Chapter 6
AI-Driven Music Composition by Integrating RNNs and GAs for Personalized Pop Songs

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ABSTRACT

An AI-powered music composition framework is introduced, capable of generating complete pop songs by integrating Recurrent Neural Networks (RNNs) with Genetic Algorithms (GAs). RNNs produce melodically coherent MIDI sequences that reflect long-term musical dependencies, while GAs refine song structure based on user preferences such as variation, transition smoothness, and catchiness. Unlike the MAGMA framework, which is limited to instrumental MIDI creation, the proposed

DOI: 10.4018/979-8-3373-6279-3.ch006

system incorporates vocals using a realistic Text-to-Speech (TTS) engine. Lyrics can be user provided or generated through NLP and are precisely synchronized with the MIDI output using tools such as librosa, pydub, and fluidsynth. The implementation uses Python libraries including tensorflow, torch, pretty-midi, music21, pandas, and matplotlib, and a feedback loop allows users to iteratively improve song quality. The framework aims to make high-quality, personalized music production accessible to musicians, content creators, and professionals.

1. INTRODUCTION

Music composition, one of humanity's oldest and most expressive art forms, has long been viewed as a domain reserved for human creativity, intuition, and emotion. Traditionally, composing music required a deep understanding of harmony, rhythm, melody, and orchestration—skills honed through years of study and practice by maestros such as Mozart, Bach, and Beethoven. Over centuries, this process remained largely manual and subjective, relying on the composer's aesthetic sense and emotional experience. However, the advent of technology has gradually transformed this landscape, introducing tools that augment, simulate, or even reinvent the act of composition. From early mechanical instruments to sophisticated digital audio workstations (DAWs), the continuous evolution of technology has redefined both the process and perception of music creation. In recent decades, the integration of artificial intelligence (AI) into music composition has emerged as a revolutionary paradigm, enabling machines not just to assist but to autonomously generate music that rivals human-created works. Early explorations in algorithmic composition date back to the 1950s, when the Illiac Suite—considered the first computer-generated musical piece—was composed using simple rule-based algorithms. These early systems relied on deterministic mathematical rules, probability theory, and logic, generating sequences of notes according to pre-defined constraints. While groundbreaking, such methods lacked the expressiveness and emotional depth characteristic of human creativity. The evolution of Machine learning (ML) and Deep learning (DL) has since expanded the creative potential of computers, enabling systems to learn musical structures and patterns from vast datasets rather than relying on rigidly encoded rules. Particularly, the introduction of Recurrent Neural Networks (RNNs) and their variant, the Long Short-Term Memory (LSTM) architecture, has been pivotal in modeling music as a time-dependent sequence. RNNs excel at learning temporal relationships, making them ideal for capturing melodic progression, rhythmic repetition, and harmonic context across time. By training on a large corpora of