Hidden Markov Music

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Algorithmic Composition

Knowledge-based Systems

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

Machine Learning

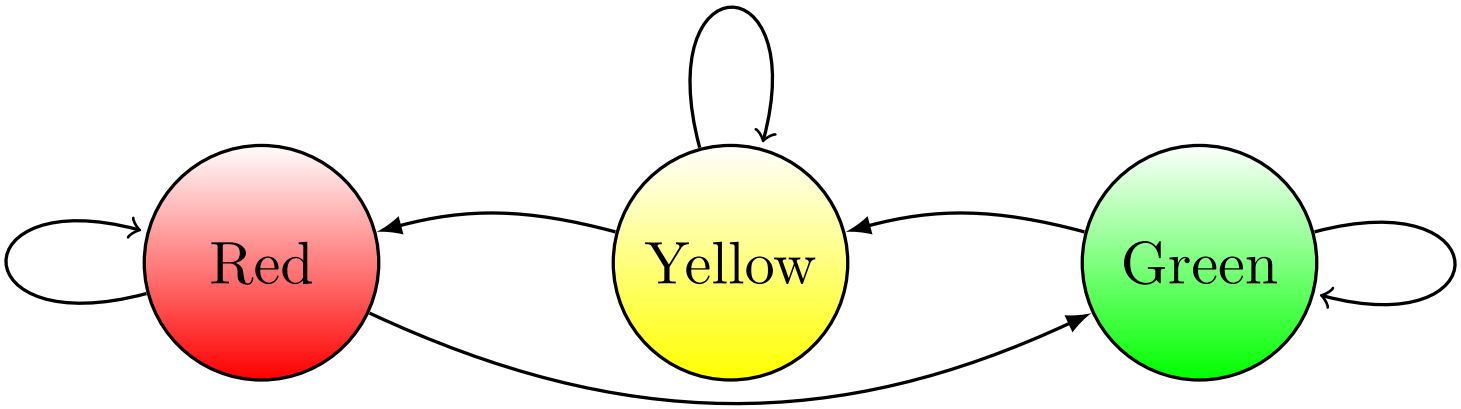
- existing compositions are used to create a model
- new compositions are produced based on the model
  - deterministic
  - probabilistic
- challenging to find a model which captures the essence of music

Markov Processes

Definition

- the future depends only on the present
- nondeterministic
- may not perfectly represent the system being modeled
  - often serves as a good approximation

Markov Chain



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

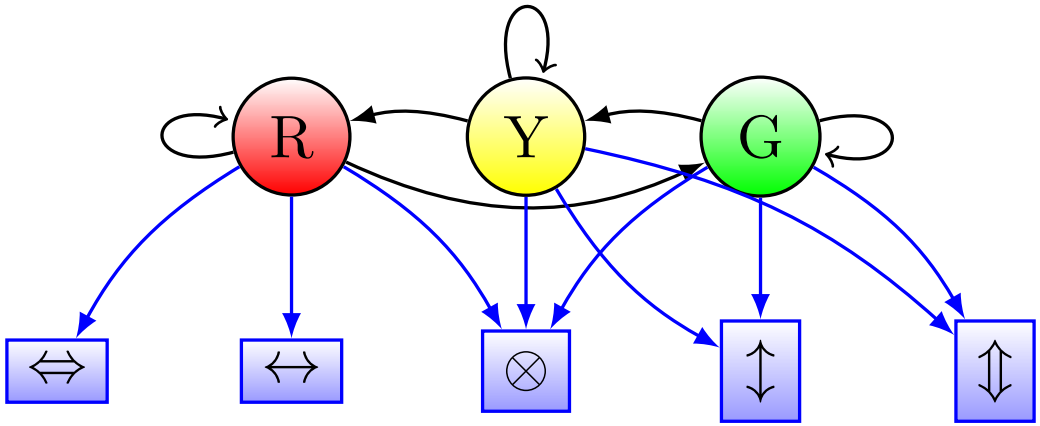
$\Rightarrow$

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

Hidden Markov Model

- Marvin the Martian is looking down at a traffic light from space
- he cannot see the actual lights, but instead he sees the speed and direction of the cars
- he can still model the traffic light, using an HMM

Hidden Markov Model Example

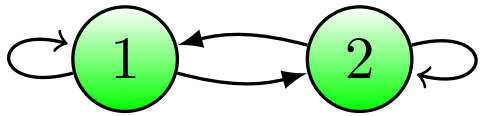


Hidden Markov Music

Overview

- we model songs as Markov processes
- notes are observed
- some underlying states of the song are hidden from us
  - we choose the number of states, and everything else is automatic
- we train the model on a song
  - allows us to generate new songs (algorithmic composition)

Model



C D E F G A B END

First Song

- trained a model on Twinkle, Twinkle, Little Star

Play

- produced the following song

Play

Für Elise

- trained a model on Beethoven's Für Elise
- using 5 states
- using 15 states

Composer Models

- want to train models on composers, not just individual songs
- training algorithm only works on a single song at a time
- can join the songs together, but loses information

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Acknowlegements

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Questions?

Listen to more pieces here

https://dwysocki.github.io/csc466/music.html

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Bonus Samples

- *add some extra samples in case time permits*