Hidden Markov Music

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1. Algorithmic Composition
2. Markov Processes
3. Hidden Markov Music

Algorithmic Composition

Knowledge-based Systems

- follow a set of rules defined by the programmer
- depends on knowledge of the programmer

Machine Learning

- existing compositions are used to create a model
- new compositions are produced based on the model
  - deterministic
  - probabilistic
- the challenge is in finding a model which captures the essence of music

Markov Processes

Definition

- a Markov process is a system which can exist in a number of states
- each state has a certain probability of transitioning into the next state
- that probability is independent of the past states
  - only the present matters
- may not perfectly represent the system being modeled
  - often serves as a good approximation

Markov Chain

- one of the simplest forms of a Markov process
- *do the traffic light here*

Training a Markov Chain

- to train a Markov chain, simply count the occurences of each transition
- divide each element by its row's total

	G	Y	R
G	45	5	0
Y	0	25	25
R	30	0	20

$\Rightarrow$

	G	Y	R
G	0.9	0.1	0
Y	0	0.5	0.5
R	0.6	0	0.4

Hidden Markov Model

- often the states cannot be observed directly (hidden)
- perhaps you do not even know what the states are
- hidden Markov models are Markov chains with hidden states
  - each state has a certain probability of "emitting" one or more observables

Hidden Markov Model Example

- *do the traffic light here, and talk about Marvin the Martian or whatever*

Classic HMM Problems

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   - forward and backward algorithms

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2. Given a model and an observation sequence, we want to determine the most likely sequence of hidden states
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3. Given a model and an observation sequence, we want to improve that model (or train it) to fit the observations
   - Baum–Welch algorithm

Hidden Markov Music

Overview

- we model songs as Markov processes
- notes are observed
- some underlying states are hidden from us
- we train the model on a song
  - allows us to generate new songs (algorithmic composition)
  - allows us to compare existing songs against the model, to determine how similar it is (classification)

Random Walk

- *show a graph of a simplistic model and walk through it*

First Song

- trained a model on Twinkle, Twinkle, Little Star

Twinkle, Twinkle, Little Star

- produced the following song

First Song

Audio Samples

- *play a few audio samples here*

Composer Models

- want to train models on composers, not just individual songs
- Baum–Welch algorithm only works on a single song at a time
- can join the songs together into one long one, but not ideal

Composer Model Training Issue

- *display single and multiple song training side-by-side*

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Thank You

This project is free to download at

https://github.com/dwysocki/hidden-markov-music

OSWEGO
STATE UNIVERSITY OF NEW YORK

Bonus Samples

- *add some extra samples in case time permits*