From Music Popularity Prediction to Dynamic Promotion Optimization: An Explainable and Transformer AI Framework for Spotify Marketing

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Abstract

Artificial intelligence (AI) is transforming the digital music industry, fundamentally changing how music is created, distributed, promoted, and consumed. Streaming platforms such as Spotify have evolved into sophisticated digital marketing ecosystems where algorithmic recommendations, personalized playlists, and promotional campaigns influence music discovery and listener engagement. Understanding how to optimize promotional strategies has become increasingly important for artists, record labels, and music marketers.

Our previous research investigated the determinants of music popularity using machine learning and Explainable AI (XAI). Analyzing 232,442 Spotify songs, we employed Random Forest, SHAP, LIME, and Bayesian optimization to identify influential musical attributes and develop strategies for optimizing song characteristics. Building upon this foundation, the present research shifts the focus from music content optimization to dynamic music promotion optimization.

The central research question is: How can AI identify and optimize the timing, combinations, and sequences of promotional activities to maximize listener engagement and long-term music performance? Specifically, we investigate the effectiveness of Spotify promotional mechanisms, including Discovery Mode, Marquee, Showcase, and playlist pitching, and examine how their effects vary across artists, songs, audiences, and release stages. We conceptualize music promotion as a dynamic process:

Promotion Strategies → Music Exposure → Listener Engagement → Active Listening → Long-Term Fan Development.

The empirical research utilizes a newly constructed longitudinal dataset obtained through Soundcharts, comprising 50 artists, 100 songs, and 5,262 track-week observations over approximately one year. The dataset includes weekly streaming performance, historical performance, and playlist exposure measures, including editorial and user-generated playlist counts and reach. Additional Spotify for Artists and campaign-level data are being explored to capture promotional activities, campaign timing, expenditure, and audience conversion.

Methodologically, the research proposes an integrated framework combining traditional machine learning, temporal Transformer AI, Explainable AI, and dynamic optimization. While conventional machine-learning models identify important predictors of music performance,

Transformer models can capture temporal dependencies and interactions among promotional activities. This enables an investigation of how promotional timing, duration, and sequences influence subsequent streaming performance. Explainable AI methods will identify influential variables and time periods, while optimization techniques will explore effective promotional strategies under budget constraints. Econometric methods will complement these approaches when suitable campaign data permit causal analysis.

Preliminary research has established the feasibility of constructing a multi-artist longitudinal dataset linking playlist exposure with streaming performance. The next phase will evaluate predictive performance and investigate promotional effects as additional campaign-level data become available.

This research contributes to marketing theory by extending music popularity prediction into dynamic promotional decision-making. Methodologically, it explores the integration of Transformer AI and Explainable AI for understanding sequential marketing processes. Managerially, it aims to help artists, record labels, and streaming platforms allocate promotional resources more effectively, enhance listener engagement, and develop sustainable audiences.

Ultimately, the research advances a broader transition from predicting music popularity to AI-driven optimization of music promotion and long-term customer relationships, with implications extending beyond music streaming to digital platform marketing.

Keywords: Spotify; Digital Music Marketing; Artificial Intelligence; Transformer AI; Explainable AI; Dynamic Promotion Optimization; Listener Engagement; Marketing Analytics.