

## Markov Chains<sup>1</sup>

Markov chains are employed in algorithmic music composition, particularly in software programs such as CSound or Max. In a first-order chain, the states of the system become note or pitch values, and a probability vector for each note is constructed, completing a transition probability matrix (see below). An algorithm is constructed to produce and output note values based on the transition matrix weightings, which could be MIDI note values, frequency (Hz), or any other desirable metric.

1st-order matrix				2nd-order matrix			
				Note	A	D	G
Note	A	C#	Eb	AA	0.18	0.6	0.22
A	0.1	0.6	0.3	AD	0.5	0.5	0
C#	0.25	0.05	0.7	AG	0.15	0.75	0.1
Eb	0.7	0.3	0	DD	0	0	1
				DA	0.25	0	0.75
				DG	0.9	0.1	0
				GG	0.4	0.4	0.2
				GA	0.5	0.25	0.25
				GD	1	0	0

A second-order Markov chain can be introduced by considering the current state *and* also the previous state, as indicated in the second table. Higher, *n*th-order chains tend to "group" particular notes together, while 'breaking off' into other patterns and sequences occasionally. These higher-order chains tend to generate results with a sense of phrasal structure, rather than the 'aimless wandering' produced by a first-order system.

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<sup>1</sup> URL: [http://en.wikipedia.org/wiki/Markov\\_chain#Music](http://en.wikipedia.org/wiki/Markov_chain#Music) [23.11.2008]