Case Study: Artificial Intelligence in Spotify

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Background

Today, Spotify is the most popular audio streaming service with 350 million users and 150 million subscribers (Garrett, 2024). Spotify was founded in 2006 by Daniel Ek and Martin Lorenzo and offered users access to a vast digital library of music during a time when people traditionally bought individual songs and albums (van de Haar, 2019). It was this unique value proposition that propelled Spotify to the top of the market of music streaming. But more importantly, Spotify transformed from a simple on–demand music streaming service to a company that offered a hyper-personalized music listening experience. It was this transformation that began around 2014 and their unwavering commitment to creating the best user experience that cemented their top position in the music streaming market (van de Haar, 2019).

At the core of this transformation was artificial intelligence as they used it to deeply understand the user's listening habits. Today's Spotify is defined by its integration of AI with its service. This case study will discuss the timeline of Spotify's AI transformation, the effects of AI, as well as implications for the future.

AI In Spotify

Acquisition of Echo Nest

The first instance of Spotify's shift to utilizing AI occurred in 2014 with its acquisition of machine learning company Echo Nest (van de Haar, 2019). Echo Nest was integral in laying the foundation for Spotify's music recommendation algorithm as they worked on predicting user's music preferences. This technology allowed Spotify to categorize the music that users listen to and in turn create taste profiles to represent users' listening habits. AI was still working in the background at this stage, until 2015, where AI music recommendation started to become highlighted in Spotify's user experience.

Introduction of Discover Weekly

The next development of AI was the introduction of Discover Weekly in 2015 which is a feature where Spotify curates a playlist every week for the user based on the user's listening habits. The marketing around Discover Weekly and its upfront position on the front page demonstrated that Spotify was actively pushing for a more individualized experience. Discover Weekly reaffirmed Spotify's commitment to changing the way people listen to music, but it also signified the company using AI to retain its competitive advantage and solidify its place as the number one streaming service (Pasick, 2015; van de Haar, 2019). According to one Spotify user, Kiana McBride, "Discover Weekly is often fire. Spotify has such good data analytics, it can tell what

music I'm likely to enjoy" (Pau, 2021). To many users, Spotify's music recommendation is the unique value proposition that keeps them hooked to the app. But what exactly is Spotify doing behind the scenes to recommend music to its users?

Technology Behind Spotify's Music Recommendation and Discovery

This section will briefly cover the main components of Spotify's AI framework. Covering the mathematical intricacies behind the algorithms goes beyond the scope of this case study.

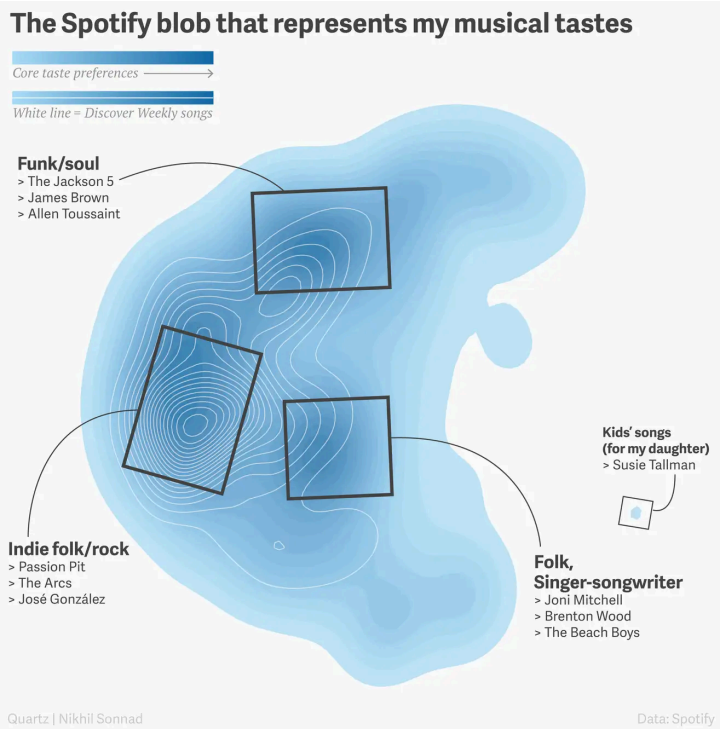
Data Collection

The main machine learning algorithm used to power Spotify's music recommendation system is Bandits for Recommendations as Treatments (BaRT) (Aoun et al., 2022). BaRT helps Spotify curate the home screen with personalized recommendations, such as the Discover Weekly playlist, keeping the user engaged while also "balancing exploitation and exploration" (Aoun et al., 2022). To emphasize, BaRT powered Spotify's shift with their unique value proposition to satisfy their customers with personalized services. Broadly, this algorithm can be broken down into a few steps: data collection, segmentation and categorization, and finally targeting and recommendation.

Spotify collects an extensive amount of data from song information—like genre and tempo—to user behaviors such as skipped songs and listening history (Aoun et al., 2022). Research has shown that data concerning the user is analyzed on both the macro and micro levels (Hanlon, 2019; van de haar, 2019). For example, the algorithm looks at the geographics and demographics of the user but also a user's social interactions and listening habits and much more. This only scratches the surface, but the point is that Spotify collects a vast amount of qualitative and quantitative data for each user. While the individual user's data alone is powerful, the true power of the data is harnessed when Spotify channels the individual data into collaborative models where users are compared to each other.

Categorization of Data

After collecting data, the next step is to segment and categorize the data. First, Spotify categorizes the songs. Audio models and natural language processing are used to analyze the sonic data from songs and identify genres, artists, and titles (van de Haar, 2019). Then via a collaborative filtering process, Spotify can link users to songs based on data from other users with similar profiles and create a map of clusters representing different categories of music (Torabi, 2023).



Spotify's musical map (Pasic, 2015)

Essentially, if a pattern emerges where users with comparable music tastes to an individual enjoy a particular song, it's highly probable that the individual will also like that same song. Furthermore, the model organizes tracks in the map such that its proximity to other songs relates to its similarity to those songs. So, given two songs that are frequently "listened to in sequence are placed close to each other on the map" (Torabi, 2023). If multiple tracks are observed to be paired with each other in playlists, then clustering will emerge, which helps with the last step of the recommendation process.

Targeting and Recommendation

At this stage, most of the work that goes into recommending music has already been done through the segmentation process. The next step is to target songs to recommend to the user based on the collaborative models. Songs are selected from the model that match the criteria of the specific curated playlist.

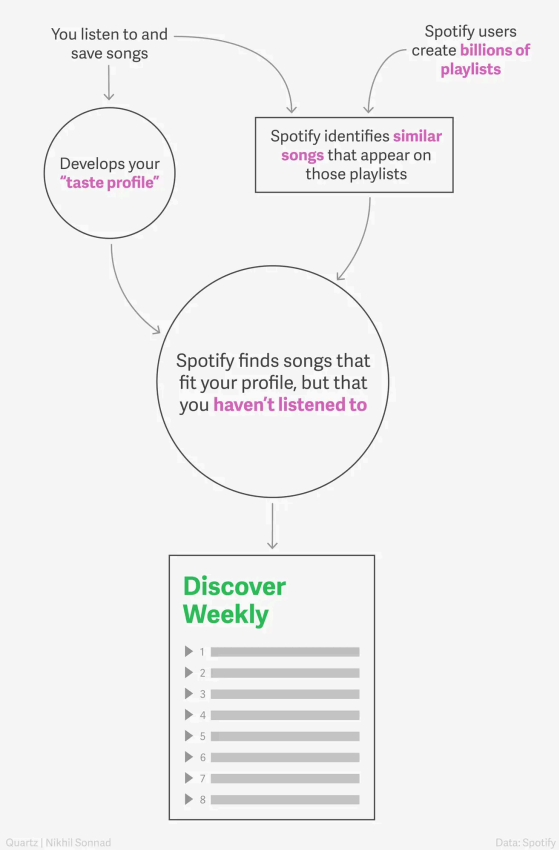


Diagram of music recommendation (Pasick, 2015)

In context, to choose songs that appear in a user's Discover Weekly playlist, the algorithm would pick songs that the user has never heard within the clusters of the model (Torabi, 2023). An analogous situation in everyday life is when you get a music suggestion from a friend who knows your musical preferences.

Spotify's implementation of AI in its music recommendation system has proven to work, increasing user engagement and retainment. While Spotify often succeeds in recommending new music that users find out they enjoy, it is then important to consider the ethical implications; BaRT directly impacts which artists and genres are promoted to users.

Ethical Issues in AI Music Recommendation

Bias in Machine Learning

As with any use case of AI, it is important to look at the ethical concerns. In Spotify's case, its recommendation system is powered by machine learning, which is inherently unfair.

For starters, even if the data that Spotify collects seems completely fair and free of bias, reports have shown that AI itself is “encoded with bias” and has been proven to discriminate (Pau, 2021). Moritz Hardt, a machine learning researcher at UC Berkeley, argues that machine learning algorithms can be unfair even if the training data is unbiased. In recommendation systems, machine learning is used to optimize the accuracy of the predictions. And the more data points there are to analyze the more accurate the system is. However, Hardt argues this is a problem: "There is always proportionately less data available about minorities. This means that our models about minorities generally tend to be worse than those about the general population” (Hardt, 2014). This underscores the broader theme: that data inherently acts as a social mirror (Hardt, 2014). If social biases against a minority group exist, they will be reflected in the training data, leading machine learning algorithms to incorporate these biases as well.

Spotify exemplifies Hardt’s argument. Due to the algorithm’s reliance on user data, it can potentially reinforce social biases (Aoun et al., 2022); this can happen in multiple ways. Firstly, if a user mostly listens to music made by white artists, then the algorithm could reinforce this behavior and may only suggest music by white artists (Aoun et al., 2022). Secondly, the algorithm can perpetuate structural biases inherent in certain genres like country music which is dominated by white male artists. In 2019, country music artist Martina McBride said that her country music playlist on Spotify mostly suggested male artists (Kruh, 2019). While this is a reflection of the genre itself, a capacity for more diverse suggestions should be explored. Spotify did address these concerns by enabling users with more control over suggested content, allowing them to like and dislike songs recommended to them (Aoun et al., 2022).

Musical Diversity and the Core Ethical Predicament

Hardt’s argument on the fairness of machine learning and the concerns of Martina McBride highlights a greater ethical issue: musical diversity. Going back to the musical map and collaborative filtering approach, there are inherently more data points representing the majority group, therefore, the algorithm tends to promote music from the majority in efforts to increase the likelihood that the user is satisfied with the recommendation. This is the intrinsic bias in machine learning recommendation systems like Spotify’s. But this undermines the diversity of music that users are recommended. Ultimately, Spotify faces the dilemma of utilizing BaRT to boost user engagement but perpetuate the homogeneity of music, or reducing the reliance on BaRT to promote diversity but potentially at the expense of user engagement.

This ethical dilemma has been described by student researchers as balancing exploitation and exploration (Aoun et al., 2022). But, Spotify has also recognized this issue internally. A study, led by a team of Spotify employees and computer science researchers, dove into the algorithmic effects on the diversity of music consumption. Early on in the findings, they observed that when users begin to listen to more diverse

music, “they do so by shifting away from algorithmic consumption and increasing their organic consumption” (Anderson et al. 2020). The study dove deeper into the evolution of content diversity as well as classifications of users based on their music consumption. But the results of the study culminated to one central predicament:

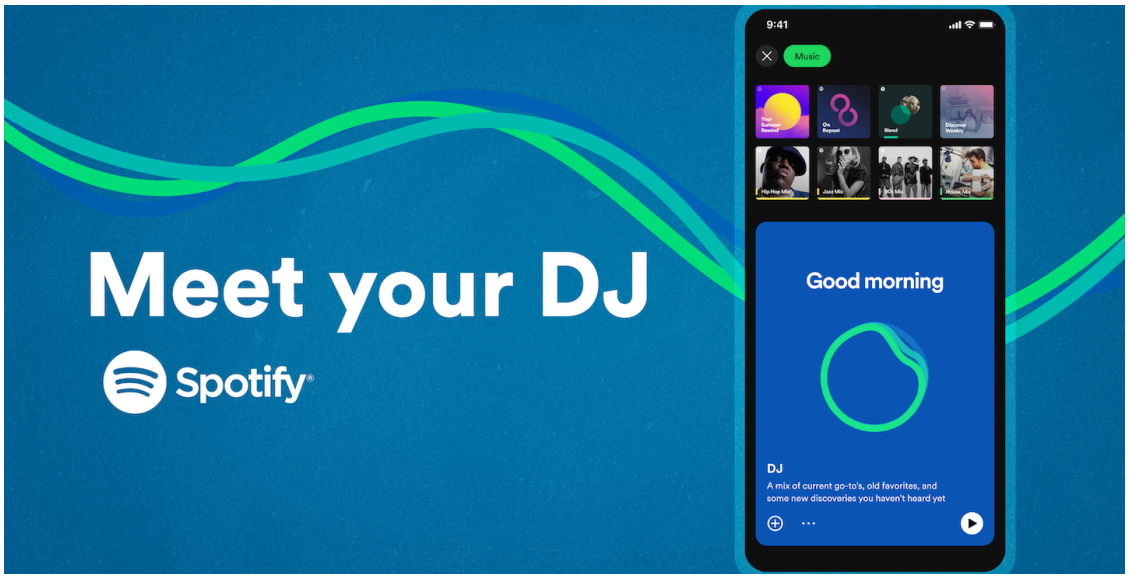
> “how do we design online platforms that cater to pressing and specific user needs, but that also allow users to fully explore the world of content available to them? This is a tension between short- and long-term goals: if we need to recommend content urgently, a good strategy is to promote relevance (and thus discourage diversity), but if we want to attract and retain users, ensuring that consumption is sufficiently diverse appears important. The challenge going forward will be to develop methods and algorithms that can simultaneously deal with these conflicting incentives” (Anderson et al., 2020)

What we see is that the ethical quandary in Spotify’s AI recommendation system can be traced to its shift to utilizing AI in 2014. Spotify pivoted to maximizing user engagement and satisfying user needs at scale, but this is where the moral dilemma emerges. We see that it’s not so much the ethics of the technology itself but the underlying motives by which it’s being used. The ethical framework of Spotify is closely connected to the overarching business strategy of maximizing user engagement, but this inadvertently affects the diversity of users’ music consumption at large.

Spotify’s Stance on AI and the Future

As AI continues to advance rapidly, Spotify too looks ahead to implementing new AI technologies while carefully navigating ethical issues. On the topic of AI-generated music, Spotify’s CEO, Daniel Ek, emphasizes ethical use but wants to avoid a complete ban (Multiplatform.AI, 2023). AI-generated music is a contentious issue, but Ek is ensuring that Spotify’s content cannot be used for abusive forms of AI-generated music: "While AI-generated content isn’t banned in all forms on Spotify, the company does not permit its content to be used for training machine learning or AI models, which could then produce music” (Multiplatform.AI, 2023).

Spotify will continue to develop its music recommendation experience with AI, continuing to focus on strengthening the relationship between the consumer and the brand. Spotify will achieve this by humanizing the platform and personalizing the service further (van de Haar, 2019). One avenue that Spotify has already been exploring is generative AI and voice synthesis with the introduction of Spotify DJ in 2023 (Torabi, 2023).



(Spotify, 2023)

The AI DJ extends the BaRT recommendation system interacting with the user in a “human-like manner”, providing insights to music recommendations, and implementing reinforcement learning by interacting with the user (Torabi, 2023).

Conclusion

Spotify’s success can be attributed to its quick shift to AI in 2014, creating a personalized experience that attracted users and kept them engaged with the platform. BaRT proved that AI is a powerful tool to help users discover new music that they enjoy. And this is true in the broader scope: AI has the power to enhance humans and serve as a valuable tool. However, in many cases, there are unexpected consequences that arise and factors that must be taken into consideration when innovating these new technologies. In Spotify’s case, they should continue examining the effects of past AI technologies and incorporate ethical perspectives as they expand their AI capabilities.

References

Anderson, A., Maystre, L., Mehrotra, R., Anderson, I., & Lalmas, M. (2023). Algorithmic Effects on the Diversity of Consumption on Spotify. www.cs.toronto.edu/~ashton/pubs/alg-effects-spotify-www2020.pdf.

Aoun, N., Currie, C., Harrington, A., & Wardrop, C. (2022). Discover Weekly: How the Music Platform Spotify Collects and Uses Your Data. MAIEI. montrealethics.ai/discover-weekly-how-the-music-platform-spotify-collects-and-uses-your-data/.

Garrett, U. (2024). Best music streaming services in 2024. CNN Underscored. edition.cnn.com/cnn-underscored/reviews/best-music-streaming-service.

Hanlon, A. (2019). The Segmentation, Targeting and Positioning Model. Smart Insights. www.smartinsights.com/digital-marketing-strategy/customer-segmentation-targeting/segmentation-targeting-and-positioning/.

Hardt, M., (2014). How big data is unfair. Medium. medium.com/@mrtz/how-big-data-is-unfair-9aa544d739de.

Kruh, N., (2019). MARTINA MCBRIDE STIRS BATTLE WITH SPOTIFY OVER GENDER IMBALANCE: 'I'M FRUSTRATED FOR MY SISTERS'. People. www.martinamcbride.com/martina-mcbride-stirs-battle-with-spotify-over-gender-imbalance-im-frustrated-for-my-sisters.

Multiplatform.AI. (2023). Spotify Commits to Embracing AI in Music But With Boundaries. Medium. medium.com/@multiplatform.ai/spotify-commits-to-embracing-ai-in-music-but-with-boundaries-596333a7fb50.

Pasick, A. (2015). The Magic That makes Spotify's Discover Weekly Playlists So Damn Good. Quartz. qz.com/571007/the-magic-that-makesspotifys-discover-weekly-playlists-so-damngood/.

Pau, K. (2021). Spotify Wrapped, unwrapped. Vox. www.vox.com/culture/22814121/spotify-wrapped-2021-algorithm-data-privacy.

Spotify. (2023). Spotify Debuts a New AI DJ, Right in Your Pocket. For the Record. newsroom.spotify.com/2023-02-22/spotify-debuts-a-new-ai-dj-right-in-your-pocket/.

Torabi, N., (2023). The Inner Workings of Spotify's AI-Powered Music Recommendations: How Spotify Shapes Your Playlist. Medium. neemz.medium.com/the-inner-workings-of-spotifys-ai-powered-music-recommendations-how-spotify-shapes-your-playlist-a10a9148ee8d.

van de Haar, I., Doshoris, I., & Broberg, C. (2019). How Artificial Intelligence is changing The Relationship between The Consumer and Brand in The Music Industry. lup.lub.lu.se/luur/download?func=downloadFile&recordOId=9007033&fileOId=900709.