4All-Onion is a large-scale, multi-modal music data set, which expands the Music4All-dataset with additional features and meta-data. For the purpose of this task only the text-based features like “Title” or “lyrics” are considered.

[info about the the feature vectors]

[info about the two tsv files]

2.1 Random baseline

for the random baseline we first shuffled the songs to get a random order, so we get a different result each time the function is called. Then we excluded the query song from the data frame, so it does not appear in the result-list. Afterwards we retrieve top N random songs and save them to the result list.

2.2 Cos-sim based on tf-idf

To calculate the cosine-similarity of the tf-idf representation of the lyrics, we created a wrapper function called “cos\_sim” that takes two Numpy-arrays as input and reshapes them to 2d arrays so they can be used in the cosine similarity function which is provided by the scikit-learn library.The result of the cos\_sim function is the similarity score of the two arrays. The similarity function cos\_sim is then passed to the “text\_based” function, as well as the query song-id and the dataset containing the tf-idf values. The first thing the test\_based function does, is search for the query song in the tf-idf dataset and extract the vector from the queried song. Then we create an array which is called similarities.

Afterwards the “text\_based” function iterates through all the rows in the tf-idf dateset and selects all the tf-idf values which start at the third column. The similarities between the query-vector and track-vector are then calculated using the cos\_sim function. The song-id as well as the similarity-score are then saved in the similarities array. The similarity scores can range from -1 to 1, 1 meaning perfect similarity and. Afterwards we sort the list from the most to least similar and retrieve the ids of the 10 most similar songs.

2.3 Cos-sim based on word2vec

The next retrieval system uses the word2vec-embedding with the cos-sim-similarity measure. Word2vec represents each word as a high-dimensional vector and uses a neural network to learn the optimal distance of these vectors in the embedding space. The flow of the code is the same as tf-idf. So only a parameter has to be changed when calling the function.

2.4 Cos-sim based on BERT

As the last retriever that we have implemented for this project, we have chosen cosine similarity as its similarity function and lyric representation generated by BERT. As mentioned above, we have adopted a modularized scheme when implementing the text\_based function. Thus, for this step, we just set the repr parameter of the text\_base function to “bert”, and the sim\_func parameter to “cos-sim.” The flow of execution is the same as when using the other two representations.

3 Qualitative Analysis

For the qualitative analysis we selected 3 tracks for each retrieval system and retrieved 10 tracks for each query track:

3.1 Random baseline

The random baseline function will produce a different result set every time it is called, no matter what input query you give. It produces songs of different genres that mostly have nothing in common with the query song.

3.2 Cos-sim based tf-idf

Query song 1: Love me by the 1975:

Result list:

|  |  |  |  |
| --- | --- | --- | --- |
| Song | Oh Yeah | Artist | Big Time Rush |
| Song | The Gospel | Artist | Alicia Keys |
| Song | Fire Starter | Artist | Demi Lovato |
| Song | Rat Fink | Artist | Misfits |
| Song | How Bad Do You Want It (Oh Yeah) | Artist | Sevyn Streeter |
| Song | Yeah! (feat. Lil Jon & Ludacris | Artist | Usher |
| Song | Regarde-moi | Artist | Céline Dion |
| Song | Miss Independent | Artist | Ne-Yo |
| Song | Euphoria | Artist | BTS |
| Song | Let There Be Love | Artist | Simple Minds |

In the result are songs of different genres like R&B, K-Pop, Pop, Indie-Rock, and Punk. The lyrics of the query song “Love me” have many appearances of the words “yeah” and “love”. By looking at the lyrics of the retrieved songs we noticed that all of them also have many appearances of the word “Yeah”. The songs “Let There Be Love” and “Miss Independent” also have many appearances of the word “Love”. Other than that, the query song, and the retrieved songs do not have so much in common and come from different genres.

Query Song 2: One by U2

Result list:

|  |  |  |  |
| --- | --- | --- | --- |
| Song | One | Artist | Mary J. Blige |
| Song | One Love (feat. Estelle) | Artist | David Guetta |
| Song | Love the One You're With | Artist | Stephen Stills |
| Song | One | Artist | Alanis Morissette |
| Song | No One | Artist | Alicia Keys |
| Song | One Tribe (Defqon.1 2019 Anthem) | Artist | Phuture Noize |
| Song | You Can Be the One | Artist | Late Night Alumni |
| Song | Rape Me | Artist | Nirvana |
| Song | Palavras No Corpo | Artist | Gal Costa |
| Song | No One in the World | Artist | Anita Baker |

For the second query song, we picked “One” by U2 which has been covered by Mary J. Blige, so it makes sense, that the cover version appears first in the result set because the lyrics are the same. We also have very different genres in this result set, The query song is a rock ballad, the retrieved songs are from the genres R&B, Grunge, EDM and Pop-Rock. There is also one Spanish song in the result.

Query Song 3: Every Christmas by Kelly Clarkson

Result list:

|  |  |  |  |
| --- | --- | --- | --- |
| Song | Christmas Conga | Artist | Cyndi Lauper |
| Song | Three Ships | Artist | Cyndi Lauper |
| Song | Hellhound On My Trail | Artist | Robert Johnson |
| Song | St. Patrick's Day | Artist | John Mayer |
| Song | Last Christmas | Artist | Carly Rae Jepsen |
| Song | My Only Wish (This Year) | Artist | Britney Spears |
| Song | Christmas Vacation | Artist | Descendents |
| Song | Last Christmas - Studio Version | Artist | Jimmy Eat World |
| Song | The Christmas Song (Merry Christmas To You) | Artist | Nat King Cole |
| Song | I Shut Doors and Windows | Artist | September Malevolence |

For the third query we wanted to analyze a Christmas song because Christmas songs usually have some specific words that are often used in the lyrics for example the words year, wish or mistletoe. As we can see in the result list, we retrieved 9 Christmas songs and 1 other song. The song“I Shut Doors and Windows” by September Malevolence Is not particularly a Christmas song but it also has one appearance of the word “Christmas” in the lyrics. We have 2 songs from the same artist “Cyndi Lauper” and they are also from the same album which is a Christmas album.

3.3 Cos-sim based on word2vec

Query song 1: Love me by the 1975:

Result list:

|  |  |  |  |
| --- | --- | --- | --- |
| Song | Miss Independent | Artist | Ne-Yo |
| Song | If Our Love Is Wrong | Artist | Calum Scott |
| Song | Looking For Clues | Artist | Robert Palmer |
| Song | Out on the Tiles | Artist | Led Zeppelin |
| Song | So Much Love | Artist | The Rocket Summer |
| Song | Let There Be Love | Artist | Simple Minds |
| Song | In the Evening | Artist | Led Zeppelin |
| Song | All You Got | Artist | Tegan and Sara |
| Song | Rosalyn | Artist | David Bowie |
| Song | How Bad Do You Want It (Oh Yeah) | Artist | Sevyn Streeter |

In the result list we have 2 different songs by the same Artist “Led Zeppelin”. We noticed that in this result set we retrieved many songs of British Artist. The Artists of the Query Song are also a British Band. One reason could be that British English is different than American English. The genres that are retrieved are Rock, Pop, R&B and Rap in decreasing order.

Query Song 2: One by U2

Result list:

|  |  |  |  |
| --- | --- | --- | --- |
| Song | One | Artist | Mary J. Blige |
| Song | One Love (feat. Estelle) | Artist | David Guetta |
| Song | Quien Eres Tu (Feat. Trey Songz) | Artist | María José |
| Song | Dance With The One That Brought You | Artist | Shania Twain |
| Song | Apocalyptic | Artist | Halestorm |
| Song | I Will Survive - Extended Version | Artist | Gloria Gaynor |
| Song | King For A Day | Artist | Thompson Twins |
| Song | Never Let Me Down | Artist | Kanye West |
| Song | Fica Mais um Pouco Amor | Artist | Emicida |
| Song | I Will Survive | Artist | Gloria Gaynor |

For the query Song “One” by “U2 we retrieved the cover version by Mary J. Blige as the most similar, just like we did with the tf-idf representation. We noticed that we retrieved one Spanish and one Portuguese song. The Genres we retrieved are Rock, Pop, Electronica, Country, Hip-Hop and Samba and Pagode.

Query Song 3: Every Christmas by Kelly Clarkson

Result list:

|  |  |  |  |
| --- | --- | --- | --- |
| Song | St. Patrick's Day | Artist | John Mayer |
| Song | Junesong Provision | Artist | Coheed and Cambria |
| Song | My Only Wish (This Year) | Artist | Britney Spears |
| Song | PERFECT! | Artist | WJSN |
| Song | Si Tu Novio Te Deja Sola | Artist | J Balvin |
| Song | So Doggone Lonesome | Artist | Johnny Cash |
| Song | The Best Day | Artist | Taylor Swift |
| Song | Wait For You | Artist | Elliott Yamin |
| Song | Jesus Christ | Artist | Brand New |
| Song | Alone (feat. Big Sean & Stefflon Don) | Artist | Halsey |

For the third track we retrieved one Korean and one song in Spanish. We retrieved all kinds of different genres like country, Rock, and Pop. The entropy of the genre is high. We did not retrieve as many Christmas songs as we did with the other representations.

3.4 Cos-sim based on BERT

Query song 1: “Love me” by “The 1975”

|  |  |  |  |
| --- | --- | --- | --- |
| Song | Dance Gavin Dance | Artist | Thug City |
| Song | Shine | Artist | Take That |
| Song | One, Two, Three, GO! | Artist | Belanova |
| Song | Right There | Artist | Ariana Grande |
| Song | Bing Bing | Artist | Crayon Pop |
| Song | Come Get It Bae | Artist | Pharrell Williams |
| Song | We Made You | Artist | Eminem |
| Song | Here I Am | Artist | Monica |
| Song | Wannabe | Artist | why mona |
| Song | Edge of the World | Artist | Faith No More |

For the result generated by first query track with the BERT data, none of the ten retrieved tracks appears in the result from the other two dataset. In terms of genre, the result is similar to the results from the other two datasets. The genres appeared in the results including Pop, Indie Rock, R & B, Funk, Hip Hop and K pop.

Query song 2: “One” by “U2”

|  |  |  |  |
| --- | --- | --- | --- |
| Song | One | Artist | Mary J. Blige |
| Song | What About Love | Artist | Austin Mahone |
| Song | All of Your Glory | Artist | Broods |
| Song | La Tortura | Artist | Shakira |
| Song | Love One Another | Artist | Cher |
| Song | Black Lake | Artist | Björk |
| Song | El Triste | Artist | José José |
| Song | Love Makes the World Go Round | Artist | Ashlee Simpson |
| Song | Keep It Together | Artist | Madonna |
| Song | U Want Me 2 | Artist | Sarah McLachlan |

For the result generated by the second query track with the BERT data, again, does not overlap with the results of using the other two representations with exception being “One” by Mary J. Blige. As explained in the section above. It is a cover version of the query song, and therefore its lyrics is identical to that of the query song. In terms of genre, most tracks appeared in the result belongs to the Pop genre, which is different from Rock, the genre of the query song

Query song 3: “Every Christmas” by “Kelly Clarkson”

|  |  |  |  |
| --- | --- | --- | --- |
| Song | My Only Wish (This Year) | Artist | Britney Spears |
| Song | Christmas Conga | Artist | Cyndi Lauper |
| Song | Merry Christmas, Kiss My Ass | Artist | All Time Low |
| Song | St. Patrick's Day | Artist | John Mayer |
| Song | The Christmas Song (Merry Christmas To You) | Artist | Nat King Cole |
| Song | Last Christmas | Artist | Carly Rae Jepsen |
| Song | Next Year | Artist | Foo Fighters |
| Song | December's Boudoir | Artist | Laura Nyro |
| Song | Last Xmas | Artist | Allie X |
| Song | Santa Claus Is Coming To Town | Artist | The Jackson 5 |

For the result generated by the third query track with the BERT data, again, five of the retrieved tracks appear in the result from other datasets. Also, in terms of genre, most tracks appeared in the result belongs to the Pop genre, which could be attributed to the theme of the song, Christmas. Christmas music is known to be associated with the instrumental, Carol and Pop genre. It is also worth mentioning that the song “St. Patricks Day”, which appears in the results obtained from other datasets, is also included in the result. An examination of the lyrics reveals that, despite the title of the song being St Patricks Day, there are repeated references to words such as "cold", "snow", "December" and other words that might be found in other Christmas songs, as well as the phrase "Christmas times" itself appears three times.

4. REFERENCES

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