Review: A key-finding algorithm based on tonal hierarchies by Carol L. Krumhansl

In chapter four, of the book *Cognitive foundations of musical pitch*, Carol L. Krumhansl describes an algorithm that determines the key of a musical piece, given a series of tones. This method is compared with Longuet-Higgins and Steedman’s algorithm designed to achieve the same task. Krumhansl’s algorithm gives fairly accurate results while requiring, on average, fewer notes to correctly determine the key than the other algorithm. This algorithm is based mainly on matching the music to tonal hierarchies which are described in chapter two. The tonal hierarchies represent how stable a tone is, or how good the tone sounds, within the context of a key. Since the hierarchy represents how “good” a note is in the context of a key, it can be inferred that the “good” notes would also be the most used in a musical piece in the specific key. This idea forms the basis of the algorithm described and tested by Krumhansl.

In chapter two, Krumhansl describes how the tonal hierarchies where determined and discusses how they correlate to music theory. The primary method for determining these values is the probe tone method. In this method study participants first listen to a musical context that establishes a specific key, then listen to a probe tone and asked to rate how well the probe tone fits with the context. This test was done in multiple studies across a range of participants young to old and those with little to extensive experience in music. While adults with more experience in music where more likely to rate the probe tones in a manner that is consistent with the musical distinction between the tones, the studies showed that musically untrained children in grade school gave ratings consistent with the trained adults. This shows that there is agreement among people of what tones are “good” given a specific context. It was also determined that transposition of the context and probe tone did not significantly alter the ratings for the probe tone. This means that the tone ratings can be simplified to the tone’s offset from the context’s key’s dominant tone. Using these studies researchers have been able to develop a rating of tones based on their offset from the dominant. The ratings create the tonal hierarchies that Krumhansl’s algorithm uses.

Another use for the tonal hierarchies is to compare different keys to each other and to determine how related they are. By comparing the hierarchies one can calculate a value that represents the differences between two keys. Using this information Krumhansl generated a visual representation of key relationships. This representation shows the different keys on the surface of a torus and adequately conforms to how they keys are related in music theory.

In chapter four an algorithm to find the key of a musical piece or segment is described. The algorithm sums the notes and their duration to create a hierarchy of the tone based on total duration the tone sounds in the piece. This hierarchy is then compared to the tonal hierarchies that have been previously established. The tonal hierarchy that most closely fits the hierarchy from the piece is assumed to be from the key for which the music is based in. This is in contrast to Longuet-Higgins and Steedman’s method. Their method disqualifies keys by determining whether or not each successive note in the piece belongs to a subset of notes for each key. If the note doesn’t belong to the key’s set, the key is removed. This occurs until one key is left. In comparison Krumhansl’s algorithm is able to determine the correct key using about 40% fewer notes.
Reference