Homework 6, I546

This assignment builds a simple harmonic analyzer using a hidden Markov model. Rather than focusing on *key*, as in past examples, you will build the recognizer around *chord* (e.g. I,V,etc.) , assuming the key is known and is major. The model will be constructed by hand, rather than learned from real data. I would suggest modifying the program **key_hmm.r** to do this assignment, though you are free to develop it from scratch if you prefer.

1. Choose a piece to work on from

   (a) Chopin Prelude 1 in C Major (chpn-p1.mid)

   (b) Chopin Prelude 7 in A Major (chpn-p7.mid)

   (c) Chopin Prelude 11 in B Major (chpn-p11.mid)

   (d) Chopin Prelude 23 in F Major (chpn-p23.mid)

   These pieces are short and do not stray far, if at all, from the nominal key.

2. Identify the musical time unit you will use for your harmonic analysis. The measure is usually a good choice, but some of the pieces may require, or be better served by, a different choice. You should think of the time unit as the "tatum" of the harmonic rhythm — all chord lengths should be multiples of this unit. You may wish to do this looking at printed music, but it is fine to do this simply by listening and examining the data file.

3. Build by hand a transition model using the triads built on the seven scale degrees as your states: I,ii,iii, etc. You may augment the model with additional chord states (e.g. dominant 7th, etc.) if you think this is appropriate, but it is not necessary. Create a transition probability matrix corresponding to your model. This should be represented as a $L \times L$ matrix, Q, where each row sums to 1 and L is the number of states.

4. Build a bag of notes model for each of your chords. You may do by giving probabilities to the four categories of pitch:

   (a) the root of the triad (or chord)

   (b) in the chord, but not the root

   (c) in the scale, but not the chord

   (d) out of the scale.

   However, you may want to consider more sophisticated ways of doing this (for example certain non-scale tones may be more likely under different chords). Ultimately, you must be able to compute the probability of any pitch class given any chord as a bag of notes model.

5. Partition the pitch data into measures, or whatever time unit you are using. Then compute the most likely labelling of your data using your model, using dynamic programming.

6. Create a visual display of your harmonic analysis.