


Chapter 5

Markov–Chain Melody: A Mathematical Approach to AI–Assisted Songwriting

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ABSTRACT

This study examined whether simple probabilistic models can generate coherent melodic fragments for AI-assisted songwriting. The work focused on building first- and second-order Markov chains, analyzing the statistical properties of their outputs, and comparing listener perceptions with human-composed hooks. A dataset of 20 popular MIDI melodies was standardized to C major and used to estimate transition probabilities, from which 30 sequences of 8–16 notes were generated. Structural measures showed that human melodies had higher entropy (2.29 vs. 1.80) and greater pitch diversity (6.37 vs. 5.92), while Markov outputs had higher repetition (0.43 vs. 0.34). A perceptual survey with 30 listeners rated human melodies higher in catchiness (4.19 vs. 3.78), musicality (4.33 vs. 3.63), and preference (3.98 vs. 3.68), though Markov sequences were still viewed as acceptable. Findings show that Markov chains capture short-term tendencies and can generate usable motifs but lack long-range structure, making them useful for low-resource music tasks.

INTRODUCTION

Artificial intelligence (AI) has rapidly transformed the landscape of creative production, particularly in music composition and songwriting. Once confined to symbolic rule-based systems, algorithmic composition has evolved through advances in machine learning, enabling AI to act not only as a compositional tool but as a

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collaborative partner in the creative process. Within this domain, AI-assisted songwriting highlights a shift from autonomous generation toward co-creation, where computational systems provide melodic or harmonic ideas that human composers refine into musical pieces. Despite the rise of complex neural architectures such as generative adversarial networks (GANs) and transformers, simpler stochastic approaches like the Markov chain continue to play an essential role in modeling the statistical structure of music. Their interpretability and controllability make them ideal for exploring how algorithmic processes can augment, rather than replace, human creativity.

The origins of computer-based composition can be traced to early experiments such as *The ILLiac Suite* (1957), which used Markov chains to generate musical sequences. While these early models were limited by computational resources, their conceptual foundation—representing melody as a probabilistic process—remains influential. In modern AI systems, probabilistic models serve as a fundamental building block for understanding musical expectation and stylistic imitation (Michi et al., 2021). As commercial AI systems like MuseNet, AIVA, and MusicLM demonstrate increasing sophistication, researchers have revisited Markov models not for their computational novelty but for their transparency, a quality often absent in deep learning systems.

Although AI systems capable of autonomous composition exist, few provide songwriters with interpretable tools that integrate probabilistic modeling and human creativity. Deep generative networks often function as black boxes requiring extensive datasets, while simpler statistical models, though accessible, are rarely evaluated for creative utility in songwriting contexts (Deruty et al., 2022; Yin et al., 2023). This study addresses that gap by implementing and evaluating first- and second-order Markov-chain models as a basis for melody generation in AI-assisted songwriting.

The study pursued three primary objectives:

1. To construct and implement first- and second-order Markov chains using a corpus of popular MIDI melodies, modeling the probabilistic relationships between notes and visualizing these through transition probability matrices;
2. To analyze and compare the statistical properties of Markov-generated and human-composed melodies using quantitative metrics—Shannon entropy, repetition index, and pitch diversity—as indicators of unpredictability, motif recurrence, and tonal range; and
3. To assess listener perceptions of human and AI-generated melodies in terms of catchiness, musicality, and overall preference, thereby gauging the perceptual validity of probabilistic modeling in creative composition.

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