A BROADCAST MODEL OF SPREAD OF DIGITAL MUSIC COMPOSITION AMONG ARTIFICIAL AUDIENCE

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A BROADCAST MODEL OF SPREAD OF DIGITAL MUSIC COMPOSITION AMONG ARTIFICIAL AUDIENCE

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ABSTRACT

A BROADCAST MODEL OF SPREAD OF DIGITAL MUSIC COMPOSITION AMONG ARTIFICIAL AUDIENCE

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This thesis explores a novel paradigm in the realm of digital music composition, presenting a comprehensive model that simulates the intricate social dynamics between composers, broadcasters, and artificial audiences. Employing advanced machine learning algorithms, the study investigates the evolution of compositions in a dynamic ecosystem where composers continually adapt their styles based on feedback from an artificial audience. Composers, acting as content creators, generate a diverse array of musical compositions. Broadcasters play a pivotal role by selecting and disseminating compositions. The artificial audience, designed to mimic human preferences, influences the trajectory of compositions through their collective feedback. As compositions circulate within this network, composers receive real-time data on audience preferences, prompting them to refine and tailor their artistic expressions. This research contributes to our understanding of the emergent social dynamics in the digital music landscape, shedding light on the interplay between creators, broadcasters, and audiences. By employing a broadcast model, this thesis not only explores the dissemination of digital music but also elucidates how artificial audiences and broadcast mediums shape and influence the evolution of artistic creations in the digital era.

Keywords: digital music composition, artificial audience, broadcast model, machine learning algorithms, compositional evolution

ÖZ

DİJİTAL MÜZİK KOMPOZİSYONUNUN YAPAY DİNLEYİCİLER ARASINDAKİ YAYILIM MODELİ

Karabıyık, Emre
Yüksek Lisans, Bilişsel Bilimler Bölümü
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Bu tez, dijital müzik kompozisyonu alanında yeni bir paradigmayı araştırıyor ve besteciler, yayıncılar ve yapay dinleyiciler arasındaki karmaşık sosyal dinamikleri simüle eden kapsamlı bir model sunuyor. Gelişmiş makine öğrenimi algoritmaları kullanan çalışma, bestecilerin yapay dinleyicilerden gelen geri bildirimlere dayanarak stillerini sürekli olarak uyarladıkları dinamik bir ekosistemde bestelerin evrimini araştırıyor. İçerik yaratıcısı olarak hareket eden besteciler çok çeşitli müzik besteleri üretiyorlar. Yayıncılar, besteciler tarafından kompozisyonları seçip yayarak çok önemli bir rol oynuyorlar. İnsan tercihlerini taklit etmek için tasarlanan yapay dinleyiciler, kolektif geri bildirimleri yoluyla kompozisyonların gidişatını etkiliyor. Besteler bu ağ içinde dolaşırken, besteciler dinleyicilerin tercihlerine ilişkin gerçek zamanlı veriler alıyor ve bu da onları sanatsal ifadelerini iyileştirmeye ve uyarlamaya teşvik ediyor. Bu araştırma, yaratıcılar, yayıncılar ve dinleyiciler arasındaki etkileşime ışık tutarak dijital müzik ortamında ortaya çıkan sosyal dinamikleri anlamamıza katkıda bulunuyor. Bu tez, bir yayın modeli kullanarak yalnızca dijital müziğin yayılmasını araştırmakla kalmıyor, aynı zamanda yapay dinleyicilerin ve yayıncıların dijital çağda sanatsal yaratımların evrimini nasıl şekillendirdiğini ve etkilediğini de açıklıyor.

Anahtar Kelimeler: dijital müzik kompozisyonu, yapay dinleyiciler, yayın modeli, makine öğrenme algoritmaları, kompozisyonel evrim

Anneannem’e

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CHAPTER 1

INTRODUCTION

In the evolving landscape of digital music, the dynamics of creation, distribution, and consumption are continually reshaped by advancements in technology (11). This thesis presents a novel broadcast model that simulates the complex interplay between composers, broadcasters, and listeners within a digital environment. The study employs machine learning algorithms to venture beyond traditional studies which are related to the spread of music among audiences by introducing a computerized model where artificial audiences actively influence the music creation process through dynamic feedback mechanisms. This innovative approach not only provides insight on potential pathways for the evolution of digital music but also, it explores how broadcast mediums can fundamentally alter the production, reception and consumption of artistic content.

The advent of digital music has both revolutionized music production and dissemination and also introduced a plethora of challenges and opportunities for artists and the collaborators of the industry(2). This thesis investigates the significant impact of broadcast mediums on music trends, audience engagement, and preferences with the help of integration of advanced technologies of machine learning into a broadcasting model. The model simulates a digital ecosystem where artificial broadcasters and audiences interact with artificial music composers. The simulation offers a unique lens through which to examine how broadcast channels influence creative processes and market dynamics in the music industry. This exploration aims to highlight the transformative role of broadcasting in shaping listener habits and composition trend that are being adopted by music composers.

Moreover, the influence of broadcast mediums extends to the cultural fabric of music consumption. It reshapes how communities engage with music. As broadcasters adopt increasingly sophisticated algorithms to curate and recommend music, they are able to influence existing audience preferences and shape future musical tastes. This dynamic can lead to both the reinforcement of popular trends and the emergence of niche genres, making broadcasters pivotal in the music ecosystem (16). This study delves into how these changes might affect not just consumption patterns but also the creative strategies of artists, who adjust their creations in response to the feedback loop governed by broadcast mediums based on their audiences' preferences.

1.1 Background and Context

The digital music industry has undergone tremendous transformations over the past few decades, evolving from physical media formats to digital streaming platforms that offer vast libraries of accessible content at the click of a button. In this digital age, music consumption has become more personalized and data-driven, thanks to algorithms that recommend content based on listener preferences (7). However, the role of audience preferences in effecting the compositional style of the music composers in this scenario often remains static and unexplored, particularly in how they adapt to and evolve with changing audience tastes and broadcasting options.

1.2 Research Gap

Existing literature has extensively documented the algorithms behind music recommendation systems and the computational models for music generation. In the field of music cognition, earlier generative and combinatory theories (such as Schenkerian Analysis, the Generative Theory of Tonal Music, and Combinatory Categorial Grammars) primarily focused on explaining well-structured musical pieces within tonal culture but there is a need for a convenient study on some other social facets of music cognition as Öztürel and Bozşahin discusses. There is a notable gap in understanding how these elements interact within a broader ecosystem that includes real-time feedback from listeners. Most studies isolate the creative process from the reception process, without considering the continuous loop of feedback that could influence ongoing musical composition and broadcasting strategies. This thesis proposes a model that synthesizes these elements and it creates a more holistic view of the social music landscape.

1.3 Thesis Objectives

The objectives of this thesis are designed to address these gaps by:

1. Creating a computational model that encapsulates the interactions between composers, broadcasters, and artificial audiences.

2. Analyzing how the feedback from artificial audiences affects the evolution of musical compositions over time.

3. Evaluating the influence of broadcasters in curating and shaping the distribution of music.

4. Examining the broader implications of these interactions for understanding the future of digital music distribution and artistic creation.

1.4 Structure of the Thesis

This thesis is structured to methodically explore the integration of composers, broadcasters, and audiences within a digital music broadcast model:

- **Chapter 1: Introduction** - Provides an overview of the research landscape, outlining the motivation, objectives, and significance of the study.
- **Chapter 2: Literature Review** - Reviews existing studies on digital music distribution, artificial intelligence applications in music, and the roles of feedback in creative industries.
- **Chapter 3: Theoretical Framework** - Discusses the theoretical underpinnings and foundational concepts that guide the development of the simulation model.
- **Chapter 4: Methodology** - Details the design and implementation of the simulation model, explaining the computational algorithms and the setup of the artificial audience's feedback mechanism.
- **Chapter 5: Results and Analysis** - Presents the empirical findings from the simulation, providing detailed analyses of how variables influence the evolution of music within the model.
- **Chapter 6: Discussion** - Interprets the results within the context of the broader music industry, discussing the implications for composers, broadcasters, and audience engagement.
- **Chapter 7: Conclusion and Recommendations** - Summarizes the key insights and contributions of the study, emphasizing the impact of AI on music distribution and creation. Also offers recommendations for future research, potential enhancements to the model, and practical applications for stakeholders in the music industry.

1.5 Significance

This research contributes significantly to our understanding of the potential music broadcasting medium futures by illustrating how broadcasters can transform and influence artistic creation and audience interaction. By exploring the interactive dynamics between all parties involved in the music distribution process, this thesis provides a comprehensive look at the dynamics of how music spread among audiences and it offers insight on the possible new directions for music consumption and production (3; 14).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to the Digital Music Landscape

The music industry has gone through a radical transformation as a result of the adoption of digital technologies (9). This study delves into the multifaceted role of online platforms, streaming services, and the emergence of artificial intelligence in reshaping music creation, distribution, and consumption. It explores how these innovations converge within a broadcast model that encapsulates the dynamic interrelations among composers, broadcasters, and an artificial audience.

2.2 Transformation of Music Dissemination

Historically, music dissemination was controlled by a limited number of gatekeepers, such as record labels and radio stations. However, the digital revolution has dramatically altered this landscape. As Kusek and Leonhard (8) argue, the age of digitization has made music production and promotion more accessible, that allows musicians to get beyond conventional boundaries and connect with audiences directly. As a result, lots of new broadcasting mediums emerged. This shift has given rise to a "prosumer" culture, a term popularized by Toffler (17), where consumers are also producers, engaging actively in the creation and dissemination of content.

2.3 Role of Online Platforms and Streaming Services

How people access, share, and monetize music is significantly influenced by online platforms and streaming services which became central to music distribution. As noted by Aguiar and Waldfogel (1), streaming services like Spotify and Apple Music have changed the economic landscape of the music industry, affecting everything from copyright to consumer behavior. These platforms optimize user experiences with the implementation of advanced recommendation algorithms that influence listening habits and musical discovery.

2.4 The Broadcast Model in Digital Music

This thesis introduces a broadcast model that conceptualizes the role of broadcasters within this digital ecosystem. Drawing on the works of Lysloff (10) and Prey (13), this model simulates how broadcasters select and promote musical compositions, influencing their reach and reception among audiences. By integrating insights from studies on media influence and technology adoption (15), the model provides a framework for understanding the strategic decisions made by digital broadcasters in curating and positioning musical content.

2.5 Artificial Intelligence and Music Creation

The application of artificial intelligence in music composition represents a groundbreaking shift. Research by Briot et al. (4) demonstrates how AI can not only generate new musical pieces but also emulate specific styles and genres. Also, as demonstrated in the study of Öztürel and Bozşahin, machine learning can also be used to simulate an adaptive behavior towards learning from listener feedback by artificial composers in artificial music composition. This thesis expands on these findings by incorporating an artificial audience—equipped with AI algorithms that simulate human musical preferences—into the broadcast model. This innovative approach allows for an exploration of how real-time feedback from this audience can steer composers' creative processes.

2.6 The Evolving Role of Digital Audiences

The role of audiences in the digital age extends beyond passive consumption. As Burgess and Green (5) discuss, digital platforms enable audiences to participate actively in the curation and dissemination of content. This thesis builds upon such insights by examining how an artificial audience, designed to mimic human engagement patterns, impacts the musical creation process. By providing continuous feedback, this artificial audience plays a critical role in shaping the evolution of musical compositions within the simulated ecosystem.

2.7 Conclusion

The interplay between digital technology, creative processes, and audience engagement forms the core of this thesis. By employing a broadcast model that integrates these elements, the research aims to illuminate the complex dynamics of digital music composition, consumption and distribution. This literature review sets the stage for a deeper investigation into how digital innovations, particularly broadcasting mediums, are redefining the music industry.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 Conceptual Foundations

To comprehend the working mechanisms of digital music composition and dissemination engaged with artificial parties such as composers, broadcasters and audiences, this chapter elaborates on extensive theoretical framework that creates the basis for claims and implications of this study by enlightening the concerned concept and terms. To explain the social interactions and adaptive processes among these parties of the musical environment, a simulation model encompassing machine learning techniques is operated. As a result of driving the model by continuous feedback loops and adaptive learning mechanisms lead to this study's main aim of illustrating how digital compositions evolve within this simulated ecosystem.

3.1.1 Music Theory

Instead of following fundamental principles of western music composition and theory to structural basis for generating digital compositions, this simulation allows both composers and audience to create new musical preferences from scratch. This process includes the construction of melodies and excludes harmonic progressions, and rhythmic patterns.

For example, one of the parameters of the simulation model which we may modify is number of musical pitches and it can reflect any kind of music theory when modified, whether it is a real or imaginary music theory system. For example, 12 pitches can be used for depicting Western music, implying one semitone between every successive pitch, whereas 24 pitches can be selected for demonstrating Turkish music which uses microtones and different intervals between pitches. As a result, along with the opportunity to work on the existing music theories and kinds, the model also provides music composers a ground where they can enter realms of unexplored musical expressions with limitless possibility of microtonality and generate unique musical systems and melody patterns.

3.1.2 Artificial Intelligence and Machine Learning

Artificial Intelligence and Machine Learning techniques and probabilistic models, facilitate the simulation of learning and decision-making processes by artificial composers and audiences. These techniques enable entities within the model to adapt and evolve over time in response to feedback which enables the model to better resemble the dynamic nature of real world interactions between music composers and listeners.

3.1.3 Social Dynamics

To emulate the interaction between different stakeholders in the music industry, the model incorporates concepts and influences from social sciences. These interactions mainly focuses on the diffusion of musical trends and the influence of collective audience preferences on the popularity and evolution of musical styles.

3.2 Components of the Broadcast Model

The broadcast model operationalizes these theoretical concepts through a simulation framework that includes the following components:

- **Composers:** These are agents tasked with creating music. Each composer is equipped with a transition table that guides the probabilistic generation of melodies based on learned preferences.
- **Broadcasters:** These agents are responsible for curating and distributing the music created by composers to the audiences. They are the medium which decides which compositions are listeners will be exposed to.
- **Audiences:** Modeled as listeners, these agents evaluate the music they receive from broadcasters. Their evaluations, expressed through ratings, influence the learning processes of both composers and other listeners.

3.3 Dynamics of Adaptive Learning

In the simulation, composers and listeners update a transition table (explained in detail in "Methodology" chapter) that dictates the likelihood of moving from one musical pitch to another, essentially creating a map of musical evolution. This table is dynamically updated based on feedback, allowing for the adaptation of musical preferences over time. This process is crucial for understanding how certain patterns or trends in music can emerge and stabilize within the simulated environment.

3.4 Feedback Loop Mechanisms

A central feature of the model is the feedback loop, a cyclical process where:

1. **Creation:** Composers generate new compositions.
2. **Distribution:** Broadcasters select and distribute these compositions to audiences.
3. **Evaluation:** Audiences provide feedback in the form of ratings.
4. **Adaptation:** Feedback influences future compositions both directly, by altering composer preferences, and indirectly, by changing the landscape of popular music within the simulation.

3.5 Simulation of Social Dynamics

The simulation captures complex social interactions through the iterative processes where composers adjust their outputs based on real-time data on audience preferences. This not only simulates artistic adaptation but also allows the exploration of broader social dynamics such as the influence of popular trends and the role of media in shaping cultural landscapes.

3.6 Conclusion

This theoretical framework lays the groundwork for a deeper understanding of the interplay between creation, curation, and consumption in the digital music ecosystem. By modeling these interactions within a controlled artificial environment, the research offers insights into the mechanisms through which digital music evolves and how it is influenced by the collective behavior of its audience.

CHAPTER 4

METHODOLOGY

4.1 Problem Statement and Objective

The research sets out to explore the multifaceted landscape of digital music dissemination within artificial audiences, leveraging a broadcast model as the foundational framework. Surrounded by the proliferation of digital platforms and the evolving dynamics of audience engagement, understanding the interplay between composers, broadcasters, and artificial audiences emerges as a paramount objective. By delving into the underlying social dynamics, the study aims to elucidate the mechanisms driving the spread and evolution of musical compositions in the digital era.

This research presents an appealing subject for the field of cognitive science due to its investigation of complex behavior within artificial audiences and the intricate interplay between composers, broadcasters, and digital platforms in shaping the dissemination and evolution of music in the digital age.

4.2 Model Design

The model is designed to simulate the interactions between composers, broadcasters, and artificial audiences over multiple iterations. It is posited that in order for composers to garner appreciation from listeners, their compositions must align with the expectations of the audience. In other words, the assumptions regarding agents and their interactions are tailored such that a consensus on a universally accepted musical preference framework can manifest through agent interactions.

Composers within the simulation model are endowed with the ability to generate musical compositions guided by transition probabilities derived from iterative learning processes. Each composition is represented by a unique identifier and a melody sequence. The compositions are then introduced into the composition pool, where they become available for selection and dissemination.

The composition generation process is iterative, with composers continually refining their strategies based on feedback received from artificial audiences. Upon exposure

to compositions, artificial listeners rate them based on predefined success thresholds, providing feedback that influences the evolution of composer preferences.

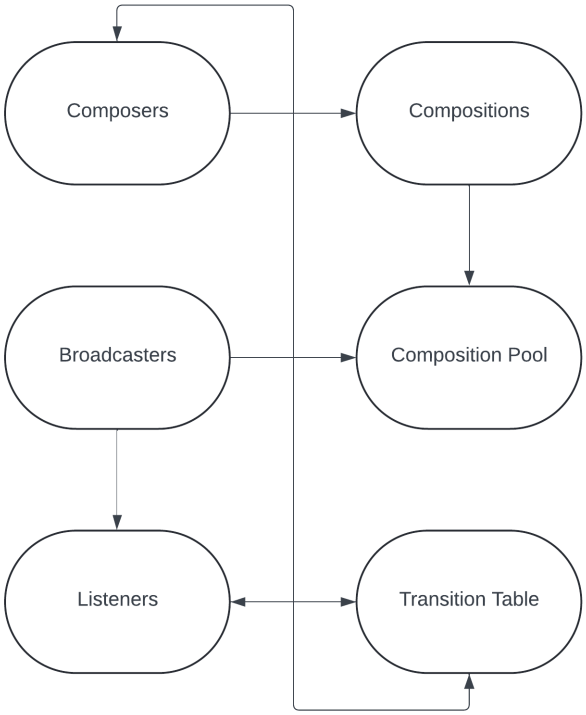

Figure 1: Flowchart of the simulation execution process

Broadcasters play a crucial role in the spread of musical content by curating playlists for artificial audiences. In the broadcast scenario, broadcasters select compositions from the pool to construct playlists, which are then broadcasted for consumption by artificial listeners.

Artificial audiences, modeled to mimic human preferences, engage with compositions within the simulated ecosystem. Listeners rate compositions based on their perceived quality and alignment with personal preferences. These ratings serve as valuable feedback for composers, influencing their respective strategies and decision-making processes.

Central to the model's functionality are learning and adaptation mechanisms employed by composers and artificial listeners. To understand the collective learning, the transition tables from all composers and listeners are aggregated and normalized to create a global transition table that reflects the overall musical preferences within the simulated society. These transition tables are utilized to track and update preferences for pitch transitions based on observed patterns and feedback. Composers and listeners adjust their transition tables dynamically, incrementally refining their preferences over successive iterations of the simulation.

The simulation unfolds iteratively, with each cycle representing a discrete period of interaction and adaptation within the simulated society. Success rates of compositions are meticulously logged and analyzed at each iteration, facilitating the observation of evolutionary trends in audience preferences and composition effectiveness over time.

To simulate the dynamic nature of the digital music ecosystem, a random decay mechanism is introduced, wherein a percentage of compositions in the pool are randomly forgotten or decayed at each iteration. This mechanism ensures turnover within the composition pool, preventing stagnation and facilitating the exploration of new musical content.

In scenarios where broadcasting is not employed, pairwise interactions between random composers and listeners drive the simulation forward. Composers create new melodies, which are subsequently rated by listeners, leading to updates in transition tables and adaptation of preferences based on interaction outcomes.

The integration of these components forms a comprehensive simulation model that captures the nuanced dynamics of digital music dissemination, offering insights into the interplay between creators, broadcasters, and audiences in shaping the evolution of musical compositions.

4.3 Parameters

The simulation is parameterized with a myriad of parameters to govern the behavior and dynamics of the simulation, each meticulously calibrated to encapsulate the intricacies of the digital music ecosystem.

These parameters listed as follows:

- **Number of Composers** (C):

  $$C = \text{Total number of composers in the simulation}$$

- **Number of Listeners** (L):

  $$L = \text{Total number of listeners in the simulation}$$

- **Number of Broadcasters** (B):

  $$B = \text{Total number of broadcasters in the simulation}$$

- **Number of Iterations** (I):

  $$I = \text{Total number of iterations for the simulation runs}$$

- **Playlist Size** (P_s):

  $$P_s = \text{Number of compositions each broadcaster selects for their playlist}$$

- **Number of Musical Pitches** (M_p):

  M_p = Total number of distinct musical pitches available for compositions

- **Length of Compositions** (L_c):

  L_c = Number of musical pitches in each composition

- **Success Threshold** (T_s):

  T_s = Threshold score required for a composition to be considered successful

- **Learning Rate** (α):

  α = Rate at which composers and listeners update their transition tables

- **Decay Rate** (D_r):

  D_r = Percentage of compositions in the pool that are randomly forgotten at each iteration

These parameters control the scale, behavior, and adaptation rates of the simulated society.

4.4 Simulation Execution

The simulation unfolds iteratively, with each cycle representing a discrete period of interaction and adaptation within the simulated society. At the onset of each iteration, composers generate compositions based on learned transition probabilities, while broadcasters curate playlists for artificial audiences. Subsequently, artificial audiences engage with compositions, providing ratings and feedback that inform the refinement of composer strategies.

To create ground for comparisons between simulations with and without broadcasters, the simulation is completed in two different styles: first, without any broadcasters present and with audiences and composers directly interacting with each other, and second, with broadcasters present and audiences and composers interacting with each other through broadcasters.

The iterative nature of the simulation enables the exploration of emergent phenomena and the evolution of audience preferences over time. Success rates of compositions are meticulously logged and analyzed at each iteration, facilitating a granular understanding of the factors driving the dissemination and reception of digital music within artificial audiences.

4.5 Data Collection and Analysis

Ratings provided by artificial audiences are collected and analyzed to determine the success rates of compositions. Data collection within the simulation is conducted with meticulous precision, encompassing the collection of ratings, feedback, and success metrics pertaining to individual compositions. Ratings provided by artificial audiences serve as proxies for audience preferences, providing invaluable insights into the efficacy of composer strategies and broadcaster curation efforts.

Success rates are plotted against iterations to visualize the trend of audience preferences and the overall effectiveness of compositions. Additionally, an example of a global transition table of audience and composers is presented to show the musical implications of the results of the simulation.

4.6 Global Transition Table Computation

4.6.1 Transition Tables

- **Composers** and **listeners** maintain transition tables that record the preference scores for transitioning from one musical note to another.
- These tables are updated iteratively based on feedback received from the simulation environment, which includes ratings from listeners.

4.6.2 Learning Mechanism

- **Composers** generate compositions by selecting pitches based on the highest preference scores in their transition tables.
- **Listeners** rate these compositions. Their ratings are based on how well the compositions align with their transition table preferences.
- Both composers and listeners update their transition tables based on the success or failure of the compositions.

4.6.3 Reinforcement Learning Elements

The process of updating transition tables is similar to **reinforcement learning**, where agents learn and adapt their strategies based on the rewards (positive feedback) or penalties (negative feedback) they receive. For example:

- A listener who likes a composition will increase the preference scores for the transitions in that composition, reinforcing those transitions as favorable.

- Composers adjust their tables similarly based on feedback about the success of their compositions.

To understand the collective learning and adaptation of the agents within the simulation, a global transition table is computed. This table aggregates the preferences of both composers and listeners, providing a comprehensive view of the evolved musical preferences within the simulated society.

The global transition table is created by averaging the transition tables of all composers and listeners. Each agent (composer or listener) maintains a transition table that records their preferences for transitioning from one musical note to another. These individual tables reflect the learning and adaptation processes of the agents based on their interactions and feedback within the simulation.

To construct the global transition table:

1. **Initialization**: The simulation is run for a specified number of iterations, during which composers create compositions, broadcasters curate playlists, and listeners rate the compositions.

2. **Collection**: After the simulation, the transition tables from all composers and listeners are collected.

3. **Aggregation**: The preference scores for each possible note transition (from one pitch to another) are summed across all individual transition tables.

4. **Normalization**: The aggregated scores are then normalized by the total number of agents to ensure that the global transition table accurately reflects the average preferences within the simulated society.

Mathematically, the global transition score $T_{global}(i, j)$ for transitioning from pitch i to pitch j is calculated as follows:

$$T_{global}(i, j) = \frac{1}{N} \sum_{k=1}^{N} T_k(i, j)$$

where: - N is the total number of agents (composers and listeners). - $T_k(i, j)$ is the transition score for the k-th agent for transitioning from pitch i to pitch j.

This process results in a global transition table that encapsulates the collective musical preferences that have emerged through the interactions and adaptations of all agents in the simulation. The global transition table provides valuable insights into the dominant musical patterns and trends, illustrating how certain note transitions become more preferred over time.

4.7 Evaluation and Interpretation

The culmination of the simulation entails a comprehensive evaluation and interpretation of findings, aimed at distilling actionable insights and theoretical contributions. Success rates and evolving trends serve as focal points for interpretation, shedding light on the relative influence of composers, broadcasters, and audience preferences on the spread and evolution of digital music compositions.

Interpretation of simulation results is contextualized within the broader landscape of digital music dissemination, drawing parallels with real-world scenarios and empirical observations. Comparative analysis with existing models and theoretical frameworks enriches the interpretative process, enabling the identification of novel phenomena and emergent behaviors within the simulated ecosystem.

4.8 Limitations and Future Work

The model may have simplifications and assumptions that limit its representativeness of real-world complexities.

Future work could focus on enhancing the model's realism by incorporating additional factors such as genre preferences, social network dynamics, and external influences on audience behavior.

Validation of the model against empirical data from real-world digital music platforms could further validate its utility and predictive power.

4.9 Ethical Considerations

Ethical considerations permeate every facet of the research methodology, underpinning a commitment to fairness, transparency, and responsible conduct. Central to ethical deliberations is the equitable representation of diverse musical styles and genres, ensuring the mitigation of biases and the promotion of inclusivity within the simulated ecosystem.

Privacy and consent issues are addressed concerning the use of artificial audience data and the potential implications of the model's findings on digital music consumption and production practices.

CHAPTER 5

RESULTS AND ANALYSIS

The simulation's experimental conditions were rigorously defined by two distinct parameter sets, designed to isolate the effect of broadcasters on the evolution of digital music preferences among artificial agents. The initial lack of specialized preferences among the agents provided a blank slate, enabling the observation of pure learning dynamics as preferences were formed through interactions.

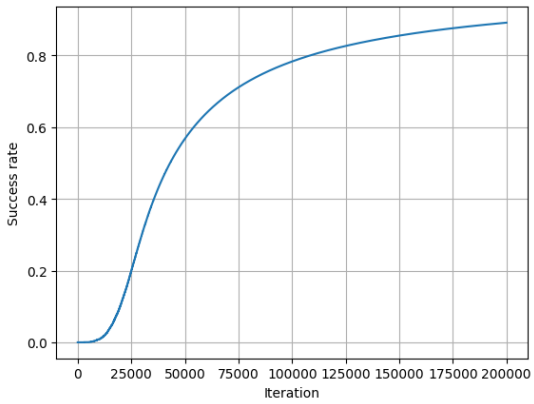

Figure 2: Success rate of interactions and convergence on a shared table of expectations without broadcasters where C=10, L=1000, B=None, I=200000, P_s=None, M_p=12, L_c=16, T_s=0.8, α=0.025, D_r=None

Figure 2 depicts the outcome of a prolonged simulation (200,000 iterations) with 10 composers and 1,000 listeners interacting directly, absent any broadcaster influence. The success rate is measured against a stringent success threshold of 0.8, revealing a gradual ascent indicative of a learning rate set to 0.025. The observed plateau beyond the 110,000th iteration implies a near-equilibrium state within the agents' learning, where their preference models reach maturity. The absence of a decay mechanism allowed for a cumulative effect, enabling a deep and comprehensive exploration of the compositional space since every single composition made by the composers are rated by the audience.

In stark contrast, Figure 3 introduces broadcasters into the model, resulting in a dramatically different evolution pattern over just 20 iterations. The success rate's swift escalation reflects the effectiveness of the broadcasting algorithm, which capitalizes

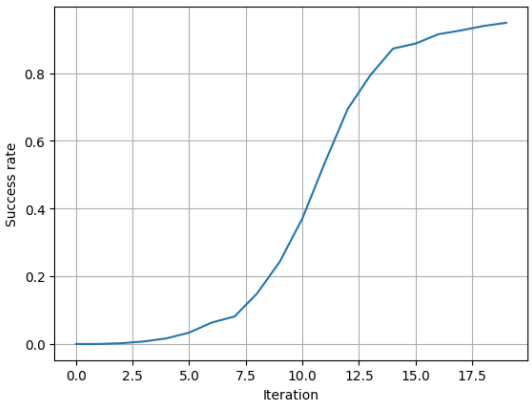

Figure 3: Success rate of interactions and convergence on a shared table of expectations with broadcasters where C=10, L=1000, B=5, I=20, P_s=2, M_p=12, L_c=16, T_s=0.8, α=0.025, D_r=0.5

on a small, selective playlist size (2) and a notable decay rate (0.5). These parameters shape a more dynamic musical environment where half of the compositions are replaced in each iteration, simulating the volatility of real-world music trends. This efficiency is further accentuated by the quick surpassing of the 0.8 success threshold, demonstrating the broadcasters' pivotal role in promoting compositions that resonate with the audience's emerging preferences.

The analytical juxtaposition of Figures 2 and 3 offers a compelling narrative. The direct-interaction model (without broadcasters) showcases a slow and steady progression towards a shared musical language, echoing the real-world phenomenon where music genres develop and mature over time. Conversely, the broadcaster model accelerates this process, simulating an environment akin to today's digital music platforms where trends can skyrocket to popularity rapidly.

This difference underscores the significance of curation and selection mechanisms inherent in digital platforms. The broadcasters' curatorial role efficiently amplifies compositions that resonate with the audience's preferences, catalyzing a rapid convergence of tastes. This function, akin to playlist curation on digital music platforms, highlights how such platforms could influence musical trends and listener behaviors.

In conclusion, the interplay between the agents' learning capabilities and the broadcasters' selective influence poses intriguing implications for understanding and forecasting trends within the digital music industry. These results suggest that in the presence of curatorial agents like broadcasters, the music landscape may evolve more rapidly, favoring a faster churn of musical styles and potentially impacting the diversity of music available to listeners.

As we further examine the impact of broadcasters in the simulation, we turn our attention to the role of composition complexity, determined by melody length, on the agents' success rates. Two simulations, each varying only in melody length, reveal

distinct numerical trends and outcomes under the influence of broadcaster intermediaries.

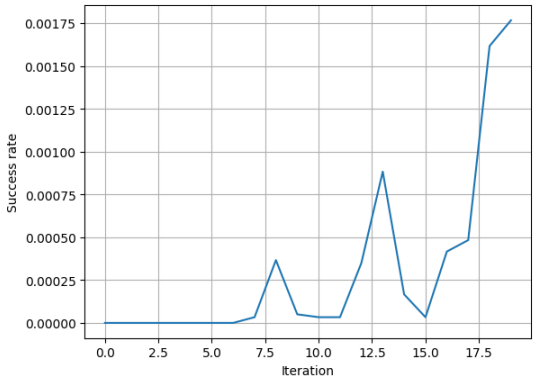

Figure 4: Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=5, I=20, P_s=2, M_p=12, L_c=8, T_s=0.8, α=0.025, D_r=0.5

Figure 4 corresponds to a simulation with a melody length of 8 musical pitches. The success rate here oscillates within the range of 0 to 0.00175, suggesting a struggle to identify and consolidate successful musical structures. It is not until the latter part of the simulation that we observe a significant numerical increase, with the success rate reaching its peak. This quantitative analysis underlines the nuanced exploration of the agents within a constrained melodic space before reaching a consensus.

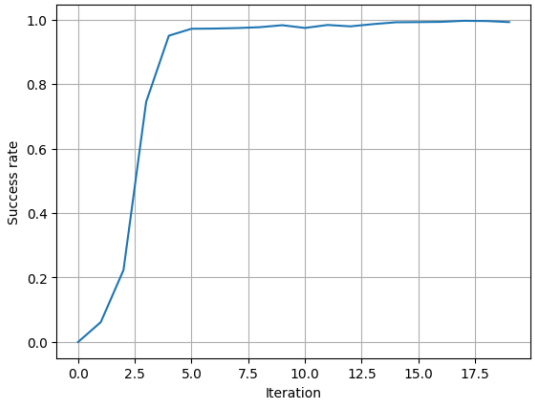

Figure 5: Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=5, I=20, P_s=2, M_p=12, L_c=32, T_s=0.8, α=0.025, D_r=0.5

In Figure 5, extending the melody length to 32 musical pitches yields a contrasting numerical trend. The success rate climbs rapidly within the initial iterations, reaching and sustaining a level close to 1.0 throughout the simulation. This numerical trend indicates that a more extended melodic framework allows for a richer and more varied compositional output, which aligns with the listeners' preferences almost immedi-

ately and consistently. The sustained high success rate numerically demonstrates the system's rapid convergence towards a stable set of preferred musical patterns.

Comparing Figures 4 and 5 from a numerical perspective highlights the distinct impact of melody length on the rate and stability of success in the simulated environment. The extended melody offers a broader canvas for composers, resulting in a high success rate that suggests a diverse yet consistent appeal to the audience's tastes. Meanwhile, the shorter melody necessitates a period of fluctuation and gradual alignment, reflected in the low and variable numerical success rates before reaching a late-stage peak.

This numerical analysis showcases how an increase in complexity, via melody length, can facilitate a more rapid and stable convergence in musical preference. Broadcasters' role in this process is pivotal, as they can effectively curate and amplify the diversity of compositions made possible by longer melodies. These insights provide a quantitative foundation for understanding the dynamics of music evolution and broadcaster influence within digital platforms, with broader implications for the music industry's understanding of trend formation and audience engagement.

The following figure represents an additional layer to our analysis, wherein we investigate the influence of playlist size on the success rate of compositions in a simulation that includes broadcasters. Maintaining all parameters from Figure 3 constant except for the playlist size, which is now increased to 5, provides insight into how the amount of music selected for distribution impacts the convergence of preferences.

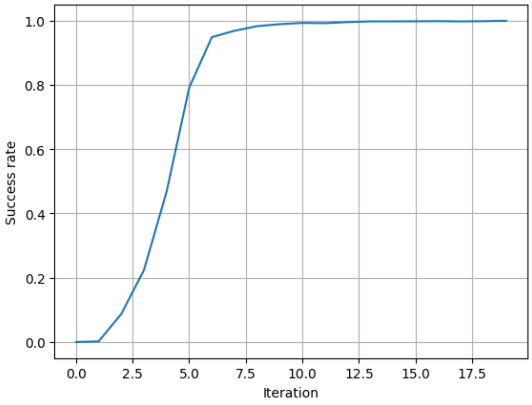

Figure 6: Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=5, I=20, P_s=5, M_p=12, L_c=16, T_s=0.8, α=0.025, D_r=0.5

Figure 6 presents the success rate trajectory with the adjusted playlist size. A notable observation is the rapid climb to a success rate that levels off at approximately 0.8, indicative of an effective alignment between composers' outputs and listeners' preferences. This suggests that a larger playlist size does not disrupt the learning process or the convergence towards a shared musical expectation. On the contrary, it may indicate that providing a more diverse array of compositions does not dilute the qual-

ity or the listeners' ability to discern and appreciate patterns that meet their musical preferences.

The plateauing of success rates at a high level throughout the simulation suggests that an increased playlist size enables broadcasters to offer a wider selection without compromising the emergence of preferred musical patterns. The sustained high success rate may also point towards the robustness of the system's ability to maintain a stable preference landscape even when more options are available, a desirable feature in platforms where variety is equated with user engagement and satisfaction.

Comparing Figure 6 with Figure 3, where the playlist size was set to 2, provides a compelling narrative: increasing the playlist size to 5 does not negatively affect the convergence of musical preferences. In fact, the system seems to maintain a high success rate efficiently, suggesting that the broadcasters are successfully curating and promoting a more extensive but equally resonant set of compositions to the audience.

This result has significant implications for understanding the balance between diversity and preference in digital music platforms. It implies that broadcasters or curators could potentially introduce a broader selection of music to listeners without overwhelming their preferences, potentially enhancing user experience and satisfaction while also encouraging the exploration of new music.

The subsequent figure examines the effect of doubling the number of broadcasters within the simulation on the success rate of musical compositions. By altering the broadcaster count while maintaining all other parameters constant from the previous broadcaster-inclusive model, we assess the role of broadcaster quantity in the evolution of music preferences.

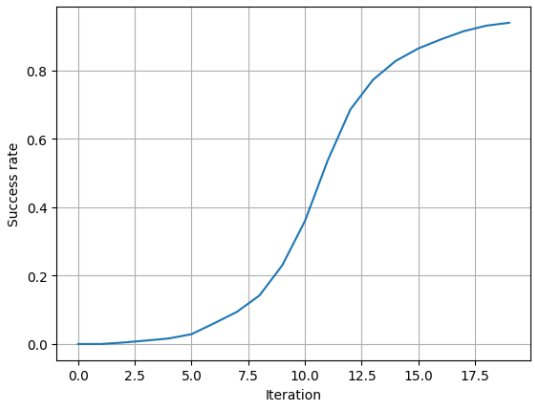

Figure 7: Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=10, I=20, P_s=2, M_p=12, L_c=16, T_s=0.8, α=0.025, D_r=0.5

Figure 7 depicts the trajectory of success rates in a simulation environment that includes 10 broadcasters. Similar to the previous scenarios with fewer broadcasters, we observe a rapid increase in success rates, plateauing near the 0.8 threshold. This pattern indicates that even with a greater number of broadcasters, the system is able

to quickly converge to a high success rate, suggesting that the agents are efficiently navigating the broader broadcasting landscape to find and favor well-aligned compositions.

Interestingly, the success rate in Figure 7 does not show significant deviations from the simulation with fewer broadcasters (as seen in Figure 3). This may imply that beyond a certain point, increasing the number of broadcasters does not disrupt the establishment of shared musical preferences among the audience. The robustness of the success rate, despite the increased number of broadcasters, could reflect the system's capacity to maintain consistent preference trends even when the sources of music distribution are expanded.

The sustained high success rate despite the increased number of broadcasters could suggest that the system has sufficient capacity to absorb more diversity in distribution without fragmenting the audience's preferences. It demonstrates the potential for larger digital music platforms with multiple curators or recommendation algorithms to offer varied content without diminishing the overall quality of the user experience.

Comparing Figure 7 with the results of simulations involving fewer broadcasters elucidates that a higher number of broadcasters does not necessarily equate to a more complex or divided preference landscape within the audience. Instead, it may highlight the adaptability and efficiency of the simulated music market in aggregating diverse inputs into a cohesive output that resonates with the collective audience taste.

This finding offers a valuable perspective on scalability within digital music ecosystems, implying that platforms can grow in terms of curator numbers without necessarily compromising the clarity of emerging trends or the unity of audience preferences.

The progression of our analysis now turns to the examination of decay rate—a parameter representing the obsolescence or persistence of musical compositions within the simulation. Figure 8 and 9 compare the effects of two extreme decay rate settings: one where compositions are never forgotten (a decay rate of 0), and another where all compositions are replaced in each iteration (a decay rate of 1).

Figure 8 illustrates the success rate trajectory with the decay rate set to 0. In this scenario, compositions have enduring presence, accumulating over time without any removal. Interestingly, the simulation yields a success rate that climbs steadily and plateaus near the 0.8 threshold, mirroring the behavior observed in scenarios with a non-zero decay rate. The absence of decay implies a more static musical landscape where compositions have a longer lifespan, potentially leading to a more extensive and diverse repertoire from which listeners can select.

Conversely, Figure 9 portrays a success rate in a highly dynamic environment with a decay rate set to 1, indicating complete replacement of compositions in each iteration. Despite this continual turnover, the success rate ascends rapidly and plateaus, akin to the scenario with no decay. This suggests that the artificial audience and broadcasters adapt rapidly, maintaining a high level of engagement with the newly introduced compositions. The result showcases the system's remarkable adaptability, suggesting that even when compositions are fleeting, the broadcasters and listeners can swiftly

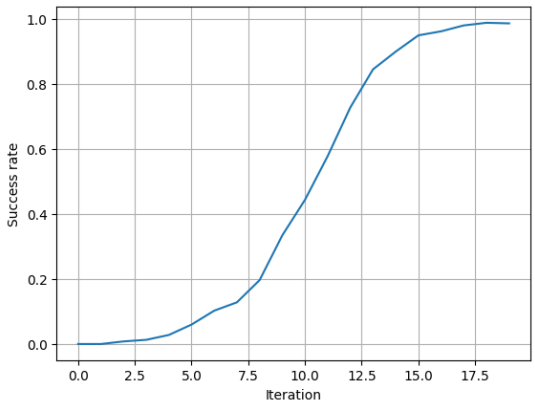

Figure 8: Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=5, I=20, P_s=2, M_p=12, L_c=16, T_s=0.8, α=0.025, D_r=0

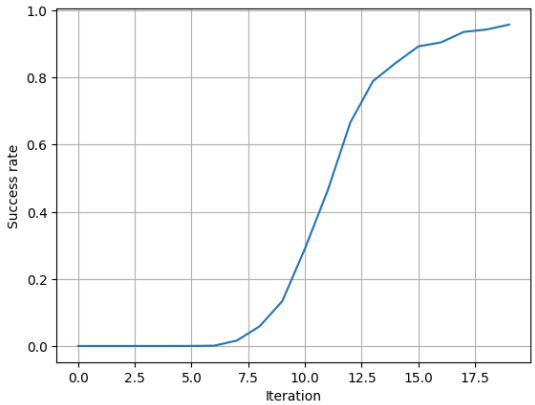

Figure 9: Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=5, I=20, P_s=2, M_p=12, L_c=16, T_s=0.8, α=0.025, D_r=1

recalibrate their preferences to ensure that the success rate remains high. This could be interpreted as a resilience of the simulated digital music ecosystem to constant change, a scenario reminiscent of contemporary music streaming platforms where trends can be fleeting, yet the overall satisfaction remains relatively stable.

When comparing Figures 8 and 9 to the previous scenarios, we observe a common pattern: regardless of the decay rate, the system tends to reach a stable high success rate. In the zero decay rate scenario (Figure 8), the persistence of compositions allows for a rich library of musical choices, potentially fostering a more complex interplay of evolving preferences. In contrast, a decay rate of 1 (Figure 9) emulates a scenario where trends are highly transient, reflecting the fast-paced change seen on digital platforms where users' attention and engagement are constantly refreshed with new content.

These findings emphasize that within the simulated environment, the decay rate has less of an impact on the eventual success rates than might be intuitively expected. It suggests that broadcasters play a crucial role in filtering and promoting content that aligns with listeners' tastes, irrespective of the turnover rate of compositions. This has profound implications for our understanding of digital music consumption, suggesting that users are capable of adapting quickly to a constantly changing musical landscape without diminishing their overall experience.

In summary, the numerical stability across different decay rates accentuates the robustness of broadcasters' influence and listeners' adaptability within the simulated music market. This may provide valuable insights into the strategies employed by digital music services to sustain user engagement amidst the ever-shifting panorama of musical trends.

Further exploring the versatility of our broadcast model, we now introduce Figures 10 and 11, which showcase the model's operation under alternative musical systems. Specifically, we investigate the model's performance when adjusted to a 24-pitch scale, which aligns with the microtonal intervals found in Turkish music, thus broadening the scope of our analysis beyond the Western 12-pitch scale.

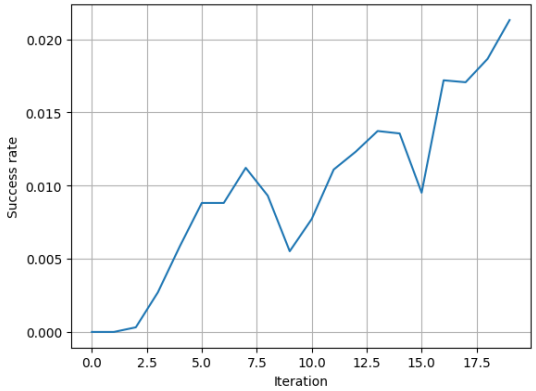

Figure 10: Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=5, I=20, P_s=2, M_p=24, L_c=16, T_s=0.8, α=0.025, D_r=0.5

Figure 10 presents the success rate in a simulation employing a 24-pitch scale. Unlike the previous simulations with a 12-pitch scale, we observe a more varied progression of the success rate, which peaks at approximately 0.02. This suggests that while the broader pitch range offers a rich tapestry for compositional variety, it may also introduce a higher level of complexity in achieving consensus on musical preferences. However, the gradual increase in success rate indicates that both composers and listeners are capable of adapting to this complexity over time.

Figure 11 extends the iteration count to 60 within the same 24-pitch system. The longer iteration period allows us to observe a more complete evolution of the success rate, which displays a pronounced increase and then plateaus near the 1.0 mark. This extended simulation suggests that given more time, the system is able to converge

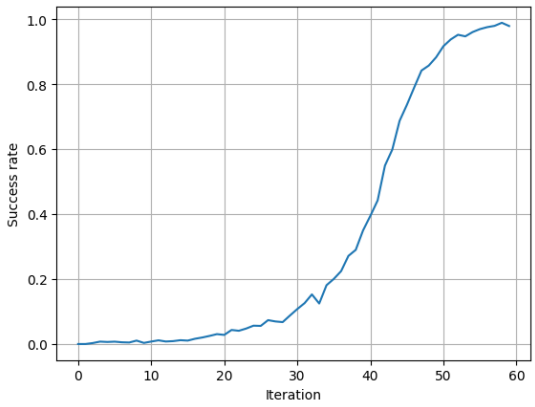

Figure 11: Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=5, I=60, P_s=2, M_p=24, L_c=16, T_s=0.8, α=0.025, D_r=0.5

successfully, even within the complexity of a microtonal scale. The approach to a high success rate reflects the system's capacity to align compositional output with listeners' preferences, even as the complexity of the musical structure increases.

Comparing Figure 10 and Figure 11 to Figure 3 (the standard 12-pitch simulation over 20 iterations), we notice that the success rate in the 24-pitch system starts at a lower point and takes longer to ascend, reflecting the increased complexity and the agents' adaptation period to a more nuanced musical scale. However, the extended iterations in Figure 11 illustrate that the system is indeed capable of achieving a high success rate in this more complex scale, albeit over a longer period.

These findings underscore the simulation model's capability to adapt to diverse musical systems, emulating the broad spectrum of musical preferences and traditions that exist globally. This versatility is crucial for understanding the spread of digital music in a multicultural landscape and provides a framework for analyzing music evolution in various cultural contexts, not limited by the constraints of the Western musical tradition.

The success of the model in accommodating a 24-pitch scale and achieving high success rates after an extended period suggests that digital music platforms could potentially cater to a wide range of musical tastes and traditions, fostering a more inclusive and diverse musical ecosystem.

The following image depicts an example of a global transition table that emerged after running the simulation under the conditions outlined for Figure 3. This transition table is crucial as it captures the cumulative learning of the system's agents—both composers and listeners—regarding their musical preferences.

The global transition table shown in Table 1 is a matrix where the rows and columns represent different musical pitches within a 12-pitch musical system. Each cell in the matrix contains a numerical value that represents the learned preference or propensity

Table 1: Example Global Transition Table where Success rate over time with broadcasters and convergence on a shared table of expectations where C=10, L=1000, B=5, I=20, P_s=2, M_p=12, L_c=16, T_s=0.8, α=0.025, D_r=0.5

	0	1	2	3	4	5	6	7	8	9	10	11
0	0.9258	0.0371	0.0441	0.0734	0.0089	0.0144	0.0906	0.5518	0.0791	0.0208	0.0657	0.0168
1	0.0768	0.1026	0.0585	0.0316	0.0114	0.092	0.0376	0.0037	0.2816	0.3307	0.0547	0.0043
2	0.0005	0.024	0.0456	0.0022	0.0311	0.0301	0.0605	0.1757	0.2539	0.0278	0.0238	0.0156
3	0.0818	0.1303	0.0149	0.0242	0.0168	0.0589	0.0202	0.0042	0.0867	0.0317	0.112	0.0145
4	0.0226	0.019	0.0028	0.0384	0.3525	0.055	0.0666	0.0284	0.0996	0.0435	0.0205	0.0272
5	0.0038	0.0468	0.0257	0.11	0.0397	0.0408	0.0383	0.128	0.0127	0.0521	0.0634	0.0386
6	0.0803	0.1322	0.1515	0.0411	0.027	0.127	0.0826	0.0026	0.0395	0.0416	0.0414	0.0886
7	0.5961	0.0293	0.0665	0.0044	0.0235	0.1124	0.1508	0.0011	0.0318	0.064	0.0317	0.0397
8	0.0316	0.2777	0.1262	0.0422	0.1244	0.0281	0.0045	0.2126	0.9395	0.0405	0.0369	0.0817
9	0.0478	0.2717	0.0237	0.0371	0.0636	0.053	0.0923	0.0177	1.1023	0.0457	0.3371	0.0355
10	0.002	0.0287	0.0588	0.0413	0.0838	0.0337	0.0073	0.0431	0.1119	0.0499	0.0304	0.333
11	0.0648	0.0047	0.0044	0.0838	0.0176	0.0221	0.0581	0.0086	0.0482	0.3955	0.0127	0.0351

for transitioning from one pitch (the row) to another pitch (the column) within the compositions created during the simulation.

A higher value in a cell indicates a stronger learned preference for that particular pitch transition. For example, a high value in the cell at the intersection of row 0 and column 1 would suggest that transitioning from the first pitch to the second is a common and favorable pattern according to the collective preferences of the audience. This table effectively encapsulates the musical 'vocabulary' that has developed as a result of the interaction and feedback between the simulated agents.

The data contained within this table is the result of complex adaptive processes where both the composers and the listeners alter their transition preferences over time. Composers tend to favor transitions that have been previously successful, while listeners' preferences evolve as they are exposed to different compositions, influencing future compositional choices in a feedback loop.

This global transition table serves as a powerful analytical tool for understanding how certain patterns and sequences of pitches become more prevalent over others, providing insights into the emergent musical trends within the simulated environment. It reflects the adaptation of the artificial society to a shared set of musical expectations, forming a cornerstone of the system's emergent cultural language in music.

In summary, completed simulations has provided a comprehensive examination of the complex dynamics within a simulated digital music ecosystem. Through a series of simulations varying in parameters such as melody length, playlist size, number of broadcasters, and decay rate, we have observed the intricate interplay between compositional creation and audience reception. The robustness of the model to adapt to these varying parameters underscores the versatility and relevance of the broadcast model in understanding the digital dissemination of music.

Our findings highlight the broadcasters' influential role in shaping musical preferences and trends, a role that parallels that of curators and algorithms on contemporary digital music platforms. The adaptability of the system to a wide range of

musical structures—from a 12-note Western scale to a 24-note microtonal Turkish scale—further demonstrates the model's applicability across diverse cultural contexts. The global transition table further consolidates this adaptability, revealing the underlying patterns that emerge as a result of cumulative adaptive processes.

This research not only sheds light on the potential trajectories of digital music evolution but also poses significant implications for the future of music curation, recommendation systems, and the sustainability of cultural diversity in music consumption. By navigating through various parameters and their implications, the study lays the groundwork for future explorations into the broader impacts of digital technologies on the arts and creative industries. The adaptability and responsiveness of the model to different musical systems and scales suggest that similar approaches could be employed to understand and anticipate the evolving tastes of diverse audiences on a global scale.

The python code of the simulation can be found on GitHub (6). It can be downloaded and used from the given URL in the bibliography.

CHAPTER 6

DISCUSSION

6.1 Interplay Between Composers, Broadcasters, and Artificial Audiences

Our exploration of the simulation's outcomes has shown us how composers, broadcasters, and audiences interact in a nuanced and dynamic way. Composers are like delicate antennas in this digital concert hall, constantly picking up feedback signals from their audience. Conversely, broadcasters operate as conductors, coordinating the presentation of musical pieces to the audience, whose responses then impact the subsequent performance. This interdependence demonstrates a digital ecosystem in which the producers' next step is influenced by every audience nod and cheer.

The simulation has effectively modeled a world where the success of a musical composition is a collective verdict, an interwoven result of creativity, curation, and consumption. It reflects a shift in the music industry's paradigm, moving away from a one-way street of musical delivery to a cyclical highway of interactive exchange.

6.2 Implications for the Future of Music Dissemination

The results of the simulation align with the main objectives of this thesis by illustrating a future in which music is shared across conventional borders. The digital age promises a fair playing field where variety in musical expression is not only feasible but also welcomed and enhanced, thanks to powerful algorithms at its core.

The robustness of digital music platforms in the future is indicated by the resilience seen across a range of simulated conditions. It is anticipated that these systems will skillfully handle the dual difficulties of rapid technical development and constantly changing client preferences. By using data to customize musical experiences, a symbiotic relationship between listener preferences and the content being given can be achieved.

The formation of a shared musical language, derived from the collective data of simulated interactions, demonstrates AI's potential as a compass in the huge ocean of digital content. This could inform not only the creation of new music that appeals

to modern audiences, but also the strategic decisions made by digital platforms when selecting their content.

In conclusion, this thesis delves into the mechanics of a digital music ecosystem, yielding insights into how composers, broadcasters, and fans might continue to co-create the music landscape of the future. It envisions a future in which the growth of music is choreographed in real time by algorithms and human tastes, offering a diversified and dynamic landscape of digital music dissemination.

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7.1 Summary of Findings

This thesis has presented a comprehensive model for understanding the dynamics of digital music composition and dissemination in a networked environment comprising composers, broadcasters, and artificial audiences. The key findings are summarized as follows:

- **Interdependence of Stakeholders:** The simulation demonstrated the intricate interdependence between composers, broadcasters, and audiences. Composers adapt their musical styles based on audience feedback, while broadcasters curate and influence the dissemination of music.

- **Role of Broadcasters:** Broadcasters play a crucial role in accelerating the convergence of musical preferences, promoting compositions that resonate with the audience. This highlights the importance of curatorial roles in digital music platforms.

- **Impact of Composition Complexity:** The complexity of musical compositions, such as melody length, significantly affects the success rates and preference alignment within the simulated environment. Longer melodies allow for more varied and rich compositional output, aligning more consistently with audience preferences.

- **Influence of Playlist Size and Broadcaster Quantity:** Variations in playlist size and the number of broadcasters demonstrated that the system can maintain high success rates, suggesting that digital platforms can offer diverse music selections without overwhelming audience preferences.

- **Adaptability to Different Musical Systems:** The model's adaptability to different musical scales, such as the 24-note microtonal Turkish scale, underscores its versatility in simulating diverse cultural contexts in music dissemination.

7.2 Contributions to the Field

This research makes several significant contributions to the field of digital music studies:

- **Novel Broadcast Model:** Introduces a novel broadcast model that integrates composers, broadcasters, and artificial audiences, providing a holistic framework for studying digital music dissemination.
- **Insights into AI and Music:** Demonstrates the potential of AI in shaping musical trends by dynamically interacting with human preferences, offering new perspectives on the role of technology in the creative process.
- **Framework for Future Research:** Establishes a foundation for future studies to explore the complex dynamics of digital music ecosystems, including the impact of social networks, genre preferences, and external influences on music consumption.
- **Implications for Digital Platforms:** Provides actionable insights for digital music platforms regarding content curation, recommendation systems, and strategies for maintaining user engagement in a rapidly evolving digital landscape.
- **Cultural Diversity:** Highlights the importance of accommodating diverse musical traditions within digital platforms, fostering a more inclusive and culturally rich music ecosystem.

7.3 Recommendations

Drawing from the insights of this study, stakeholders within the digital music landscape can consider several recommendations to enhance the creation, distribution, and reception of musical content.

Firstly, fostering closer collaboration between composers and broadcasters could be beneficial. Given the profound influence broadcasters exert on shaping artificial audience preferences, a more integrated approach to content creation and dissemination may yield more resonant and engaging musical compositions. This collaboration could involve establishing early feedback loops, jointly experimenting with new styles, and engaging in strategic content curation efforts. It could also be fruitful to use increased signal lengths to study the complex evolutionary nature of musical compositions with more emphasis on analyzing possible tri-grams, four-grams, five-grams, or even bigger n-grams. Studying larger musical fragments allows for the analysis of broader musical contexts, offering a better understanding of how music evolves in general.

Secondly, leveraging real-time data analytics tools can empower composers and broadcasters to gain deeper insights into audience preferences and consumption patterns.

By continuously monitoring audience feedback and consumption trends, stakeholders can adapt their strategies to better align with the evolving tastes of artificial audiences.

Diversification of content offerings also emerges as a recommendation. Embracing a wide range of musical styles and genres can cater to the diverse preferences of artificial audiences, thereby attracting and retaining a larger audience base. Inclusion of a more diverse set of listeners, composers, and broadcasters, considering their preferences, and involving different parties such as record labels and advertisers, can create a more complex testing environment. This helps to capture how composers are affected by listener preferences and how listeners are influenced by the music industry in a way that reflects reality.

Furthermore, stakeholders could explore innovative broadcasting formats that foster interactive participation and engagement. Experimenting with formats such as interactive live streams or immersive virtual experiences can enrich the listening experience and foster a deeper connection between composers, broadcasters, and audiences.

Lastly, continued investment in AI and machine learning technologies is crucial for refining and optimizing the broadcast model of digital music dissemination. Advancements in these areas can facilitate more sophisticated simulations and predictive modeling, ultimately enhancing the effectiveness of content delivery strategies.

7.4 Implications for Composers, Broadcasters, and Industry

The findings of this study carry significant implications for composers, broadcasters, and the broader digital music industry. For composers, understanding the pivotal role of broadcasters in shaping artificial audience preferences necessitates a more adaptive and responsive approach to creative expression. Embracing flexibility and experimentation in composition styles, coupled with the utilization of feedback mechanisms and data analytics tools, can empower composers to refine their artistic expressions in real-time and resonate more effectively with diverse audience segments.

Broadcasters, on the other hand, emerge as key influencers in the curation and dissemination of musical content. By leveraging data-driven insights and understanding audience preferences, broadcasters can optimize their content selection and delivery strategies to maximize engagement and retention. Collaborating with composers and investing in AI technologies can further enhance broadcasting platforms, enabling more personalized listening experiences and fostering stronger connections with audiences. Given the crucial role of broadcasters in curating playlists and influencing the musical habits and preferences of listeners, their strategic impact on music dissemination is profound.

From an industry perspective, this study underscores the dynamic interplay between composers, broadcasters, and artificial audiences within the digital music ecosystem. Industry stakeholders are encouraged to explore new business models and revenue streams that capitalize on collaborative content creation and distribution. Moreover,

continued innovation in AI and machine learning technologies is essential for driving advancements in digital music composition, broadcasting, and audience engagement.

7.5 Areas for Future Research

While this study provides valuable insights into the broadcast model of digital music dissemination, several avenues for future research warrant exploration. Firstly, investigating how cultural and regional factors influence the musical preferences of artificial audiences can provide a more nuanced understanding of audience dynamics and behavior. Understanding the long-term evolution of musical styles and trends within the broadcast model could shed light on the emergence of new genres and the impact of cross-cultural interactions.

Moreover, integrating user-generated content and collaborative composition platforms within the broadcast model could democratize music creation and distribution, warranting further exploration. Ethical and societal implications, such as copyright issues, algorithmic bias, and cultural representation, also merit consideration for responsible innovation in the digital music industry. Lastly, assessing the impact of emerging technologies such as virtual reality, blockchain, and decentralized platforms on the broadcast model can offer valuable foresight into future trends and opportunities.

7.6 Closing Remarks

In conclusion, this thesis has advanced our understanding of the digital music landscape by presenting a detailed model of the interactions between composers, broadcasters, and audiences. The findings underscore the transformative potential of AI and digital platforms in shaping the future of music dissemination, especially when the impact of broadcasts mediums is taken into consideration. As digital music continues to evolve, the insights gained from this research will be invaluable in navigating the complexities of this dynamic and ever-changing field.

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