The Process of Extracting N-tuples Features

Xiuyan Ni

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This document introduces the detailed process of how to extract the N-tuples features in the paper "A Sep2Tree Model for Recognizing Synthetic Bach Chorales".

There are five steps in the feature extraction process. First, we extract all the chords from the corpus. We ignore the octave designation for all the notes, replace each note with their pitch class, remove the duplicate notes, and sort all the notes. Then we adjust each chord based on the key signature of the sequence the chord in. Third, we assign a unique index to all the chords extracted from the whole corpus, and replace the chords in each sequence with the unique index. Fourth, we extract all distinguishing N-Tuples of successive chords. Fifth, for each sequence in the corpus, we count each of the types of N-Tuple, and normalize the counts to be components of the feature vector.

Suppose we have a corpus that contains two sequences, sequence 1 is the first 10 chords from Bach bwv26.6 (Figure 1) and sequence 2 is the first 10 chords from Bach 66.6 (Figure 2).

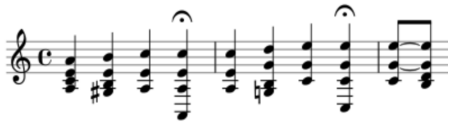

Figure 1: The first 10 chords of Bach bwv26.6.

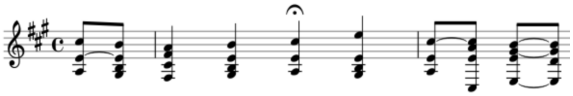

Figure 2: The first 10 chords of Bach bwv66.6.

- Step 1 and 2: after the first two steps, we will get

$$q_1 = [(1,6,9),(1,5,8),(1,6,9),(1,6,9),(1,6,9),\\ (4,8,11),(1,4,9),(1,4,9),(1,4,9),(1,4,8,11)]$$

from the sequence 1, and get

$$q_2 = [(3,7,10),(2,5,10),(0,3,7),(2,5,10),(3,7,10),\\ (2,5,10),(3,7,10),(3,7,10),(2,5,10),(2,5,8,10)]$$

from sequence 2.

- Step 3: there are 9 different chords in the corpus. If we assign an unique index to each chord as in the following:

$$\{(0,3,7):0,(1,4,8,11):1,(1,4,9):2,(1,5,8):3,(1,6,9):4,\\ (2,5,8,10):5,(2,5,10):6,(3,7,10):7,(4,8,11):8\}$$

  Then replace the chord in each sequence using the unique index, we will get $q_1 = [4,3,4,4,4,8,2,2,2,1]$ and $q_2 = [7,6,0,6,7,6,7,7,6,5]$.

- Step 4: let $N = 3$, in the fourth step, we extract all 3-Tuples from q_1, we will get

$$S_1 = \{(4,3,4),(3,4,4),(4,4,4),(4,4,8),(4,8,2),(8,2,2),(2,2,2),(2,2,1)\}$$

  , we extract all 3-Tuples from q_2, and get

$$S_2 = \{(7,6,0),(6,0,6),(0,6,7),(6,7,6),(7,6,7),(6,7,7),(7,7,6),(7,6,5)\}$$

  Then we put them together. The tuple set is then:

$$S = \{(0,6,7),(2,2,1),(2,2,2),(3,4,4),(4,3,4),(4,4,4),(4,4,8),(4,8,2),\\ (6,0,6),(6,7,6),(6,7,7),(7,6,0),(7,6,5),(7,6,7),(7,7,6),(8,2,2)\}$$

- Step 5: use S as the features, the size of the feature vector is the size of S, which is 16. For each sequence, we count the number of each 3-tuples. For example, in q_1, there is no tuple (0,6,7), so the count is 0, there is a tuple (2,2,1), so the count is 1, and so on. Then for q_1, we will get a count for all the tuples in S, that is, $q_1 = [0,1,1,1,1,1,1,1,0,0,0,0,0,0,0,1]$, similarly, $q_2 = [1,0,0,0,0,0,0,0,1,1,1,1,1,1,1,0]$. Finally, we normalize the count over the number of 3-tuples in each sequence, which in our case is 8, so the final feature vector for q_1 and q_2 are:

$$q_1 = [0.0,0.125,0.125,0.125,0.125,0.125,0.125,0.125,0.0,0.0,0.0,0.0,\\ 0.0,0.0,0.0,0.125],$$

  and

$$q_2 = [0.125,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.125,0.125,0.125,0.125,\\ 0.125,0.125,0.125,0.0]$$