# Chapter 7
# ChordCraft:
## Dataset-Driven Music Analysis Using Convolutional Neural Networks

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## ABSTRACT

*This study explores the intersection of artificial intelligence and music theory by focusing on automatic chord identification. Central to this work is the ChordCraft dataset, a purpose-built resource designed for in-depth analysis of harmonic structures, including chord transitions and stylistic variations across genres. We implement a framework based on Convolutional Neural Networks (CNNs), which excel at pattern recognition in spectral and temporal audio data. By systematically analyzing chord progressions and harmonic layers, the model identifies latent features that correspond to distinct musical signatures. This research contributes to AI-driven music analysis by showing how deep learning can decode the complex language of harmony. It highlights the potential of computational tools to augment musicological research and assist composers, educators, and producers, ultimately opening new pathways for intelligent systems in contemporary music.*

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## 1. INTRODUCTION: THE QUEST FOR AUTOMATED HARMONIC UNDERSTANDING

Music, in all its multifarious guises, is a universal pillar of human communication, crafting rich tapestries of melody, rhythm, and harmony that reach across cultural and linguistic boundaries. In the system of Western tonal music, harmony—the vertical organization of music produced by the sounding of notes simultaneously—is the structural and emotional foundation upon which works are constructed. At the center of this harmonic discourse is the chord: an aggregation of several notes that, put together in order, create the progressions that determine a work's character and narrative course. The knowledge of being able to recognize and comprehend these chord progressions is essential not merely to music theory and analysis but to the applied activities of studying, playing, and writing music as well.

The analysis of music on computers, Music Information Retrieval (MIR), has long acknowledged the precedence of harmony. Automatic Chord Recognition (ACR), the process of identifying automatically a progression of chords from recorded audio, is a basis of MIR. A strong ACR system acts as a base layer for a wide variety of higher-level analysis tasks. It allows for the computer detection of a song's musical key, supports structural segmentation of a piece into choruses, verses, and bridges, and offers an extremely strong feature set for cover song identification and music similarity analysis. The quest for a robust ACR system has been a grand challenge for decades, motivating advances in machine learning, signal processing, and computational musicology.(Scholz et al., 2005a).

The history of this endeavor can be demarcated broadly into two distinct eras, each by its dominant technological paradigm and its philosophical stance towards encoding musical knowledge. The initial era, running between the late 1990s and early 2010s, was dominated by knowledge-driven and probabilistic approaches. It started with pioneering efforts that married concepts of digital signal processing with music theory. A groundbreaking innovation was the creation of chroma features, or pitch class profiles (PCPs), that depict the energy of the twelve semitones of the chromatic scale without preserving information about octave. This representation, developed by researchers such as Fujishima, was incredibly effective because it extracted the central harmonic content of an audio signal in a fashion that was invariant to instrumentation and timbre changes. These manually created features were then usually input to probabilistic sequence models, primarily (Jiang et al., 2011) (Wikipedia contributors, 2024).

*Hidden Markov Models (HMMs).* In this framework, pioneered for ACR by Sheh and Ellis, chords are treated as "hidden" states that generate the "observable" sequence of chroma features. The HMM's transition probabilities could be trained to explicitly model the rules of musical syntax—for example, the high likelihood of a G major

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