

ISE575/CSCI575

Week 5
February 10, 2005

Mohammad Anwar Hossain
Student ID: 8813190224

A Positive-Evidence Model for Rhythmical Beat Induction

By - Douglas Eck

In one sentence, what the paper is about?

The author discusses NPOS (Normalized Positive) Model which is a rule based model derived from several existing models and is used to predict downbeat location and pattern complexity in rhythmical patterns.

Preamble on the topics:

One interesting quality of music is how it evokes a sense of movement in a listener and how this sense of movement varies by listener. This feeling of movement is what rhythmical beat induction attempts to describe in a systematic analytical manner. However, it also varies by listener, and thus is not so straightforward. As discussed by Dirk Moelants, in his introduction to the Journal of New Music Research's special issue on "Foundations of Rhythm Perception" (Volume 28, Issue #1 rhythm perception is a research area in which inter-disciplinarity is of great importance. His summary of the two merging perspectives is worthy of repeating in whole:

"Rhythm has many aspects, and each of them can be studied using different methods. Traditionally we distinguish two main directions in the field. First, cognitive psychology, where rhythm is an area of interest since the late 19th century. The main methods here are experimentation and modelling. The aim is to understand the way rhythm is processed in the brain and how people interpret specific rhythmic patterns. From this understanding perception theories are developed. Second, musicology (music theory and ethnomusicology), where the structure and effects of rhythm in specific musical styles are analyzed and theories about rhythmic structure in music are developed. Today the two directions seem to merge in one another. Music psychologists are not merely working with simple artificial sequences anymore, but try to cope with the complexities of musical (performed) rhythm. At the same time music theorists show increasing interest in the perceptual foundations of rhythm, and of music in general, adapting their analyses to comply with the findings of music psychology.

Another important factor in the development of research in rhythm perception are the increasing possibilities of computer technology. The study of musical rhythm in its natural context implies working with relatively long sequences of sound, therefore a computational approach had only limited possibilities without the availability of considerable memory and processing power. Today these possibilities are available to every researcher, and programs have been developed that allow people not specialized in computer programming to use this power efficiently. "

Discussion on the paper:

In the paper "A Positive-Evidence Model for Rhythmical Beat Induction," Douglas Eck introduces and explores the NPOS model, and compares it to 3 different rule-based models. These models fall into the second perspective, that of "musicology" mentioned by Moelants, however, the application and study he summarizes falls into the more traditional perspective of cognitive psychology.

A rule-based model contends that a simple set of rules can be used to find downbeats in patterns – at least to a limited extent. The NPOS model is a rule-based model that predicts downbeat location and pattern complexity in rhythmical patterns. It is not a very complex model, yet it is pretty effective at making correct predictions. There are two main issues in rule-based models – first, what rules should be applied and second, how should the rhythm be represented?

The NPOS model is a modified version of the popular rules based model by Povel & Essens (1985). Both models operate on clocks that sample all phases of low and middle level of a metrical hierarchy. Rules are scored in a particular order to choose the best clock from among the set of clocks. The NPOS modification adjusts the kind of pattern information used to determine the downbeat – using perceptually-accented onsets rather than rests to predict the primary beat.

Eck uses 4 databases to compare the NPOS model with 3 other rule-based models, NEG (negative-evidence model), POS (positive-evidence model), and HYBRID (full hybrid model). By using various statistical representations, regression results and ANOVA comparisons, Eck summarizes how well each model can predict the downbeats, but in some cases more importantly, how well each model can represent the variation of rhythm perceived by listeners.

In his discussion, he points out that all of the rule-based models he explores are not process models and thus are unable to make ongoing predictions and thus can not respond to unfolding patterns, such as robot or online speech recognizer.

Conclusion:

Overall, the results show that the NEG, HYBRID, NPOS models can account for the variance in the datasets that they were designed to handle. The authors, of course, state that their suggested model the NPOS is superior due to its simplicity and effectiveness. The TNPOS (a slight variation of NPOS) accounted for more variance than the other models and also was able to deal with the interaction of musical experience and rhythm perception. The datasets are a bit small, and surely these results are not conclusive evidence to support one rules-based model over another, however, the authors do contend that the evidence points to a superiority of their NPOS model.