Thesis Project Portfolio

Tempo: Development of an iOS App and Interactive Bluetooth Speaker System for Personalized Music Recommendations and Social Engagement

(Technical Report)

Bias and Diversity in AI-Based Music Recommendation Systems: Addressing Algorithmic Reinforcement and Cultural Homogeneity

(STS Research Paper)

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Michelle Monge

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Department of Electrical Engineering

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In today's digital age of music, the personalization of user content continues to grow, notably through the increasing use of Artificial Intelligence (AI). AI recommendation systems present users with a dual reality: the convenience of tailored content alongside the consequence of isolation within narrowed, overly filtered content. Thus, it is crucial to examine how technical innovation and social dynamics reciprocally shape one another and assess the broader implications to properly understand the system at hand. This thesis portfolio critically explores how personalized, AI-based recommendations influence user behavior and consumption of music through both technical and STS perspectives.

The technical project focused on creating an integrated system combining an iPhone Operating System (iOS) application with a Bluetooth speaker. The overall goal being to elevate user experiences with merging personalized music recommendations with fun, social features. The app is posed as an enhancement compared to Spotify, with the primary goals centering around creating an innovative platform that further eases music discovery, increases social connections within music, and offers an overall elevated, engaging user experience. The Tempo app utilizes Spotify's Web Application Programming Interface (API) to access extensive music libraries, and uses OpenAI's Generative Pre-trained Transformer (GPT) for generating recommendations. The application provides several key features such as personalized music streaming based on user prompts, calculated musical compatibility scores among friends via the Compatibility Web, and insights into the user's top genres and most frequently played songs organized by year, month, and week. The Bluetooth speaker was designed to complement the app by delivering high-quality audio playback, allowing on-device volume control, and providing visualization of relevant app activity through a built-in Liquid Crystal Display (LCD). Overall, emphasis on user ease of use, engagement, audio fidelity, and compliance with regulatory standards guided the

project's development in hopes of creating an interactive and modern music-listening experience. At the end of development, we created a synced app and speaker which worked effectively in generating a stream of 20 recommended songs based on prompts, all compatibility features worked on mock user data, volume controls of the speaker worked along with the LCD screen. The only aspect in which we fell short was syncing relevant app features on the screen as we were only able to display the logo due to various issues in ordering parts on time. Overall, we were satisfied with our product given our short 16 week time frame.

The STS research section offers a critical analysis of the broader socio-technical consequences associated with the increasing use of personalized algorithms in music streaming platforms. This research specifically examines Spotify's AI-driven music recommendation system, highlighting how the algorithm inadvertently reinforces cultural biases and promotes a cultural homogeneity within music. As Spotify's AI features are a recent advancement with limited public information, choosing the most relevant and informative sources became crucial. Utilizing comprehensive literature reviews, empirical studies, and a field experiment, the analysis demonstrates that while personalized recommendations significantly boost user engagement, it simultaneously reduces individual-level musical diversity. The current research conclusively identifies an engagement-diversity trade-off, where algorithmically personalized content increases short-term user satisfaction at the expense of long-term exposure to diverse content. Ethical concerns such as algorithmic bias, lack of transparency, and reduced user autonomy are also discussed, highlighting that the ethical implications of this technology cannot be ignored.

Together, these projects contribute to ongoing discussions about the socio-technical implications of advancing AI technologies. The technical work practically demonstrates the potential benefits provided by algorithmically-driven personalized music experiences, offering improvements in

user engagement and interactive social experiences. Conversely, the STS analysis emphasizes the importance of critically evaluating the ethical implications of algorithmic personalization, particularly the tension between corporate profitability and the promotion of musical diversity. As current research and results were limited, future research should explore further into how these algorithms work to the point where the system is no longer a black box. In this context, the term black box refers to an algorithm whose internal workings and decision making process are often opaque and hard to understand, even by developers. First, future studies can analyze and explain how changing algorithmic parameters can impact diversity of recommended content across users. In this scenario, effectively changing these algorithms may be a case of trial and error until there is a noticeable difference seen by multiple actors. Second, research can look further into the role of increasing user controls and if public opinion of AI shifts because of it. Looking back, the current research is sufficient in emphasizing that there are bias and over-filtering issues within Spotify's algorithm as to date, however more research needs to be done to understand how exactly the AI is producing its outcomes. These findings stress the necessity of continued active discussion in shaping the future trajectory of AI-driven personalization technologies.