# Automatic Rock ‘n’ Roll Accompaniment
## Using a Hidden Semi-Markov Model

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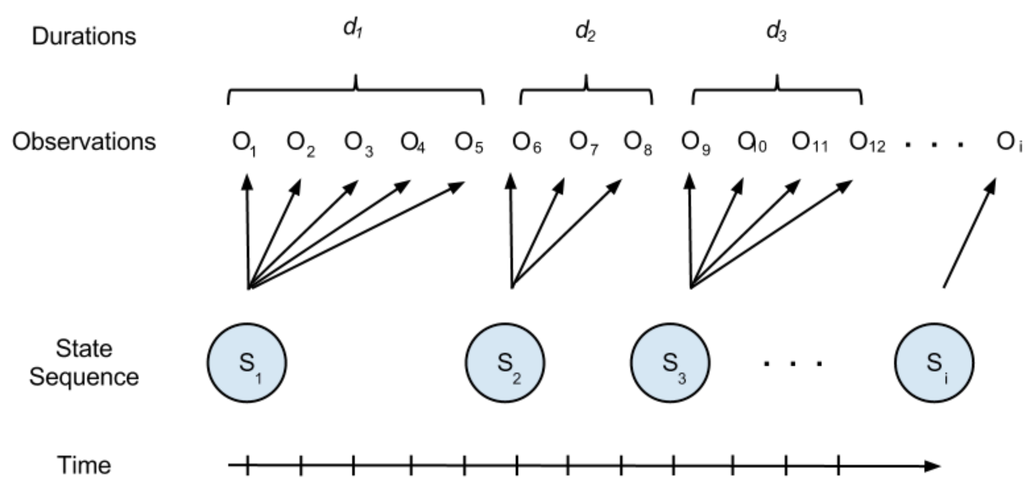
## Overview

- Hidden Markov Models (HMMs) are useful for determining likely chord progressions from melodies
- Duration of chord states is generally ignored
- Solution: Model duration of chord states (in terms of number of note observations) as an extra parameter with the Hidden semi-Markov Model (HSMM)
- Trained on a dataset of expert-transcribed Rock songs

## Model: HSMM




## Types of HSMM

- Explicit Duration HSMM
  - Transitions are independent of previous state’s duration
  - No self transitions are allowed
    - $a_{(i)} \rightarrow a_{(i+1,d)}$
- Variable Time HSMM
  - States are encoded separately for each duration
  - Self transitions allowed
  - States are often encoded uniquely for each duration
    - $a_{(i,d)} \rightarrow a_{(j,1)}$
    - $a_{(i,d)} \rightarrow a_{(i,d+1)}$
- Residential Time HSMM
  - Residential time, $\tau$, is decided upon entry into the state
  - Transitions are independent of previous state’s duration
  - Self transitions allowed

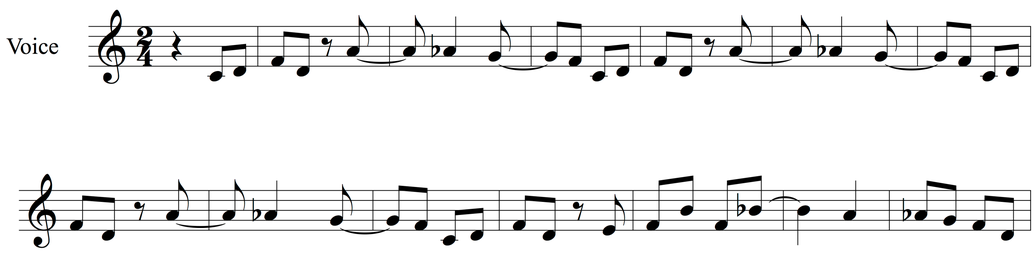
## Derived Model

- Combination of Variable Time HSMM and Explicit duration HSMM
  - Self transitions are allowed
  - Transitions are independent of previous state’s duration
  - Each state is a unique chord token, duration is modelled separately
- Viterbi Approximation
  - In order to retain realtime capabilities, self transitions are replaced with durational probabilities:

$$\frac{P(i \mid d+1)}{P(i \mid d)}$$

## Example

### Composed Melody



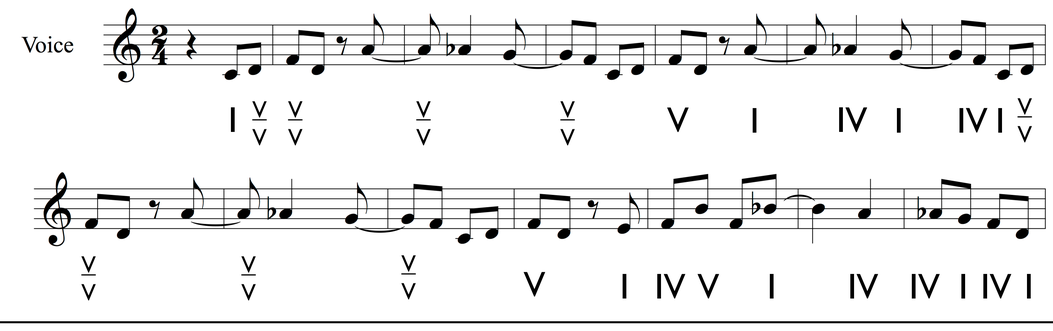

Observation Encoding for the key of C
[in key-relative pitch class]

0, 2, 5, 2, 9, 8, 7, 5, 0, 2, 5, 2, 9, 8, 7, 5, 0, 2, 5, 2, 9, 8, 7, 5, 0, 2, 5, 2, 4, 5, 11, 5, 10, 9, 8, 7, 5, 2

Resulting State Sequence [in diatonic roman numerals]

I, V/V, V/V, V/V, V/V, V/V, V/V, V/V, V/V, V/V, V, V, I, IV, I, IV, I, V/V, V/V, V/V, V/V, V/V, V/V, V/V, V/V, V/V, V, V, I, IV, V, V, I, IV, IV, I, IV, I

Resulting State Sequence aligned to initial melody input




## Future Work

- Encode duration with each note to remove duration abstraction
- Add transition dependencies on duration of previous state
- Perform large-scale evaluation

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