Analyzing and composing music with algorithms and machine learning

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Outline

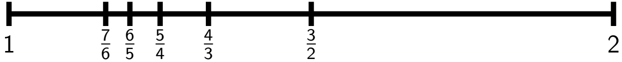
Tuning

Pythagorean tuning

Pythagorean fractions:

$$f = \frac{i+1}{i};\ \ i = 1, 2, \ldots, n$$

The Pythagorean string separation:



Equal temperment and 12-TET

Name	12-TET	Pythagorean scale
Unison (C)	$2^{\frac{0}{12}} = 1$	$\frac{1}{1} = 1$
Minor second ($C\sharp/D\flat$)	$2^{\frac{1}{12}} \approx 1.05946$	$\frac{16}{15} \approx 1.06666$
Major second (D)	$2^{\frac{2}{12}} \approx 1.12246$	$\frac{9}{8} = 1.125$
Minor third ($D\sharp/E\flat$)	$2^{\frac{3}{12}} \approx 1.18920$	$\frac{6}{5} = 1.2$
Major third (E)	$2^{\frac{4}{12}} \approx 1.25992$	$\frac{5}{4} = 1.25$
Perfect fourth (F)	$2^{\frac{5}{12}} \approx 1.33484$	$\frac{4}{3} \approx 1.33333$
Tritone ($F\sharp/G\flat$)	$2^{\frac{6}{12}} \approx 1.41421$	$\frac{7}{5} = 1.4$*
Perfect fifth (G)	$2^{\frac{7}{12}} \approx 1.49830$	$\frac{3}{2} = 1.5$
Minor sixth ($G\sharp/A\flat$)	$2^{\frac{8}{12}} \approx 1.58740$	$\frac{8}{5} = 1.6$*
Major sixth (A)	$2^{\frac{9}{12}} \approx 1.68179$	$\frac{5}{3} \approx 1.66666$*
Minor seventh ($A\sharp/B\flat$)	$2^{\frac{10}{12}} \approx 1.78179$	$\frac{16}{9} \approx 1.77777$*
Major seventh (B)	$2^{\frac{11}{12}} \approx 1.88774$	$\frac{15}{8} = 1.875$*
Octave (C)	$2^{\frac{12}{12}} = 2$	$\frac{2}{1} = 2$

Note: the values with * can't be represented like Pythagorean fractions with decent accuracy but the human ear can't differentiate this (in the most cases)

MIDI

MIDI is an acronym to “Musical Instrument Digital Interface”.
It:

- Developed by MIDI Manufacturers Association
- Targets compact representation
- Splited into chunks

This makes MIDI a perfect way to store musical data in form of notes that enables easy manipulation

Header chunk

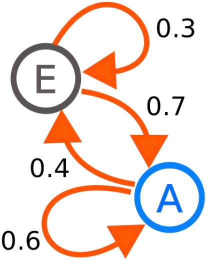
- Contains data about the file
- Always one

(M)(T)(h)(d) (0)(0)(0)(6) (0)(f) (n)(n) (d)(d)

f - the file type
nn - the number of track chunks
dd - the way of division of the time

Track chunks

Markov chains



Markov chain diagram

Andrey Markov

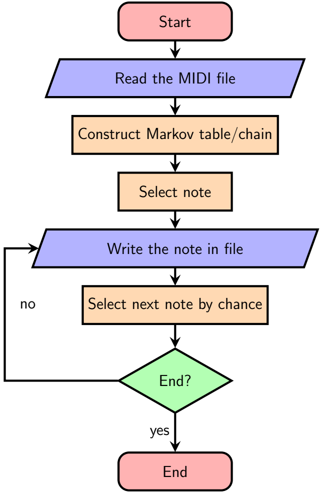
Markov chains

	Next event		
	A	B	C
A	33%	22%	45%
B	81%	9%	10%
C	30%	60%	10%

		Next event		
		A	B	C
A	A	16%	16%	68%
A	B	100%	0%	0%
A	C	12%	75%	13%
B	A	37%	25%	38%
B	B	0%	0%	100%
B	C	100%	0%	0%
C	A	33%	33%	34%
C	B	83%	17%	0%
C	C	100%	0%	0%

Example Markov chains for the string "AABAACBABACBABACCACAACBAAACBACBBCABAACBA"

Common block diagram



Diffrences between the algorithms

- First algorithm - uses only the pitch of the previous note for constructing Markov chain table
- Second algorithm - uses the pitch and the length of the previous note for constructing Markov chain table
- Third algorithm - uses only the pitch of the previous two notes for constructing Markov chain table

Reults

Questions

Thank you for the attention!