1.0 INTRODUCTION

This project is inspired by the international song contest, Eurovision, taking place annually. Analysis show that countries who participate with a track in their respective local language tends to place lower in both the jury and audience's vote. The aim of the project is to interrogate the importance of language in music recommendations on Spotify: Does Spotify have a bias towards non-English languages and how does that impact the visibility of artists.

2.0 EXPERIMENT

Two accounts were created with user names Mette Hansen and Anvi Sen to collect their Daily Drive playlist over the course of a week. The objective is to assess the improvement in song recommendations during this period of data collection. As Spotify does not provide language data for tracks, the Python library, langdetect will be used to identify the languages of the recommended tracks.

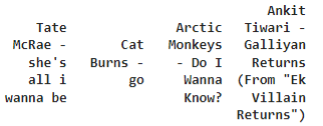
Matplotlib will be utilised to visualise the distribution of song recommendations across both user's playlists. For simplicity, this analysis will focus specifically on the songs recommended on the third and fifth days of the week. The results will be presented as part of a comparative analyses of the findings.

2.1 TOP 5 LANGUAGES

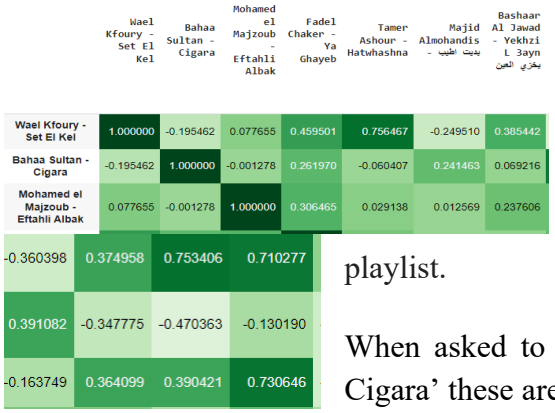
According to Music Tomorrow the Spotify recommender algorithm is based on both content and collaborative filtering. The content-based filtering is driven by audio features, including characteristics such as danceability, tempo, and instrumentalness, which are available through the Spotify API. Tempo, being an universal feature, raises the question of whether Spotify recommends songs equally across different languages based on these attributes.

To investigate this, the languages, Spanish, English, Hindi, Mandarin, Arabic and Korean were chosen in order to reflect the large number of speakers worldwide as well as the popularity of K-pop.

The playlists were identified by searching for 'most popular *language* songs by Spotify' via Google. Results showed official Spotify playlists for all languages except Mandarin, revealing an initial bias. As a result, the Mandaring playlist was excluded from the analysis.



From the heatmap analysis, it was observed that songs across different languages displayed similar score patterns. For instance 'Do I Wanna Know' by Arctic Monkeys had a similarity score of 0.753 with اطيب بديت by Majid Almohandis from the Arabic playlist.



Similarly, "Yo También" by Romeo Santos (feat. Marc Anthony) from the Spanish playlist has a score on 0.91 with "Cigara" by Bahaa Sultan from the Arabic playlist. However, this same track had minimal similarity with العين يخزي by Bashaar Al Jawad - Yekhzi L 3ayn, even though both songs belong to the same Arabic-language playlist.

When asked to do recommendations based on Arabic 'Bahaa Sultan - Cigara' these are the recommended songs:

'Justin Bieber - Ghost', 'Manuel Turizo - Esperándote', **'Olivia Rodrigo - good 4 u'**, 'Tainy - Agua - Music From "Sponge On The Run" Movie', 'Mau y Ricky - Desconocidos', **'NewJeans - Zero', 'THE NEW SIX - Love or Die',** 'Bad Bunny - Yonaguni', 'Aditya A - Chaand Baaliyan', 'YUJU - Without U']

The ones in bold are non-English songs. 4/10 are English songs. None of them are Arabic.

1) Recommendations based on Korean, BTS - Take Two.

'Arctic Monkeys - Do I Wanna Know?', **'GAYLE - abcdefu'**, **'Camila Cabello - Bam Bam (feat. Ed Sheeran)**', 'Lunay - Soltera - Remix', 'YUJU - Without U', 'ENHYPEN - SHOUT OUT', 'Amr Diab - Habiby Ya Omry', **'Justin Bieber - Ghost'**, 'Maninder Buttar - Sakhiyan2.0 (From "BellBottom")', 'Majid Almohandis - اطيب بديت"]

4/10 are English songs. 2/10 are Korean songs.

2) Recommendations based on the Spanish, King - Tu Aake Dekhle:

'Wael Kfoury - Set El Kel', 'Tamer Ashour - Hatwhashna', **'NewJeans - Zero'**, **'OneRepublic - I Ain't Worried'**, 'Alvaro Soler - Sofia', 'Ozuna - Dile Que Tu Me Quieres', 'Yasser Abd Alwahab - Allah Honej', 'Fadel Chaker - Ya Ghayeb', 'Aditya A - Chaand Baaliyan', 'A.R. Rahman - Param Sundari'

2/10 are English songs. 2/10 are Spanish songs.

3) Recommendations based on the Hindi, A.R. Rahman - Param Sundari

'aespa - Welcome To MY World (feat. nævis)', 'Jesse & Joy - ¡Corre!', 'Majid Almohandis - اطيب بديت"', 'Pritam - Shayad (From "Love Aaj Kal")', 'Han Dong Geun - dawn call from you', 'ENHYPEN - SHOUT OUT', 'BTS - Take Two', **'Arctic Monkeys - Do I Wanna Know?'**, 'GAYLE - abcdefu', 'Amr Diab - Habiby Ya Omry']

1/10 is English. 1/10 is Hindi.

4) Recommendation based on English, Frank Ocean - Lost:

'Ahmed Saad - Mansethosh Men Mosalsal El Aghar', 'Ramy Gamal - بعادك لحظة', 'Nouamane Belaiachi - Wala Bghiti', 'Tamer Hosny - Nasseeny Leih', 'Yasser Abd Alwahab - Allah Honej', 'Rochak Kohli - Dil De Diya (From "Thank God")', 'Mohamed el Majzoub - Eftahli Albak', **'Tom Odell - Another Love'**, 'Angham - ارضيك عشان', 'Wael Kfoury - Set El Kel'],

1/10 is an English song.

More than half of the songs recommended are non-English, suggesting that Spotify's recommender algorithm does prioritise audio features and content-based attributes, allowing for a varied selection of songs regardless of the language.

2.2. USER ACCOUNTS

In an attempt to test the recommender algorithm, two new accounts were created with identical demographic characteristics: both cis-women, born in 1983, and based in the UK. One account, Mette Hansen, exclusively listens to English-language songs, while the other, Anvi Sen, listens only to non-English language tracks. Interestingly, both accounts received the exact same Daily Drive playlist as a starting point.

The list included songs like:

- Libianca - People | Kali Uchis - Moonlight | Tom Odell - Another Love | Lil Durk - All My Life (feat. J. Cole) | Peso Pluma - PRC | Dua Lipa - Dance The Night (From Barbie The Album) | PinkPantheress - Boy's a Liar Pt. 2 | The Weeknd - Popular (with Playboi Carti & Mado... | Taylor Swift - Blank Space | Manuel Turizo - La Bachata

Notably, 9 out of 10 tracks were in English, indicating a heavy emphasis on Western music, despite Anvi Sen's non-English language preference.

For each recommendation, the songs were listened to and added to the playlist to ensure the algorithm could learn from the listening behaviour. Based on this approach, it appears that Spotify's initial recommendations lean towards Western music, regardless of the user's language preference. The next step s will involve monitoring how these playlist evolve over time as the account's listening histories diverge. This will provide insight into how quickly and effectively Spotify adapts to different language-based preferences.

2.3 INITIAL OBSERVATIONS

Initially, both Mette and Anvi received recommendations that were heavily Western-based. However, after Anvi started listening to artists like Jatin-Lalit and Adnan Sami, recommendations

became more diverse. This shift demonstrates Spotify's content-based recommendation system, which adapts to user preferences over time.

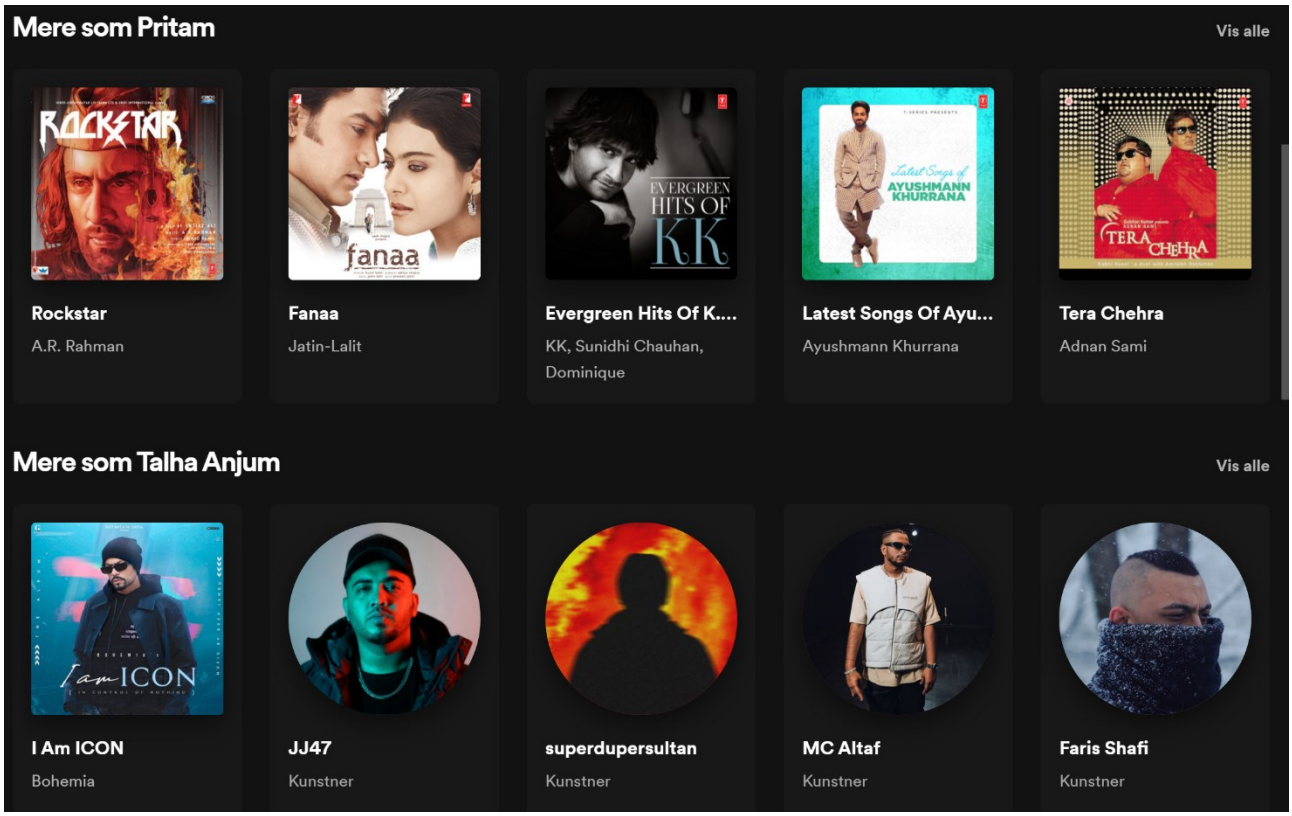


Figure 1 Anvi: Content-based recommendations

An interesting feature is the 'Try something new' recommendations, designed to expose users to music they might not typically receive based on their listening patterns. However, these suggestions are predominantly focused on English-language music.

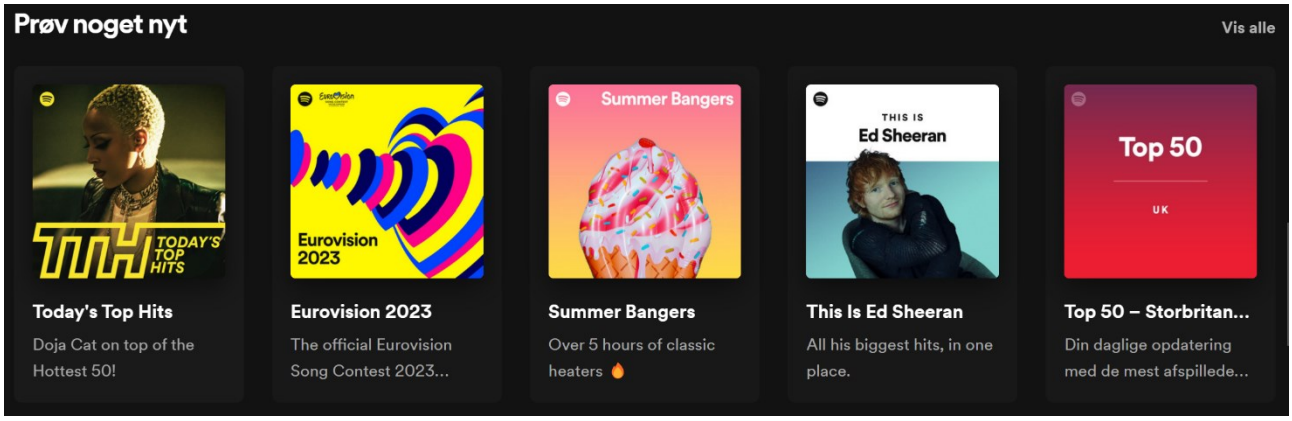


Figure 2 Anvi: Try something new recommendations

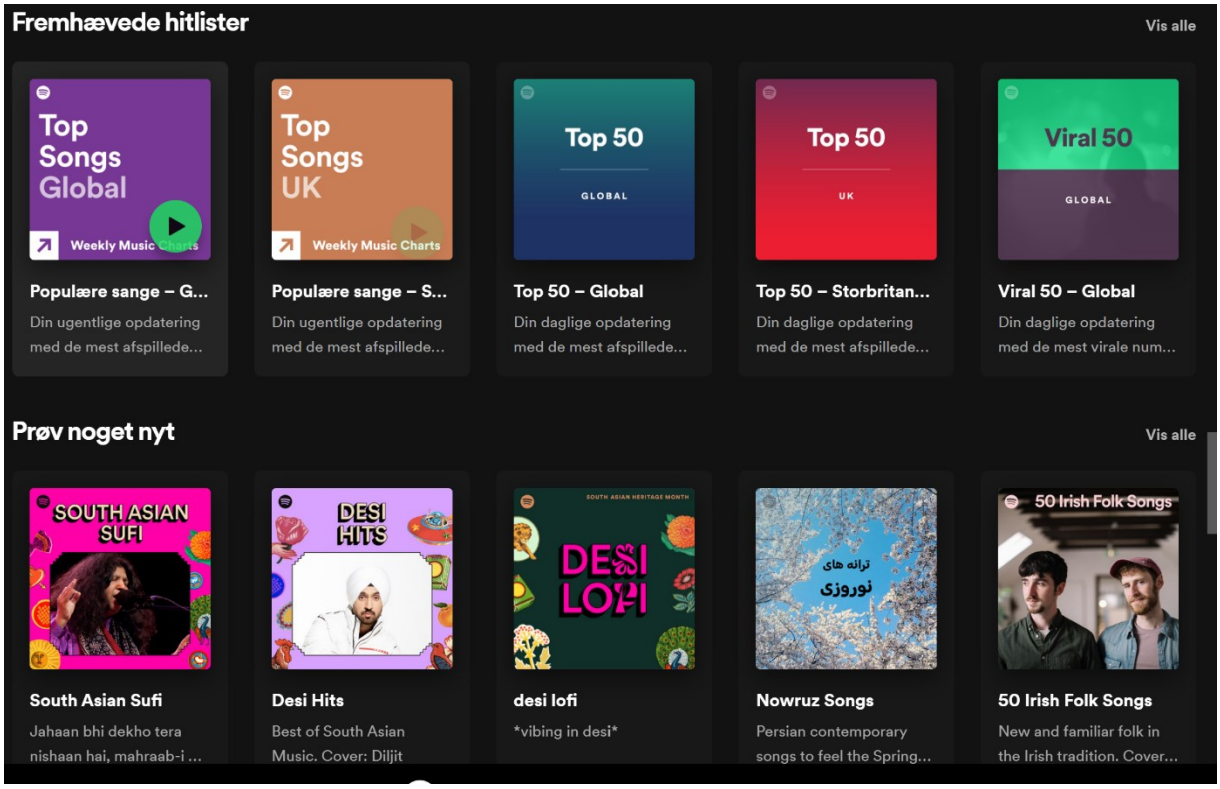


Figure 3 Anvi: recommendations after half a week

Mette got the same recommendations based on what she had listened to.

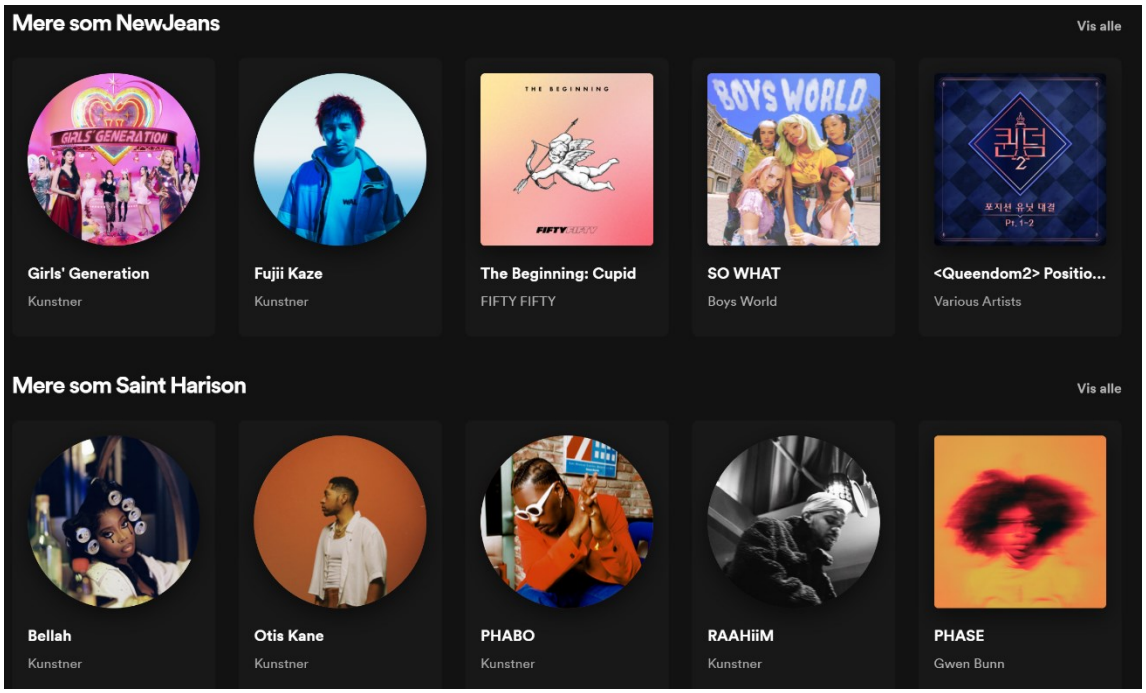


Figure 4 Mette: Content-based recommendations

She also got a 'Try something else' recommended playlist. But that didn't include music from non-English speaking artists.

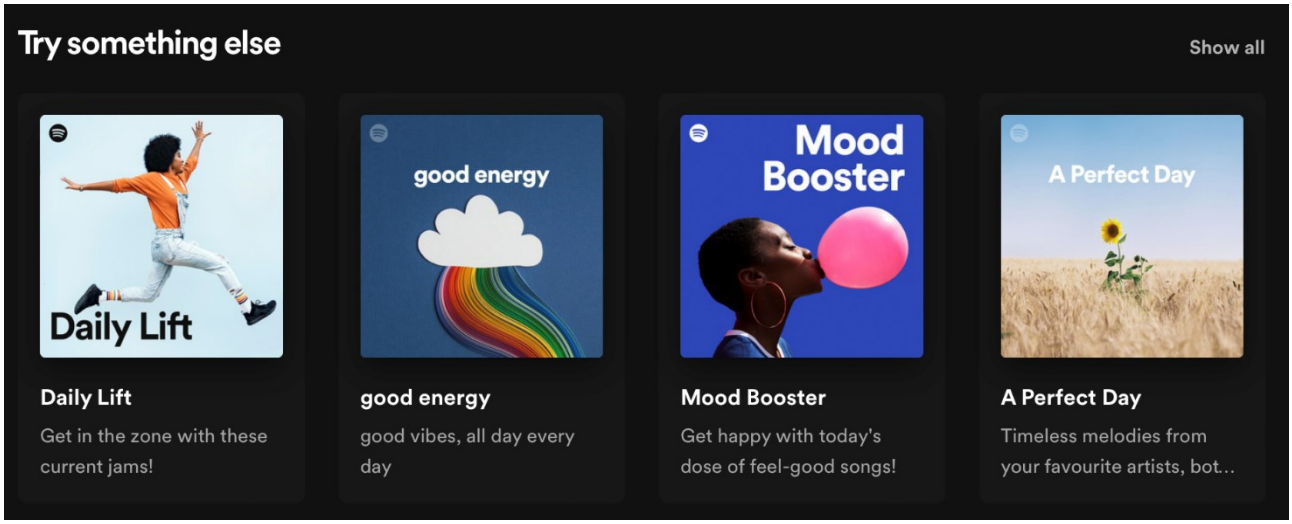


Figure 5 Mette: Try something else

Afterwards, the data was loaded using the Spotify API for developers. A personal setup was required, as the API used in class had reached its limit.

3.0 LOOKING AT THE DATA

3.1 ANVI SEN

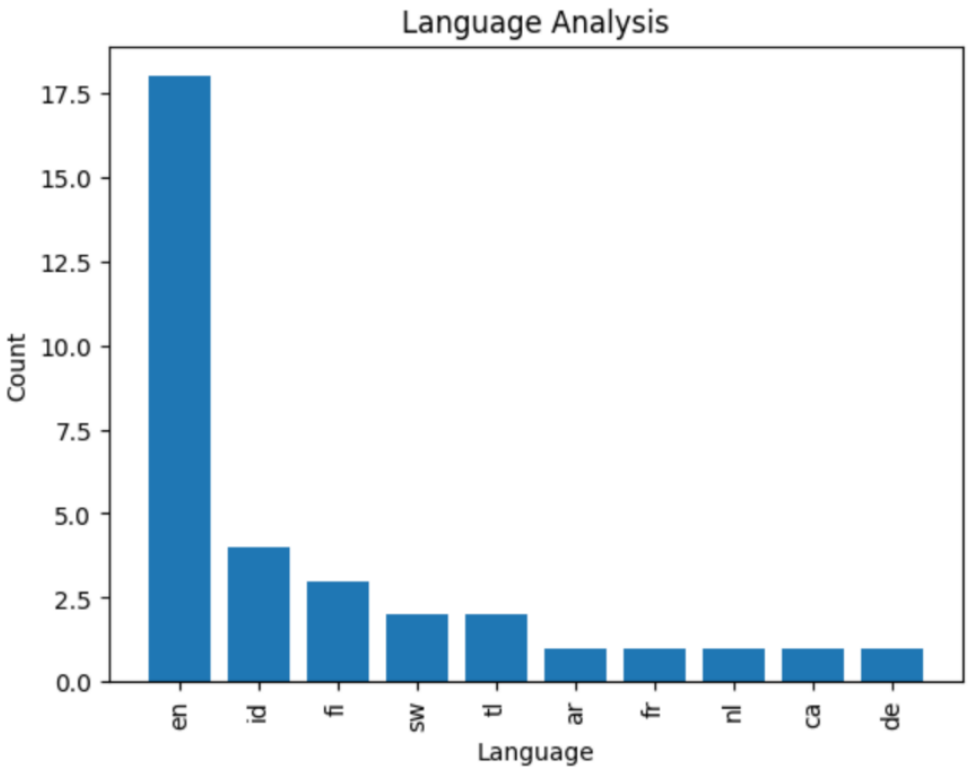
The following section presents the tabular data for the user Anvi Sen, who exclusively listened to non-English songs during the experiment period.

	Unnamed: 0	Track Name	Artist	Album	Duration (ms)	Popularity;
70	70	Entammede Jimikki Kammal	Vineeth Sreenivasan	Velipadinte Pusthakam (Original Motion Picture...	201600.0	58;
71	71	Pepeta	Nora Fatehi	Pepeta	213695.0	50;
72	72	One Night in Dubai (feat. Helena)	Arash	One Night in Dubai (feat. Helena)	158106.0	60;
73	73	Masalei Ni	TM Bax	Masalei Ni	255425.0	48;
74	74	ABUSADAMENTE - 3000beats Remix	3000BEATS	ABUSADAMENTE (3000beats Remix)	203763.0	51;
75	75	I Like You (A Happier Song) (with Doja Cat)	Post Malone	Twelve Carat Toothache	192840.0	87;
76	76	UNAVAILABLE (feat. Musa Keys)	Davido	Timeless	169911.0	81;
77	77	Dua Lipa	Jack Harlow	Come Home The Kids Miss You	135053.0	75;
78	78	Be Honest (feat. Burna Boy)	Jorja Smith	Be Honest (feat. Burna Boy)	207030.0	73;
79	79	Calm Down (with Selena Gomez)	Rema	Calm Down (with Selena Gomez)	239317.0	95;
80	80	[illegible]	[illegible]	[illegible]	240014.0	48;

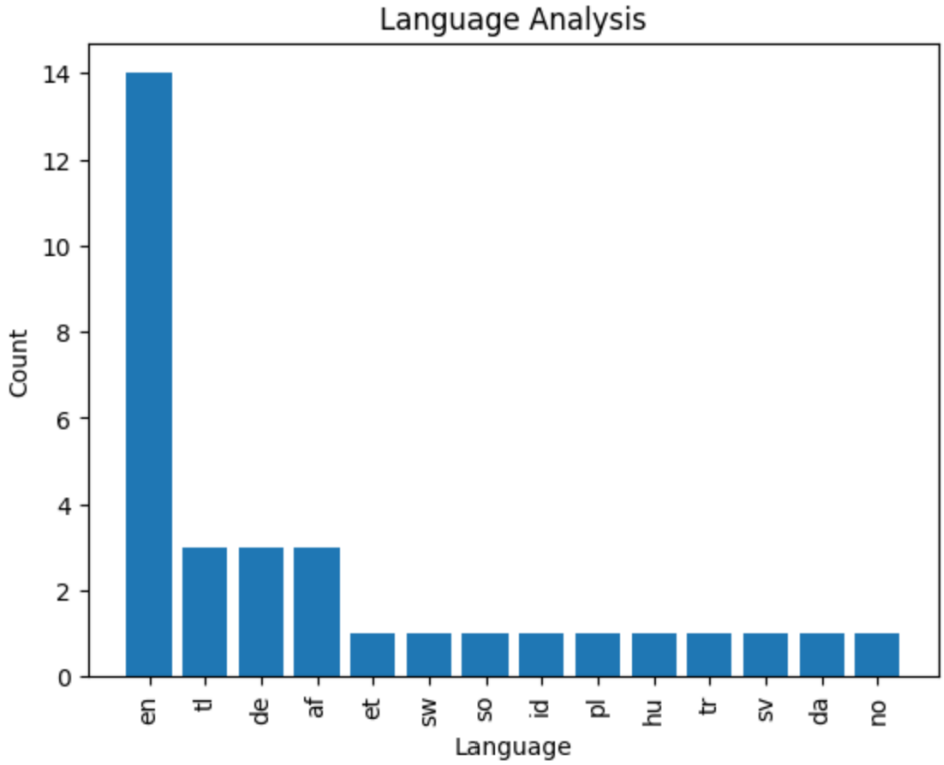
Since Spotify does not provide information on the languages of different tracks, the Python library, langdetect will be utilised to analyse the actual recommendations received.

The language codes used in the plots correspond to the following languages: English, German, French, Afrikaans, and Estonian.

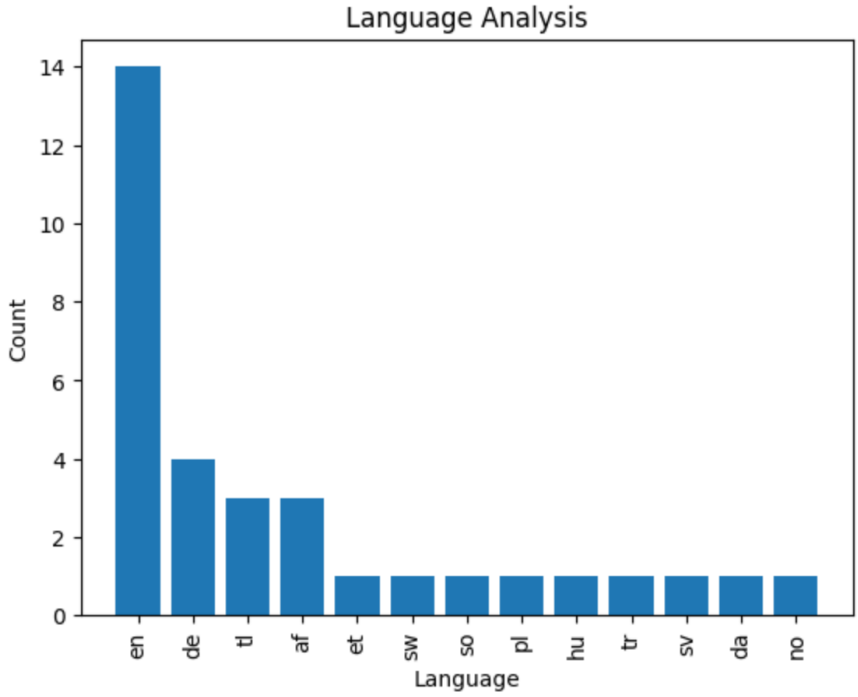
Recommendation from the first day:



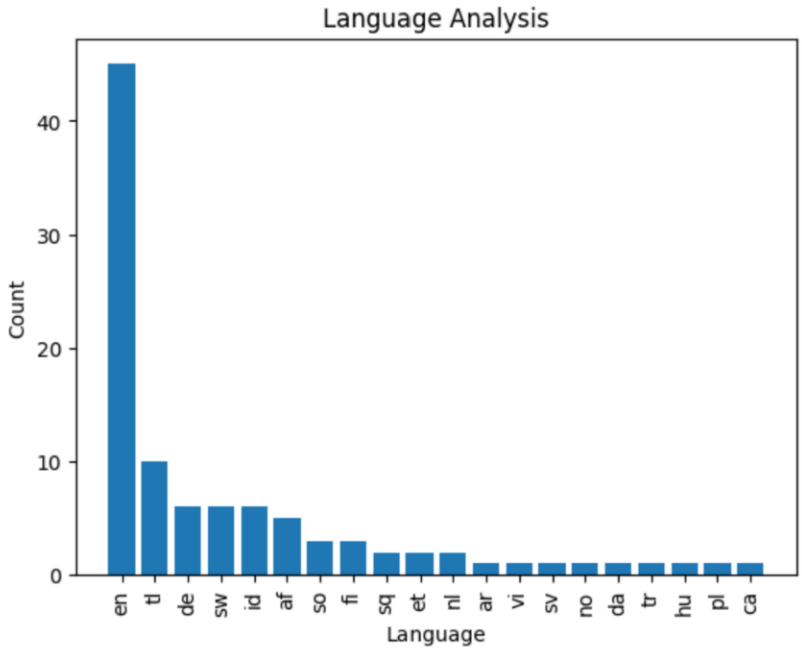
Recommendations from the third day:



Recommendation from the fifth day:



The recommendations across days appear quite similar, with a significant proportion of English songs. The number of English tracks only decreased slightly, from 17.5 to 14 out of t35 songs between day 1 and day 5, which isn't a notable drop. It is also worth noting that the majority of the recommended languages were European, despite starting with the Top 30 best Hollywood songs playlist.



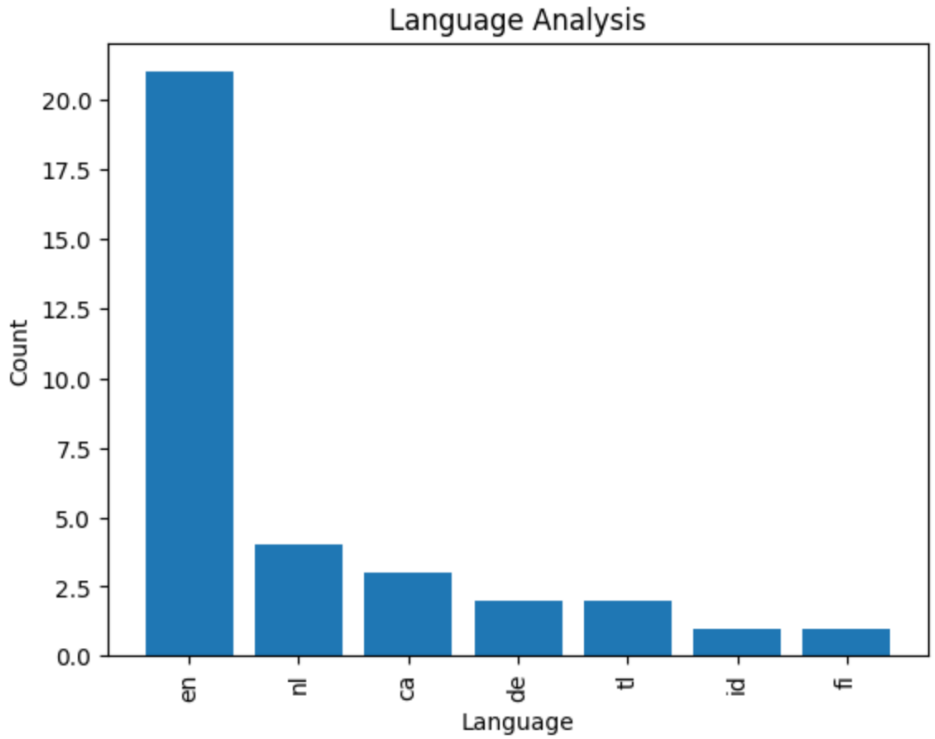
A similar pattern emerged for Anvi Sen, the user who exclusively listened to non-English songs. Despite this, most of the recommended tracks were in English, highlighting a clear bias in Spotify's recommendation algorithm towards English-language content, even when the listening behaviour focused on non-English music.

This clearly indicates that most of the recommended songs were in English, despite the user's exclusive focus on non-English music, revealing a significant bias in the recommendation algorithm.

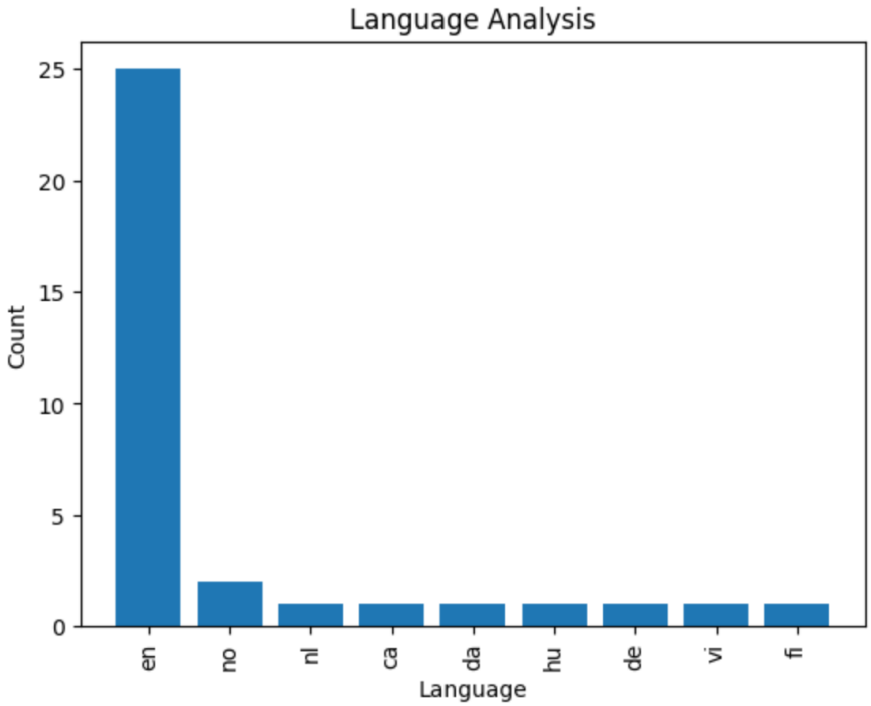
3.2 METTE HANSEN

Same was done for the user, Mette Hansen, who exclusively listened to English songs.

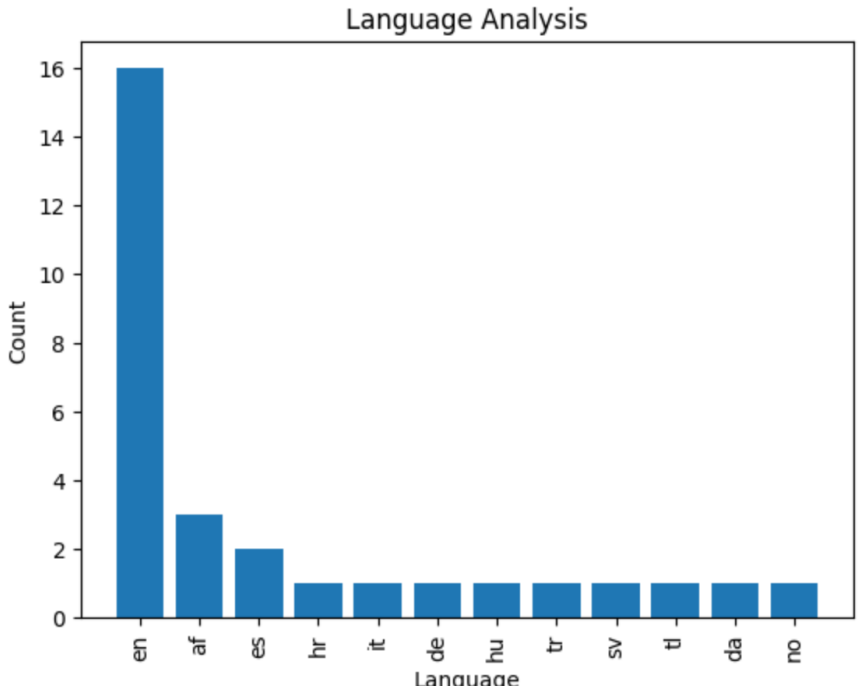
Recommendations from the first day:



Recommendations from the third day:

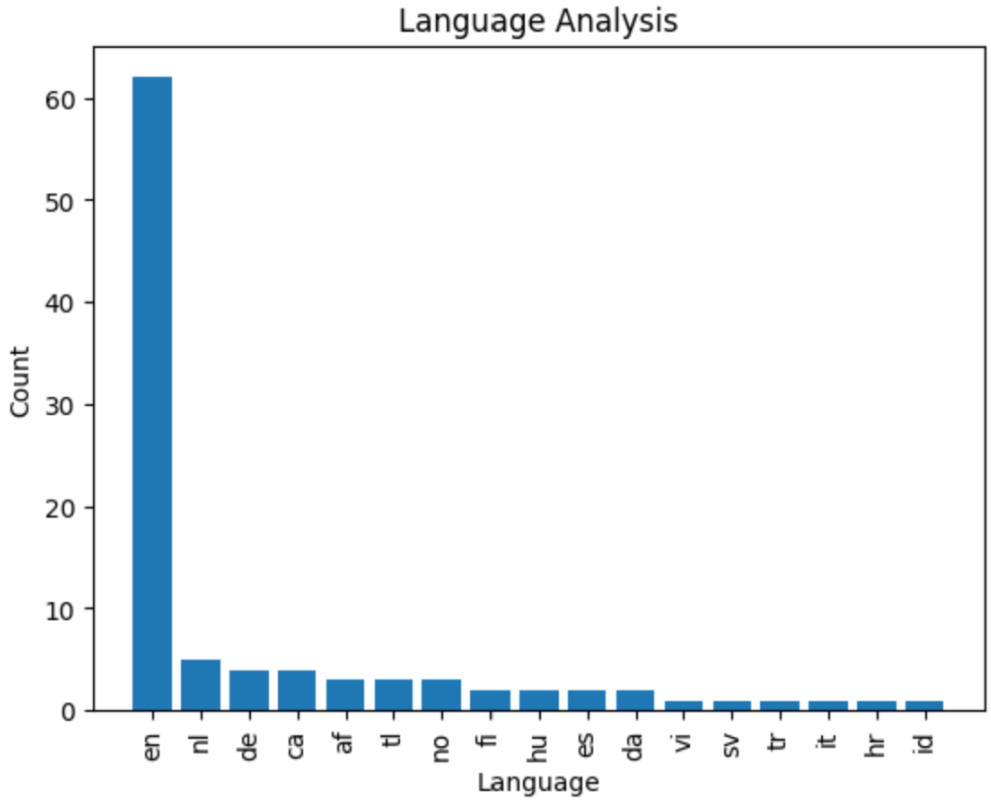


Recommendation based on fifth day:



The results here are not surprising. Mette, who exclusively listened to English songs also received predominantly English recommendations. Initially, the number of English tracks was high, dropping from 25 on the third day to the 16 on the fifth day, which is somewhat unexpected. Additionally, it is

notable that a few songs were detected as Afrikaans, indicating some diversity beyond European languages. The same pattern in observed in the overall distribution of recommended songs.



4.0 CONCLUSION AND FINAL REFLECTIONS

While this small experiment revealed some patterns in Spotity's recommender system, several pitfalls may have significantly influenced the results. One major limitation is that both users were based in the UK, which introduced a bias. This was evident in the number of recommended playlists focused on UK top charts, even for non-English tracks. Using a VPN for one of the users could have mitigated this geographic bias.

Another issue lies in the Python library, langdetect, used for language detection. As a recently adopted tool, it may have biases of its own, particularly favoring English and European languages over languages like Hindi, Arabic, and Spanish. This could have skewed the results, as the software might not perform as well with non-European languages. More reliable conclusions will have to wait until Spotify provides direct language data for tracks.

The time frame of the experiment is also a limitation. While Spotify is quick to adjust its algorithm the few days of data collection may not have been enough time for the system to fully personlise recommendations. For comparison, personal accounts used over several months or years still show

occasional inaccuracies in recommendations. A longer period of data collection would likely provide more robust results.

The final Daily Drive playlist analysed still features a high number of English songs, despite one user excluselive listening to non-English tracks. This contrasts with the varied language distribution observed when analysing audio features through Spotify's API. This discrepancy underscores the complexity of language biases in the recommendation system.

In conclusion, the experiment suggests a clear bias toward English-language music in Spotify's recommendations, despite the user's listening behaviour or preferences.

5.0 REFERENCES

Pastrukhov, Dmitry, 2022. Inside Spotify's Recommender System: A Complete Guide to Spotify Recommendation Algorithms. Retrieved June 14 from (https://www.music-tomorrow.com/blog/how-spotify-recommendation-system-works-a-complete-guide-2022)