Music and Probability

BY DAVID TEMPERLEY

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My first revelatory contact with Bayesian approaches to music came through the work of Sadakata, Desain, and Honing (2006) (although I had previously had superficial contact with related work by Taylan Cemgil, with Peter Desain and Bert Kappen, see e.g., Cemgil, Desain, & Kappen, 2000). Although I was fairly new to the whole issue of conditional probability I was impressed by the way in which this paper revealed relationships between perception and production that had hitherto been masked for want of the appropriate methodology. Temperley’s excellent book *Music and Probability* contextualizes the Bayesian approach, explains its potential for the scientific understanding of music, and provides examples of applications, both his own and those of others. Sadakata et al. (2006) was published too late to allow for Temperley to use it as an example, but I was pleased to find a wealth of older work here to flesh out my understanding of Bayesian modelling.

This book already has been reviewed in detail elsewhere (e.g., Parncutt, 2008; Pearce, Müllensiefen, Lewis, & Rhodes, 2007). I will attempt not to duplicate the approaches taken by these two reviews. Parncutt in particular provides a thorough overview of the probabilistic approach, so I shall avoid summarizing the methodological background in any detail. I will deal with four issues raised for me by his book: (1) the overall success with which Temperley advocates the application of Bayesian statistics to music; (2) the clarity with which he explains the underlying methods; (3) his and others’ application of the methods and the strength of the examples provided in support of (1); and (4) the implications of the approach he outlines for research in music perception and production.

Advocacy

As well as being a showcase for Temperley’s own work in this area, much already published in peer review journals, this book is an attempt to bring together work that illustrates the benefits of probabilistic thinking for both music theory and music psychology. Temperley himself draws attention to two looming theoretical issues that he hopes a Bayesian approach can solve. One is the issue of preference rules in generative music theory (e.g., Lerdahl & Jackendoff, 1983) and the other is the unanswered question of how more rigorously to pursue the project started by Meyer (1967). Being able to quantify the probability of one event occurring in relation to the probability of another seems central to both of these issues, and it is with some degree of success that Temperley advocates a Bayesian approach as a solution to both these problems. However, although the examples he provides present a tantalizing glimpse into how generative models of music, for example, can be better assessed and constructed in the light of conditional probabilities, they also often fall short of being fully convincing, either because of the limited choice of training datasets or because the models are only sometimes tested against human behavior in a rigorous manner.

Explanation

The main strength in this book is its clarity of expression. Temperley provides extensive explanations of basic concepts, and although he is then quick to exemplify these with much more sophisticated applications, this is a book I would recommend to students without extensive prior knowledge of probabilistic approaches. Indeed, he explicitly aims to appeal to “a broad audience in music and cognitive science” (p. x), and this is a goal he meets. Chapter 2 is an enjoyable and thorough attempt both to show the roots of his approach (and their widespread application outside music) and to explain not only how to calculate conditional probability and cross entropy, but why one might want to do so. In the later chapters this quality of explanation continues, and although it sometimes is unclear why certain decisions were taken other than on pragmatic grounds, more often than not one can follow his reasoning.

Application

The bulk of the book concerns the application of Bayesian probability to the modelling of rhythm, melody, and tonality, the major obsessions of music perception and cognition. Chapter 8 does briefly consider
the recovery of other aspects of music such as notation, phrasing and harmony from a musical surface, but the focus is clear. Generally, Temperley is fair but focused in his handling of the material. For me the discussion of tonality induction was weaker for its failure to acknowledge Parncott’s psychoacoustical approach to tonality (Parncott, 1989). His discussion of rhythmic expectancy likewise fails to acknowledge Desain’s work in this area, although he is referred to elsewhere in the text (Desain, 1992). What he undoubtedly succeeds in is showing the potential of this approach to unlock many troublesome problems in the field, especially where the relationships between data and theory need to be assessed carefully, as in cases where many models offer competing explanations. At times he touches on some fundamental questions: the most potent section of this book for me was the discussion of tonal ambiguity, tension, expectation, and emotion (pp. 122-125). Here he lives up to the expectations raised by his invocation of Meyer at the book’s outset, because of, rather than despite the speculative nature of his arguments here. Similarly, it is impressive how Temperley both highlights the complexity of an issue, such as tonality induction, without simply throwing in the towel. Many of his solutions (and those of the others he cites) do seem temporary and provisional, but this is actually a welcome and honest approach when there is a temptation to pretend a theory explains more than it does by ignoring competing explanations.

Disappointingly, but perhaps understandably, the book is focused on the Western canon (with some notable diversions into vernacular and ethnic musics). Temperley himself notes the potential for using such methods to compare musics, and it is to be hoped that others will develop his small beginnings in this area. For example, the trade-offs he discusses between syncopation and rubato are very intriguing to anyone working in the field of expressive timing, and it is to be hoped that these ideas bear scrutiny when measured against a wide range of data from real performances.

Implications

The real strength of this book lies in the ground it has broken for others. There are many individuals and groups working towards a better understanding of the ways in which different parameters of music interact who can learn from the approach Temperley has taken. Regardless of his methodological preferences, this book reminds me of the work of Longuet-Higgins (see e.g., his wide-ranging work on music in Longuet-Higgins, 1987) in its attention to a cornucopia of musical problems and its avoidance of the kind of parametric myopia that often blights both cognitive science and experimental psychology. Moreover, this book avoids the dissociation between environment and organism that so often pervades contemporary psychological accounts of music. Although not explicitly a challenge to more traditionally Chomskyan views of music cognition, Temperley does note the close match between Bayesian statistics and a more data-driven view of how we develop sensitivities to musical structure. As in linguistics, it is becoming clearer that the detection of regularities in the environment may be more important than innate capacities, and is more than just a matter of parameter setting. If the Bayesian approach allows one to quantify the overlap between perception and production, on the one hand, and perception and reality on the other, then this book will have done much to advance this idea within musical research.

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References


