Generating music using Markov Chains

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History

Figure: Andrei Markov(1856-1922)

Markov property: "The probability of the next state depends on a previous state and not on all previous states in a sequence." (A "memoryless property")

Markov Chains

Definition 0.1

Markov chains are mathematical systems that transition from one state to another under certain probabilisitic rules.

Markov Chains

A Markov chains are a stochastic process (or random process) meaning it is a collection of random variables (e.g the result of a coin toss) indexed by a set T that often represent different instants of time.
The state space (set of all possible states) of Markov chains can be discrete or continuous.
An important feature of Markov chains are that the probability of transitioning to any particular state is dependent solely on the current state and time elapsed meaning that it doesnt matter how the process arrived at the state.
This is know as the Markov assumption.

$$P(X_i|X_{i-1}, X_{i-2}, ..., X_1) = P(X_i|X_{i-1}) \tag{1}$$

Markov Chain diagram

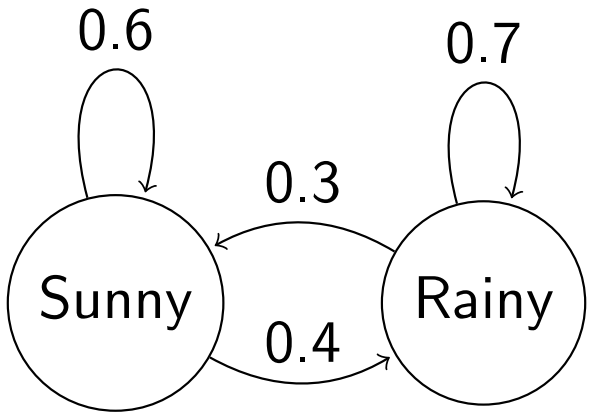


Figure: Markov chain diagram of weather

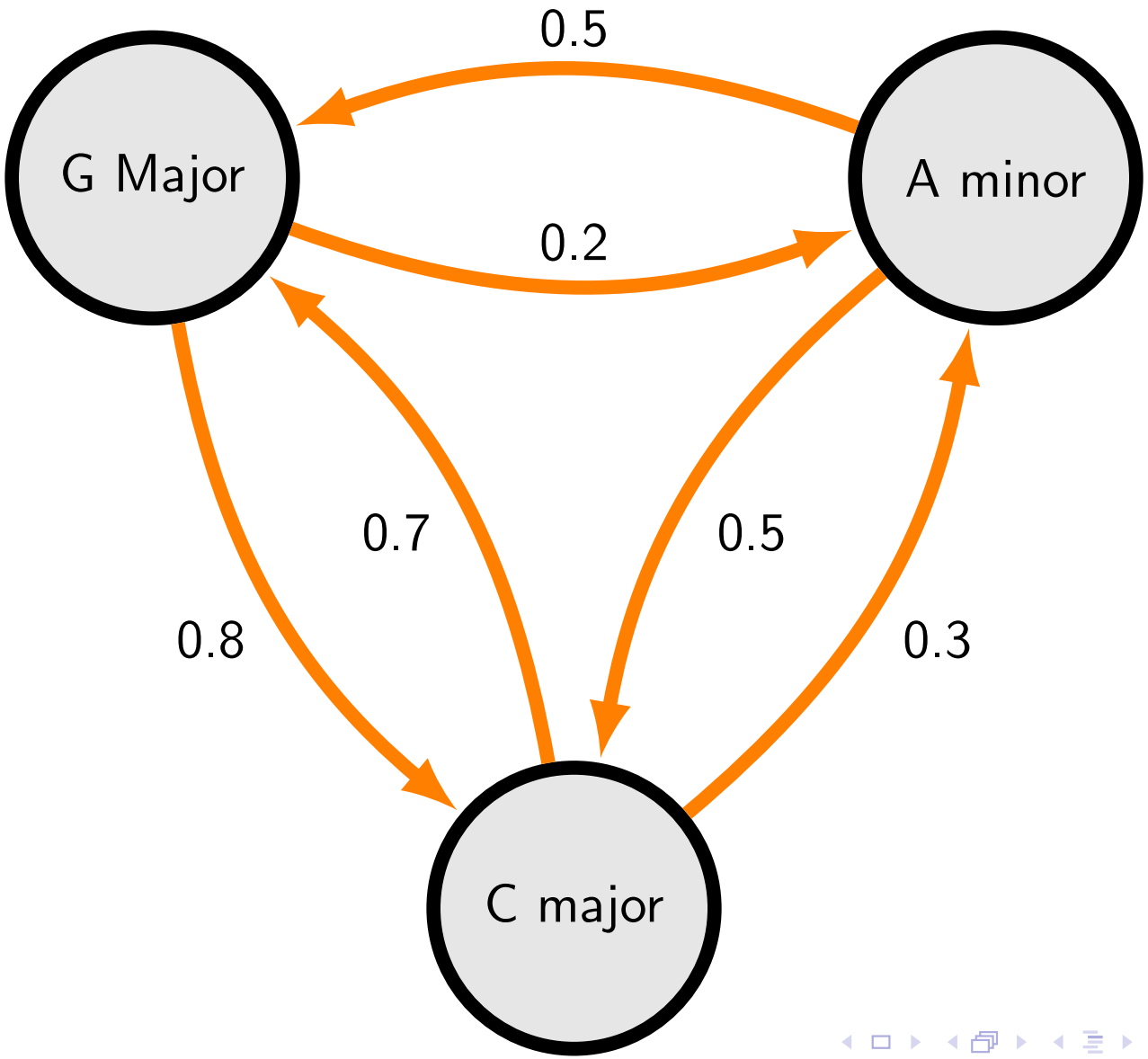
Transition matrix

	Sunny	Rain
Sunny	0.6	0.4
Rainy	0.3	0.7

Transition matrix

$$\begin{pmatrix} 0.6 & 0.4 \\ 0.3 & 0.7 \end{pmatrix}$$

Music diagram



Applications

Natural language processing
Thermodynamic
Bioinformatics
Economics
Game theory
Queueing (communication) theory
Google pagerank algorithm
Music

Research into music

I would like to generate music using markov chains. I am planning to write some code for the model.

1. Take a large data sample of chords
2. Calculate probability distribution for chords to follow a particular chord
3. Define the first chord or make a random selection
4. Make a random choice of the next chord taking into account the probability distribution, i.e the likelihood of the next chord being played from the current chord
5. Repeat step 4 for some number of steps
6. Have a finished chord progression

Using a data sample from a certain genre of music will make it so that the algorithm is more likely to generate music in the same style.

Data sample

To calculate a probability distribution I can:
1. Get a sequence of chords.
2. Make bigrams of chords next to each other.
3. Take a random chord as the initial chord in a sequence, and find the bigrams from the inital chord to another chords.
4. Then we'll calculate the frequency of each unique bigram to appear in the sequence.
5 Normalizing the result, we will get probabilities of each transition.
6. Build a graph from the initial chord then repeat the process with the nodes connected to the intial one.
I will also try other methods such as Markov Chain Monte Carlo.