

Using textmidicgm

The MIDI-to-textmidi translator

Thomas E. Janzen

Copyright © 2024 Thomas E. Janzen.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts. A copy of the license is included in the section entitled “GNU Free Documentation License.”

Table of Contents

1	Overview	2
1.1	What is textmidicgm?	3
1.2	History	3
2	Invoking textmidicgm	4
2.1	Options	4
2.2	Invocation Examples	12
3	The Model of Musical Form	13
4	The Original Text Form File	16
5	The XML Form File	21
6	The textmidi File	30
7	The Gnuplot File	31
8	Installation	32
9	GNU Free Documentation License	33
9.1	PREAMBLE	33
9.2	APPLICABILITY AND DEFINITIONS	33
9.3	VERBATIM COPYING	35
9.4	COPYING IN QUANTITY	35
9.5	MODIFICATIONS	36
9.6	COMBINING DOCUMENTS	37
9.7	COLLECTIONS OF DOCUMENTS	38
9.8	AGGREGATION WITH INDEPENDENT WORKS	38
9.9	TRANSLATION	38
9.10	TERMINATION	39
9.11	FUTURE REVISIONS OF THIS LICENSE	39
9.12	RELICENSING	40
9.13	How to use this License for your documents	40
10	Program and File Index	41
11	Bibliography	42
12	Concept Index	43

1 Overview

The `textmidicgm` program generates works of music in textmidi language, which can be converted by `textmidi` into standard MIDI file formats. Using `textmidicgm`, it is possible to generate pieces of music in a text file using textmidi language, which can in turn be converted by `textmidi` into a standard MIDI file. The resulting text files can be edited in text editors, processed with text tools, and enriched using a macro processor such as `m4`. (The C preprocessor uses the pound sign (`#`), which is a sharp sign in textmidi language.)

`textmidicgm` chooses pitches as MIDI key numbers from an even distribution of a random variable, and similarly for MIDI velocities and rhythmic durations. In addition, the current ranges of key, velocity and duration are modulated as sinusoids of any period but typically 2 to 5 minutes, which control, roughly, the mean and range for each, and the number of voices playing. A MIDI-key-based scale is specified in the input file formats, along with a pulse, which can force a pseudo-metrical feel on the music. If pulse is zero, then the rhythm will be more fluid or conversational. It is also possible to force a random-walk melody rather than use white-random key numbers. The text file specification implements this original scheme. The text file specification is deprecated and may lose support.

The XML file format implements this scheme with a few added features, such as parallel-tracking voices, setting the probabilities of a random walk moving up,down or repeating the key number; amplitudes and offsets for the form sinusoids.

Aside from a few simple added features, the compositional engine of `textmidicgm` is described in *AlgoRhythms: Real-Time Algorithmic Composition for a Microcomputer*, by Thomas E. Janzen, pp. 109-210, *Readings in Computer-Generated Music*, Denis Baggi, ed. *AlgoRhythms* 1.0 and 2.0 were released as open-source software on the Commodore Amiga and distributed at least on "Fred Fish" disks starting in 1990. *AlgoRhythms* 3.0 was probably not released; it combined MIDI and Amiga Audio voices.

`textmidicgm` writes computer-generated music using evenly-distributed random numbers controlled by sinusoidal waveforms that (usually slowly) change the character of the music. `textmidicgm` does not make use of AI (Artificial Intelligence). It does not train on other pre-existing music or other material. The mathematics it references is limited to simple population statistics (although the mean is imprecisely used) and trigonometric functions, because that's all the math I knew in 1976, when I conceived this approach to form (and prior to my engineering education). The specific key (note) numbers, durations and velocities (loudnesses) are derived from flat, evenly-distributed random numbers, because that is what I explored in about 1980 on a Radio Shack TRS80. Any resemblance to previously-existing music is purely coincidental. `textmidicgm` writes multiple monophonic lines (one line per track) and does not model themes, motifs, melodies, harmony or harmonic movement (with the exception of allowing parallel follower voices), nor a grammar of note movement or harmonic movement.

`textmidicgm` always generates one voice per track, in textmidi LAZY mode.

The textmidi language is described in the info page for `textmidi`.

1.1 What is textmidicgm?

The program `textmidicgm` generates a work of music basically using evenly-distributed ("white") random numbers to select of MIDI keynumbers, MIDI velocities, and durations. The output file is a text file in textmidi language.

Unlike the original AlgoRhythms program, which had a real-time GUI and permitted changes to a Form while playing, `textmidicgm` is a "batch" program which reads and writes files, but does not record or play over a MIDI interface.

The rationale for `textmidicgm` comprises several incentives:

- The use of simple statistical distributions as a source of musical choices has not been fully exploited. Iannis Xenakis's Akrata used a Gaussian density distribution, and LeJaren Hiller started with random notes before moving on to Markov chains, but further experimentation might have been productive before proceeding to advanced and exotic techniques. `textmidicgm` provides a tool for continued exploration of evenly-distributed random notes etc.
- The use of sinusoids to modulate the ranges of key number, loudness (dynamics), duration and number of voices explores an approach to musical form as the modulation of the character of the musical texture. This approach to musical form was used in Thomas E. Janzen's hand-composed piano works *Animations* (1977) and *Lucy's Dance* (1982). It is perfectly fine to experimental with very short periods, say 0.1 seconds, and very long ones, such as 1000000000.0 seconds (which produces a static performance).
- Just as human auditors in a Turing Test can be forgiving of computer and human entrants, those who listen to the music from `textmidicgm` can sometimes embue the music with meaning that depends on their imaginations and not on how the music was generated.
- `textmidicgm` is not, by itself, intended to imitate any known style of music. The presumption is Bach wrote all the Bach music that is needed, and bad jazz players in the 1950's made all the bad jazz that is needed. `textmidicgm` makes its own music.
- `textmidicgm` is a medium. When an artist uses a graphite pencil, they do not expect to produce a full-color image with painterly marks. A musician using `textmidicgm` doesn't expect to produce a movement in sonata form, or a Country song.
- `textmidicgm` exploits the conveniences of the MIDI interface definitions of key number, velocity, and duration. This off-loads `textmidicgm` from concerns with DSP and instrument sound generation.

1.2 History

`textmidicgm` enlarges on the approach developed in 1989 as "AlgoRhythms" for the Commodore Amiga (running AmigaDOS) and improved a couple years later. The compositional engine was adapted in 2004 for linux and to produce text-based textmidi files. Improvements in 2020 and 2021 added minor features.

`textmidicgm` is a command-line batch program and not an interactive graphical program as AlgoRhythms was.

2 Invoking textmidicgm

2.1 Options

```
textmidicgm -f|--form
    text_form_file_glob...|
-x|--xmlform xml_form_file_glob...
[-u|--update]
[-r|--random]
[-a|--answer]
[-i|--instruments {piano | chromaticpercussion | organ | guitar | bass | strings | en-
semble | brass
| reed | pipe | synthlead | synthpad | syntheffects | ethnic | percussive | soundeffects
| all | melodic | idiophone...}]
[-o|--textmidi output textmidi file] [-g|--gnuplot]
[-c|--clampscale]
[-z|--arrangements {rotateright | rotateleft | reverse
| previouspermutation | nextpermutation | swappairs | shuffle | skip | heaps }
[-t|--maxeventspertack {integer}
[-y|--arrangementsperiod {time in seconds}
[-w|--dotted_rhythms true|false
[-e|--rhythmexpression rational|simplecontinuedfraction
[-h|--help] [-V|--version] [-v|--verbose]
[-k|--stacktracks]
```

-f, --form *text_form_file*

The input file: a text file in the format used in the original 1990 version, probably. Use of this file format is deprecated.

-x, --xmlform *xml_form_file_glob...*

The input file: an XML file supporting more features. If **--random** is specified, the form's output file. This file name when used for input may be used to glob several files. Globbing filenames uses wildcards such as an asterisk to mean either nothing or any of something; A question mark is a placeholder for one mandatory character; character sets are groups with square brackets. Globbing is supported by the C standard library and POSIX.2. Each resolved filename is processed in turn; the *name_* field is used to form an output file name. If **--stacktracks** is specified, then each resolved form file's results are appended to the output file without FILEHEADER lines. The FILEHEADER may show an incorrect number of total tracks, but that is allowed because textmidi ignores the number of tracks given in the FILEHEADER line.

-r, --update

Update a version 0 XML form file to version 4. For

```
textmidicgm --xmlformfile symphony.xml --update
```

produces an updated version of symphony.xml called update_symphony.xml that is in the current format of an XML form file.

-r, --random

Make a random form, write it to the base filename given, adding ".xml" and exit.

- *name* takes the name from the argument provided to the **--random** argument (don't add a file extension extension).

- A copyright notice can be written into the *copyright* tag.
- The *len* tag is in seconds and is the total length of the music work.
- *min_note_len* is in seconds and is the shortest note length to generate, unless *pulse* is longer. It is set in the range $[0.03125 \dots 0.03125 + \text{random}[0 \dots 1.0]]$
- $\text{max_note_len} = \text{min_note_len} + \text{random}[0 \dots 1.0] * 2$
- *pulse* is random in $(0.0 \dots 16.0)$.
- The melody probabilities are set to rest 1/8 of the time on average; the probabilities of walking down and repeating the same pitch are random; the walking up probability is set to be equal to the down probability so that the voice doesn't wander off to one end of its range.
- The form sines are all set with offsets and gains such that that the sines vary in $(0.0 \dots 1.0)$.
- The form sines period is random from 1 to 6 minutes and the phase is random in the range $(-\pi \dots +\pi)$.
- The scale is randomly selected from diatonic, minor, whole, diminished, pentatonic (think Debussy), tritone (C, D, E, F, F#, G#, A#, B), chromatic, on any chromatic step. The scales themselves cover the full range of MIDI key numbers.
- The number of voices is random in $(1 \dots 24)$. MIDI channels $(1 \dots 16)$ are used sequentially save channel 10, which General MIDI assigns to idiophones; if idiophones are selected with `--instruments idiophone` then channel 10 is used for an idiophone channel. Idiophones are not used unless specified by use of option `--instruments idiophone`, along with other instrument groups if desired.
- Each voice is set to use a random MIDI channel from $(1 \dots 16)$, exclusive of 10. If the idiophone program is selected then the channel for a voice is set to 10.
- A voice is randomly selected to walk or skip.
- The General MIDI program is selected depending on the instruments selected with `--instruments`. The voices' ranges are limited by the characteristic range of the instruments selected, using <http://en.wikipedia.org> to look up the actual instruments.
- The pan is set to spread the channels across the audio field from left to right, starting from the center. Idiophones on channel 10 are always centered. We don't want other channels to be pushed over to one side. There are one more stereo zones than the number of channels. For example: If there is one MIDI channel, there will be two zones, one on the left and one on the right, and the channel is centered:

```
(-----|-----)
L-----C-----R
      ^
```

Two voices have 3 zones:

```
(-----|-----|-----)
```

L-----C-----R
 ^ ^

3 voices have 4 zones:

(---|----|-----|---)
 L-----C-----R
 ^ ^ ^

- Set each voice's follower status:
- Random follow flag and leader voice.
- If the leader is a follower, then set the voice to lead. If the leader voice is a leader, then set this voice
 - Random interval type
 - random delay to something less than a whole note.
 - duration_factor of 1.
 - randomly set whether to invert the voice
 - randomly set whether to make the voice retrograde
- Set high and low pitches to match plausible values for the General MIDI instruments
- Clamp the scale to not exceed the instruments as a whole ensemble.
- Set the arrangement definition to have
 - a randomly selected permutation algorithm and
 - a random period in [0.0..30].

After the random form file has been written it may be edited, then used as an input to the `--xmlform` option.

`-i, --instruments {piano chromaticpercussion organ guitar bass strings ensemble brass reed pipe synthlead synthpad syntheffects ethnic percussive soundeffects all melodic idiophone...}`

Select the groups of General MIDI instruments (patches) to use. The selections may be repeated to affect their probability of being selected. For example, "strings strings piano" will create a complement in the form file that is twice as likely to have strings as pianos. Note that idiophones appear on channel 10, as per the MIDI 1.1 spec, and the range of scale used will be limited to the range given in the MIDI spec for idiophones, and will also be limited to the scale used. The default is all non-idiophones.

`-o, --textmidi textmidi_output_file`

The output file, in textmidi text language.

`-g, --gnuplot`

Output a file of gnuplot data.

`-c, --clampscale`

Trims the scale to remove low notes below the lowest low pitch in the voices, and to remove high notes above the highest high pitch in the voices. The scale will still cover the union of ranges of all of the voices. The purpose of this is to avoid an effect in which the pitch curve is, say, low, and the voice just

bangs away at the voice’s lowest note for a long time without moving at all until such time as the pitch curve starts to edge up above that low pitch for the voice. Because it is not a per-voice adjustment it is not a complete solution, but is coherent with the original technique. This option does not assume an rising-ordered scale.

`-z, --arrangements rotateright | rotateleft | reverse | previouspermutation | nextpermutation | swappairs | shuffle | skip | heaps`

Periodically reorder the voice priority for the purposes of applying the texture curve, which determines how large a portion of the complement (the ensemble) is playing. Without this feature, when the texture curve was thin, and a solo instrument played, it would always be the same voice and instrument playing. By re-ordering the voices now and then, a different voice can be the soloist at those times. For example, if `arrangementsperiod` is set to the same duration as the texture period, then each time the texture permits only one track to play, a different voice and instrument will play the solo. This has no effect on which voice follows another; those remain as they were at the start. The algorithms are based (with the exception of `swappairs`) on C++ standard library algorithms for containers. For example, if a form has four voices and use apply `--arrangements rotateright` and `--arrangementsperiod 15`, then every 15 seconds the voice orders will be

```
0 1 2 3
3 0 1 2
2 3 0 1
1 2 3 0
...
```

In this example, the solo would be from voice 0 for 15 seconds, then from voice 1 for 15 seconds, then from voice 2, then voice 1. During a time when only 2 voices are playing, first voices 0 and 1 would play, then in the next 15 seconds voice 3 and 0 would play, and so on. This might be different from what it did before April 2023 (I’m not sure), but is probably more intuitive than before.

‘identity’

The identity arrangement never changes the voice priority. If ‘`--arrangementsperiod 15`’ the voice arrangements will just remain the same:

```
00:00 0 1 2 3
00:15 0 1 2 3
00:30 0 1 2 3
...
```

‘rotateright’

Rotate right pushes the voices down in priority and brings the last voice to the top. The new top voice plays the solo when the texture curve is thin. If ‘`--arrangementsperiod 15`’ the voice arrangements will change every 15 seconds and be:

```
00:00 0 1 2 3
00:15 3 0 1 2
00:30 2 3 0 1
00:45 1 2 3 0
```

```
01:00 0 1 2 3
01:15 3 0 1 2
```

‘rotateleft’

Rotate left pulls the voices up in priority and pushes the top voice to the last position.

```
0 1 2 3
1 2 3 0
2 3 0 1
3 0 1 2
0 1 2 3
1 2 3 0
```

‘reverse’ Reverse the order of voices. The last voice becomes first in priority, and vis versa. Alternate periods produce the same priority order.

```
0 1 2 3
3 2 1 0
0 1 2 3
```

‘previouspermutation’

Find and apply the previous permutation of the voice in terms of the integer priority, where 0 is the highest and plays the solo when the texture curve is thinnest. These are lexicographically sorted descending permutations.

```
0 1 2 3
3 2 1 0
3 2 0 1
3 1 2 0
3 1 0 2
3 0 2 1
3 0 1 2
2 3 1 0
2 3 0 1
2 1 3 0
2 1 0 3
2 0 3 1
2 0 1 3
1 3 2 0
1 3 0 2
1 2 3 0
1 2 0 3
1 0 3 2
1 0 2 3
0 3 2 1
0 3 1 2
0 2 3 1
0 2 1 3
0 1 3 2
```

‘nextpermutation’

Permute the voices in terms of the integer priority to the next permutation. These are lexicographically sorted ascending permutations.

```
0 1 2 3
0 1 3 2
0 2 1 3
```

```

0 2 3 1
0 3 1 2
0 3 2 1
1 0 2 3
1 0 3 2
1 2 0 3
1 2 3 0
1 3 0 2
1 3 2 0
2 0 1 3
2 0 3 1
2 1 0 3
2 1 3 0
2 3 0 1
2 3 1 0
3 0 1 2
3 0 2 1
3 1 0 2
3 1 2 0
3 2 0 1
3 2 1 0

```

‘swappairs’

Swap neighboring voices. Every other swap gets the same priority order.

```

0 1 2 3
1 0 3 2
0 1 2 3

```

‘shuffle’ Randomly shuffle the voices each scramble period. There’s no guarantee of producing all permutations.

```

0 1 2 3
3 0 1 2
3 0 1 2
3 0 2 1
3 0 2 1
0 2 1 3
0 1 3 2
2 1 0 3
3 1 2 0
3 0 2 1

```

‘skip’ Shifts the first, third, fifth, etc. voices to the right and the second, fourth, sixth, tracks to the left.

```

0 1 2 3 4
1 0 3 2 4
1 3 0 4 2
3 1 4 0 2
3 4 1 2 0
4 3 2 1 0
4 2 3 0 1
2 4 0 3 1
2 0 4 1 3
0 2 1 4 3

```

For an even number of voices it’s a little more nuanced.

```

0 1 2 3
1 0 3 2

```

```

2 3 0 1
3 2 1 0
0 1 2 3
1 0 3 2
2 3 0 1
3 2 1 0
0 1 2 3
1 0 3 2

```

‘heaps’ Applies Heap’s Algorithm to scramble voices in such a way that only 2 voices swap in each successive permutation.

```

0 1 2 3
1 0 2 3
2 0 1 3
0 2 1 3
1 2 0 3
2 1 0 3
3 1 0 2
1 3 0 2
0 3 1 2
3 0 1 2
1 0 3 2
0 1 3 2
0 2 3 1
2 0 3 1
3 0 2 1
0 3 2 1
2 3 0 1
3 2 0 1
3 2 1 0
2 3 1 0
1 3 2 0
3 1 2 0
2 1 3 0
1 2 3 0

```

-y, --arrangementsperiod time_in_seconds

The time period in seconds at which to apply the track scramble algorithm. The default is 1000 minutes.

-t, --maxeventspertack integer_events

Puts a limit on the number of MIDI events generated for a single track, in order to avoid generating over-large files. The default is 100,000 events.

-w, --dotted_rhythms true|false

Used with **-lazy**, selects dotted rhythms or only rational numbers (including an integer with an implied “1/”). The default is to use dotted rhythms. If true, any rhythm with a numerator that is a power of 2 minus 1 (n^2-1), e.g.: 3, 7, 15, 31, 63, will be written as a dotted rhythm.

If “true”, then “3/8” will appear as “4.”, else as “3/8”.

-e, --rhythmexpression rational|simplecontinuedfraction

Used with **-lazy**, selects either a rational or simple continued fraction expression of rhythm. The default is a rational-like musical rhythm. Note that **textmidicgm** uses **-e** while both **miditext** and **smustextmidi** use **-r**. See **textmidi.pdf** for details of the syntax of simple continued fractions.

- `-v, --verbose`
Write some informative messages to the screen. Errors are printed regardless.
- `-V, --version`
Print the version of `textmidicgm`.
- `-h, --help`
Print the options summary.

```
Usage: textmidicgm [OPTION]... [XMLFORMFILE]...
textmidicgm Version 1.0.86
Allowed options:
-h [ --help ]                help
-v [ --verbose ]             write more trace information
-k [ --stacktracks ]        process each form file and add its tracks to
                             the same output textmidi score
-V [ --version ]            Write version information
-f [ --form ] arg           input plain text Form files; double-quote
                             wildcards
-x [ --xmlform ] arg        input XML text Form files; double-quote
                             wildcards
-u [ --update ]             update XML file with update_ prefix on the
                             name given to --xmlform
-a [ --answer ]             Ask before overwriting a file
-o [ --textmidi ] arg       textmidi file
-g [ --gnuplot ]            gnuplot data output file
-r [ --random ] arg         write a random form to the name given and
                             exit
-i [ --instruments ] arg    random instrument groups: piano
                             chromaticpercussion organ guitar bass strings
                             ensemble brass reed pipe synthlead synthpad
                             syntheffects ethnic percussive soundeffects
                             all melodic idiophone
-c [ --clampscale ]         In each form, clamp the scale to the union of
                             the voice ranges
-z [ --arrangements ] arg   rotateright rotateleft reverse
                             previouspermutation nextpermutation swappairs
                             shuffle skip heaps identity
-t [ --maxeventspetrack ] arg Maximum number of events in a track before
                             stopping
-y [ --arrangementsperiod ] arg seconds before changing voice priority
-w [ --dotted_rhythms ] arg true or false
-e [ --rhythmexpression ] arg rational or simplecontinuedfraction

Report bugs to: janzentome@gmail.com
textmidicgm home page: https://github.com/tomejanzen/textmiditools
```

`-k|--stacktracks`

The `--stacktracks` options cause all of the form file names resolved from the list and globbing to have their resulting textmidi output to be added to one output file. The output file name may be specified with the `--textmidi` option, otherwise it will be taken from the name field of the first form file.

Note that the XML file produced can be edited to reflect your interests; you will learn what XML and boost serialization can accept for edits.

2.2 Invocation Examples

The following command will read the XML form file *graduallyitsmorning.xml* and generate the textmidi text file *graduallyitsmorning.txt*:

```
textmidicgm --xmlform graduallyitsmorning.mid --textmidi graduallyitsmorning.txt
```

The following generates a randomized form file for generation in another step, and then converted into a MIDI file:

```
textmidicgm --random --xmlform newpiece.xml  
textmidicgm --xmlform newpiece.xml --textmidi newpiece.txt  
textmidi --textmidi newpiece.txt --midi newpiece.mid
```

The following example generates a data file that can be plotted as a statistical plot with error bars:

```
textmidicgm --xmlform newpiece.xml --textmidi newpiece.txt --gnuplot
```

The gnuplot data file will be named from the name inside the XML form file, with “.plot” appended.

3 The Model of Musical Form

The `textmidicgm` program models musical form as a musical character that is modulated by sinusoids. This was explored in a traditionally-composed work in 1976/1977, and again in 1982. It was automated by the `AlgoRhythms` program distributed as open-source software for the Commodore Amiga, which was described in a paper listed in the Bibliography.

Note that a hard limit of 100,000 note events has been added to avoid filling a disk because selections produce notes of short length with a static rhythm mean.

`textmidicgm` does not model musical melody, meter, harmony, or traditional forms such as sonata form.

Musical character is described as the following instantaneous statistical quantities:

- Pitch
 - Mean: The mean, or average, pitch (actually the mean MIDI key number);
 - period: in seconds
 - phase: in radians (sorry). Note that one full circle is two pi radians (about 6.28). Ninety degrees is $\pi/2$, about 1.5707 radians, and so on. Phase may be negative, so the full range could be represented from about -3.14159 to +3.14159.
 - Range: The range of key numbers from which one is selected. A narrow range will select a narrow range around the value of the mean.
 - period: in seconds
 - phase: in radians
- Dynamic
 - Mean: The mean MIDI key velocity, or loudness.
 - period: in seconds
 - phase: in radians
 - Range: The range of velocity from which one is selected for the note event.
 - period: in seconds
 - phase: in radians
- Duration
 - Mean: The mean duration of individual notes from the overall range given separately. Note that the pulse setting in the form file specifies a minimum duration that supersedes the minimum duration given in the form file. A pulse of, for example, a fifth of a second or so tends to make the music bounce a bit, as though it had a time signature, although `textmidicgm` does not specify a time signature or other way to group rhythmic values.
 - period: in seconds
 - phase: in radians
 - Range: The range of duration from which one is selected; this range is a subset of the overall range, which is given separately.
 - period: in seconds
 - phase: in radians

- Texture (number of voices)
 - Range: The number of voices playing polyphonically.
 - period: in seconds
 - phase: in radians

These quantities can be modulated over time so that the character of the music varies. Edgard Varese explored using statistical functions to modulate musical character. `textmidicgm` uses sinusoids, typically with periods of one to a few minutes. Periods that are very long relative to the length of the piece produce static pieces that in which the musical character does not change, which has its own fascination. Because the seven sinusoids can each have a unique phase and period, the exact character of the music might not repeat at all for long pieces.

In addition to this approach to musical form, `textmidicgm` specifies a musical work as having:

- name: the name of the piece;
- len: a length in seconds for the entire piece;
- min_note_len: the global minimum length of a note in seconds;
- max_note_len: the global maximum length of a note in seconds;
- scale: the full scale in MIDI key numbers;
- pulse: which forces notes to start together on a number of pulses per second;
- melody_probabilities: the cumulative probabilities of a walking-mode melody taking a step up, down, or repeating the last key number;
- pitch_form: as described above;
- rhythm_form: as described above;
- dynamic_form: as described above;
- texture_form: as described above;
- a number of voices, each of which has the following attributes:
 - low_pitch: a pitch below which the voice is tacet;
 - high_pitch: a pitch above which the voice is tacet;
 - channel: the MIDI voice channel;
 - walking: the probability that a voice is in walking mode, randomized note to note. A zero makes the voices always random key (or somewhat jumpy); a 1.0 makes the voice walk in the scale. A value between 0.0 and 1.0 is the probability that the voice will be walking, note event to note event; if not walking, leap randomly.
 - program: in the XML form file, a MIDI program, mapped by General MIDI to an instrument sound;
 - pan: a left-right stereo pan value;
 - in the XML file each voice can be defined as a follower by:
 - follow: 0 to be a unique melody; 1 to follow another voice
 - leader: the leader voice to follow (with voices numbered 0...). The leader may be a higher-numbered voice.
 - interval_type: a scaler or chromatic interval;

- interval: the interval, from -128 to + 128;
- delay: a rational musical rhythm value to delay after the leader;
- duration_factor: a rational value with which multiply all of the leader's durations (a conventional ratio: 4 is 4 whole notes; use 1/4 for one fourth);
- inversion: 0 to not invert the melody; 1 to invert;
- retrograde: 0 to copy the leader forwards; 1 to copy it in reverse time.

4 The Original Text Form File

The original text form file was developed for the Amiga version of this music generator. It may now be slightly different from that for the Amiga, but probably it is identical to the form file for AlgoRhythms 2.0. The original text form file is now deprecated in favor of the XML form file.

Individual notes have key numbers, velocities (dynamics), and durations that are selected using evenly-distributed (“white”). At a given moment these values are selected from ranges of key number, velocity, and duration that are determined by sinusoidal curves defined in the form file. There are seven curves:

- Pitch
 - Mean Sinusoid: The peak of the sinusoid selects high pitches (MIDI key numbers); the low part selects low pitches.
 - Range Sinusoid: A narrow range will select a narrow range around the value of the mean sinusoid.
- Dynamic
 - Mean Sinusoid: The peak of the sinusoid selects high (loud) velocities; The low part selects softer dynamics.
 - Range Sinusoid
- Duration
 - Mean Sinusoid: The peak of the sinusoid selects long durations from the full duration range specified in the form file. The low part selects shorter durations. Note that the pulse setting in the form file specifies a minimum duration that supersedes the minimum duration given in the form file. A pulse of, for example, a fifth of a second or so tends to make the music bounce a bit, as though it had a time signature, although `textmidicgm` does not specify a time signature or other way to group rhythmic values.
 - Range Sinusoid
- Texture (number of voices)
 - Range Sinusoid The range sinusoid merely specifies how many voices will play, in the order of the voice list. At the peak of the texture sinusoid, all of the voices will play. At the low point, only one voice will play.

The range sinusoid is used to spread out the mean. The mean sinusoid:

```

      **
    *   *
  *     *
    *   *   *
      *     *
        *   *
          **

```

The range sinusoid: The lowest values of the range wave indicates a narrow range.

```

*****
*****          **
*****          ***

```

```

*****
*****      ***
*****      **
*****

```

The range sinusoid, by halves, added to and subtracted from the mean sinusoid:

```

****
*****
*****
*****      *
*****      **
*****      ***
*****      ****
**      *****
          * * ***** *

```

Note that the range and mean sinusoids can have different periods and different phases so that they do not align like the example above. In addition, note that when the range goes beyond the actual limits of key number or dynamic, it is clipped, or truncated to the practical limit. Because the range sinusoid, which varies (0. . . 1), is defined as covering the full range, this happens any time that the added range exceeds the peak of the mean sinusoid, or below its minimum. Originally the form sinusoids had periods of about 1 to 4 minutes. To make a static, unchanging, form, use very long periods, such as millions of seconds.

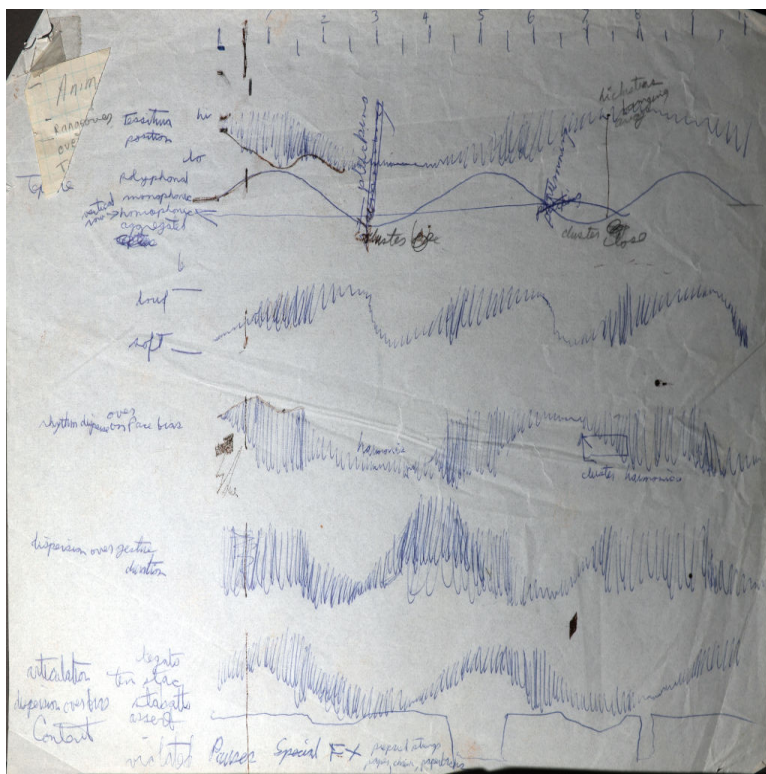


Figure 4.1: Animations (1976, conventionally composed) drawn plot

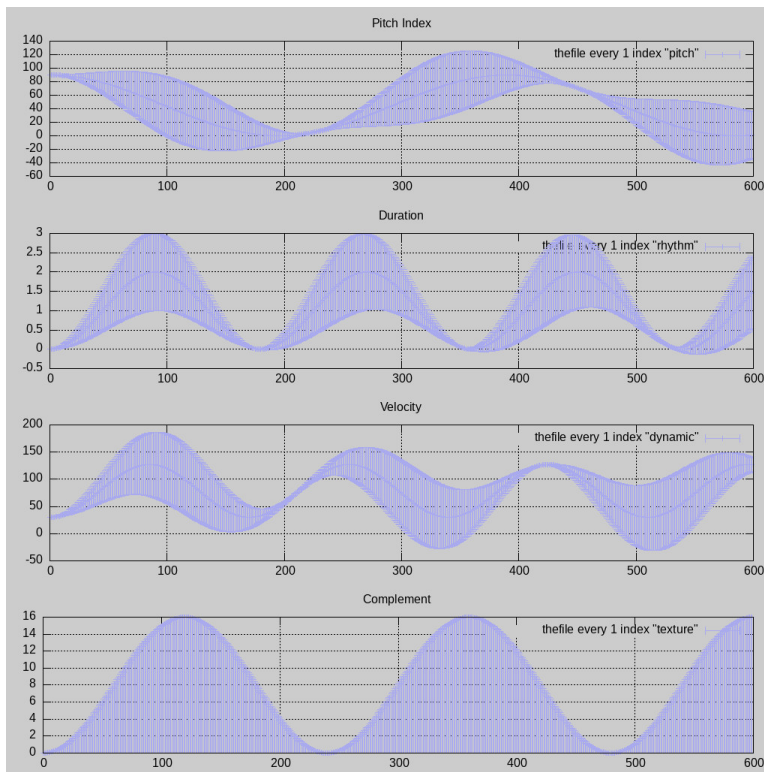


Figure 4.2: Animations (1977, conventionally composed) plot using textmidicgm.gnuplot.

```
[seconds duration of entire musical piece]
[minimum individual note length in seconds]
[maximum individual note length in seconds]
[number of scale tones]
[scale MIDI key numbers (Middle C = 60)]
...
[number of voices]
[pulses per second]
[pitch period of mean]
[pitch phase of mean]
[pitch period of range]
[pitch phase of range]
[duration period of mean]
[duration phase of mean]
[duration period of range]
[duration phase of range]
[velocity period of mean]
[velocity phase of mean]
[velocity period of range]
[velocity phase of range]
[texture period of range]
[texture phase of range]
[voice 0 low pitch] [high pitch] [channel 0-15] [walking flag]
...
```

For example:

```
600.00
0.00
2.00
13
48
50
53
55
58
60
62
65
67
70
72
74
77
4
6
200.00
-1.57
200.00
-1.57
200.00
1.57
200.00
-1.57
200.00
-1.57
200.00
-1.57
200.00
-1.57
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 96 14 1
24 120 14 0
24 120 14 0
24 120 14 0
24 120 14 0
```

5 The XML Form File

The XML version of the form file is a boost serialization XML archive format. (Cf. <https://boost.org>). The format must be exactly as expected by boost serialization; for example, comments may not be added. On the other hand, the floating point values need not have all the trailing fractional zeroes that are written by boost serialization. Note that the `<count>` tag must have the correct length of the following data, for example for the scale length. If `<count>` is corrected afterward, then you may add or delete members of a container. The new format of XML Form file adds a number of items for specifying the form to the original text format:

- Melody Probabilities When using a random walk, the probability of walking up or down, or repeating the previous key number, or by implication, resting, can be specified. These probabilities are cumulative and act as thresholds.
 - Up: **up** is the probability of a walking voice either being silent, walking down or repeating the last note; if the random variable \geq **up**, then it walks up the scale;
 - Same: **same** is the probability of a walking voice either being silent or walking down. If the random variable \geq **same** and $<$ **up**, then it repeats the last pitch.
 - Down: **down** is the probability of a walking voice being silent. If the random variable \geq **down** but $<$ **same**, then it walks down; otherwise it rests.
 - Rest: If the random variable $<$ **down**, the walking voice rests.

down = *probability(resting)*

same = *probability(resting)* + *probability(walkingdown)*

up = *probability(resting)* + *probability(walkingdown)* + *probability(repeatingthelastpitch)* ■

Because the probabilities are cumulative, the following hold:

1.0 \geq *up*

up \geq *same*

same \geq *down*

down \geq 0.0

To prevent voices from walking off to one end of their ranges, keep

up == *down*.

The original program, AlgoRhythms, did not provide for voices randomly resting; voices only rested because the current musical character's texture did not specify sufficient voices for a voice to play; the first voice always played and had no rests.

- sinusoid amplitude and offset The sinusoids can have specified amplitudes for a narrower range of change, and offsets that raise and lower the sinusoid. These features have not been thoroughly tested. Their defaults are both 0.5; this is how AlgoRhythms set them.
- MIDI Program Each voice has a program, which is a 1-based MIDI program. Refer to General MIDI for the instrument assignments to program numbers.
- Fuzzy Walking: In the XML file the walking value represents the probability that a voice will be in walking mode from note event to note event. It is a value from 0.0 to 1.0, inclusive. This is compatible with the boolean flag used before 2024, because the flag was stored as 0 or 1 in the XML file. A value of 0.0 means non-walking, and 1.0

means always walking. A value of 0.5 means that the voice will have a 50% chance of being in either walking or random mode. Other values between 0 and 1 may be used.

- Voice Pan: The pan value for a voice can be specified for the entire piece of music. A pan of -64 is all the way left, 63 is all the way right, and zero (0) is centered.
- Voice following: A voice may be specified as a follower of another voice. If <follow_> is 0, then the voice will be independent. If <follow_> is 1, then the voice will follow the voice given in the <leader> tag (voices count from zero (0)). The interval_type tag determines whether the voice follows in the scale (1) or chromatically (2). The tag <interval_> specifies how many scale steps or half-steps above (positive values) or below (negative values) the follower should be. The follower voice can be set as the inversion of the leader voice. The selection of scalar or chromatic following is observed for the inversion.

The follower voice can be set as the retrograde (time-reversal) of the leader voice. The pitch_follower field is always a 1; all followers follow the pitch of the leader. If there is a following circle, the voices in the circle will not have any notes. A following circle is created by any of the following:

- A voice follows itself.
- A voice follows another voice, which in turn follows the first voice.
- A chain of follows ultimately follow a member in the chain.

Finally, the following voice's rhythms may be multiplied (before inserting a delay) by a rational number. This value is rational but not in `textmidi` format: 4 means 4 and 1/4 means a quarter. If the duration factor is 1/4, then the follower will be four times faster than the lead voice, such that it finishes while only 1/4 of the lead voice's line has played.

The current version's format is:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<!DOCTYPE boost_serialization>
<boost_serialization signature="serialization::archive" version="18">
<xml_form class_id="0" tracking_level="0" version="4">
<name_>defaults</name_>
<copyright_>Copyright © unspecified</copyright_>
<len_>600.0</len_>
<min_note_len_>0.00128</min_note_len_>
<max_note_len_>2.0</max_note_len_>
<scale_ class_id="1" tracking_level="0" version="0">
<count>128</count>
<item_version>0</item_version>
<item>C-1</item>
<item>C#-1</item>
<item>D-1</item>
<item>D#-1</item>
<item>E-1</item>
<item>F-1</item>
<item>F#-1</item>
```



```
<item>G-1</item>
<item>G#-1</item>
<item>A-1</item>
<item>A#-1</item>
<item>B-1</item>
<item>C0</item>
<item>C#0</item>
<item>D0</item>
<item>D#0</item>
<item>E0</item>
<item>F0</item>
<item>F#0</item>
<item>G0</item>
<item>G#0</item>
<item>A0</item>
<item>A#0</item>
<item>B0</item>
<item>C1</item>
<item>C#1</item>
<item>D1</item>
<item>D#1</item>
<item>E1</item>
<item>F1</item>
<item>F#1</item>
<item>G1</item>
<item>G#1</item>
<item>A1</item>
<item>A#1</item>
<item>B1</item>
<item>C2</item>
<item>C#2</item>
<item>D2</item>
<item>D#2</item>
<item>E2</item>
<item>F2</item>
<item>F#2</item>
<item>G2</item>
<item>G#2</item>
<item>A2</item>
<item>A#2</item>
<item>B2</item>
<item>C3</item>
<item>C#3</item>
<item>D3</item>
<item>D#3</item>
<item>E3</item>
<item>F3</item>
```

```
<item>F#3</item>
<item>G3</item>
<item>G#3</item>
<item>A3</item>
<item>A#3</item>
<item>B3</item>
<item>C4</item>
<item>C#4</item>
<item>D4</item>
<item>D#4</item>
<item>E4</item>
<item>F4</item>
<item>F#4</item>
<item>G4</item>
<item>G#4</item>
<item>A4</item>
<item>A#4</item>
<item>B4</item>
<item>C5</item>
<item>C#5</item>
<item>D5</item>
<item>D#5</item>
<item>E5</item>
<item>F5</item>
<item>F#5</item>
<item>G5</item>
<item>G#5</item>
<item>A5</item>
<item>A#5</item>
<item>B5</item>
<item>C6</item>
<item>C#6</item>
<item>D6</item>
<item>D#6</item>
<item>E6</item>
<item>F6</item>
<item>F#6</item>
<item>G6</item>
<item>G#6</item>
<item>A6</item>
<item>A#6</item>
<item>B6</item>
<item>C7</item>
<item>C#7</item>
<item>D7</item>
<item>D#7</item>
<item>E7</item>
```

```

<item>F7</item>
<item>F#7</item>
<item>G7</item>
<item>G#7</item>
<item>A7</item>
<item>A#7</item>
<item>B7</item>
<item>C8</item>
<item>C#8</item>
<item>D8</item>
<item>D#8</item>
<item>E8</item>
<item>F8</item>
<item>F#8</item>
<item>G8</item>
<item>G#8</item>
<item>A8</item>
<item>A#8</item>
<item>B8</item>
<item>C9</item>
<item>C#9</item>
<item>D9</item>
<item>D#9</item>
<item>E9</item>
<item>F9</item>
<item>F#9</item>
<item>G9</item>
</scale_>
<music_time_ class_id="2" tracking_level="0" version="0">
<ticks_per_quarter_>1440</ticks_per_quarter_>
<beat_ class_id="3" tracking_level="0" version="0">
<numerator_>1</numerator_>
<denominator_>4</denominator_>
</beat_>
<meter_>
<numerator_>4</numerator_>
<denominator_>4</denominator_>
</meter_>
<beat_tempo_>60.0</beat_tempo_>
</music_time_>
<pulse_>8.0</pulse_>
<melody_probabilities_ class_id="4" tracking_level="0" version="0">
<down_>0.0</down_>
<same_>0.333333333</same_>
<up_>0.6666667</up_>
</melody_probabilities_>
<pitch_form_ class_id="5" tracking_level="0" version="0">

```

```

<mean_sine_ class_id="6" tracking_level="0" version="0">
  <period_>180.0</period_>
  <phase_>0.0</phase_>
  <amplitude_>0.5</amplitude_>
  <offset_>0.5</offset_>
</mean_sine_>
<range_sine_>
  <period_>180.0</period_>
  <phase_>0.0</phase_>
  <amplitude_>0.5</amplitude_>
  <offset_>0.5</offset_>
</range_sine_>
</pitch_form_>
<rhythm_form_>
  <mean_sine_>
    <period_>180.0</period_>
    <phase_>0.0</phase_>
    <amplitude_>0.5</amplitude_>
    <offset_>0.5</offset_>
  </mean_sine_>
  <range_sine_>
    <period_>180.0</period_>
    <phase_>0.0</phase_>
    <amplitude_>0.5</amplitude_>
    <offset_>0.5</offset_>
  </range_sine_>
</rhythm_form_>
<dynamic_form_>
  <mean_sine_>
    <period_>180.0</period_>
    <phase_>0.0</phase_>
    <amplitude_>0.5</amplitude_>
    <offset_>0.5</offset_>
  </mean_sine_>
  <range_sine_>
    <period_>180.0</period_>
    <phase_>0.0</phase_>
    <amplitude_>0.5</amplitude_>
    <offset_>0.5</offset_>
  </range_sine_>
</dynamic_form_>
<texture_form_>
  <period_>180.0</period_>
  <phase_>0.0</phase_>
  <amplitude_>0.5</amplitude_>
  <offset_>0.5</offset_>
</texture_form_>

```

```

<voices_ class_id="7" tracking_level="0" version="0">
<count>4</count>
<item_version>0</item_version>
<item class_id="8" tracking_level="0" version="0">
<low_pitch_>A0</low_pitch_>
<high_pitch_>C8</high_pitch_>
<channel_>1</channel_>
<walking_>0</walking_>
<program_>1</program_>
<pan_>0</pan_>
<follower_ class_id="9" tracking_level="0" version="3">
<follow_>0</follow_>
<leader_>2147483647</leader_>
<interval_type_>0</interval_type_>
<interval_>0</interval_>
<delay_>
<numerator_>0</numerator_>
<denominator_>1</denominator_>
</delay_>
<duration_factor_>
<numerator_>1</numerator_>
<denominator_>1</denominator_>
</duration_factor_>
<inversion_>0</inversion_>
<retrograde_>0</retrograde_>
</follower_>
</item>
<item>
<low_pitch_>A0</low_pitch_>
<high_pitch_>C8</high_pitch_>
<channel_>1</channel_>
<walking_>0</walking_>
<program_>1</program_>
<pan_>0</pan_>
<follower_>
<follow_>0</follow_>
<leader_>2147483647</leader_>
<interval_type_>0</interval_type_>
<interval_>0</interval_>
<delay_>
<numerator_>0</numerator_>
<denominator_>1</denominator_>
</delay_>
<duration_factor_>
<numerator_>1</numerator_>
<denominator_>1</denominator_>
</duration_factor_>

```

```

<inversion_>0</inversion_>
<retrograde_>0</retrograde_>
</follower_>
</item>
<item>
<low_pitch_>A0</low_pitch_>
<high_pitch_>C8</high_pitch_>
<channel_>1</channel_>
<walking_>0</walking_>
<program_>1</program_>
<pan_>0</pan_>
<follower_>
<follow_>0</follow_>
<leader_>2147483647</leader_>
<interval_type_>0</interval_type_>
<interval_>0</interval_>
<delay_>
<numerator_>0</numerator_>
<denominator_>1</denominator_>
</delay_>
<duration_factor_>
<numerator_>1</numerator_>
<denominator_>1</denominator_>
</duration_factor_>
<inversion_>0</inversion_>
<retrograde_>0</retrograde_>
</follower_>
</item>
<item>
<low_pitch_>A0</low_pitch_>
<high_pitch_>C8</high_pitch_>
<channel_>1</channel_>
<walking_>0</walking_>
<program_>1</program_>
<pan_>0</pan_>
<follower_>
<follow_>0</follow_>
<leader_>2147483647</leader_>
<interval_type_>0</interval_type_>
<interval_>0</interval_>
<delay_>
<numerator_>0</numerator_>
<denominator_>1</denominator_>
</delay_>
<duration_factor_>
<numerator_>1</numerator_>
<denominator_>1</denominator_>

```

```

    </duration_factor_>
    <inversion_>0</inversion_>
    <retrograde_>0</retrograde_>
  </follower_>
</item>
</voices_>
<arrangement_definition_ class_id="10" tracking_level="0" version="0">
  <algorithm_>1</algorithm_>
  <period_>100000.0</period_>
</arrangement_definition_>
</xml_form>
</boost_serialization>

```

Notes on XML tag versions:

- xml_form version 0: no copyright tag, no arrangement lock, and no follower for each voice tag.
- xml_form version 2 : adds an arrangement block at the bottom.
- xml_form version 2, follower_ version 2 : options for delay/inversion/retrograde.
- xml_form version 3, follower_ version 2 : adds copyright_ tag.

6 The textmidi File

The output of `textmidicgm` is a `textmidi` text file with tracks in LAZY mode. It can be converted into a standard MIDI file by using the `textmidi` program. While a text file, the `textmidi` output can be edited in text editors and processed by other text tools. For example, assignments of MIDI channels and instrument programs can be changed.

7 The Gnuplot File

The `--gnuplot` option will cause a gnuplot data file to be written with the name in the xml form file with “.plot” appended. A gnuplot file that can read the file is shown below.

```
#
# RUN WITH by specifying the data file output by textmidicgm:
# /usr/bin/gnuplot -e "thefile='tjcgm.txt'" textmidicgm.gnuplot > name.jpg
#
# AlgoRhythms 3.0 colors
#wavecolor = "green"
#textcolor = "white"
#backgroundcolor = "0x9932CC"
## AlgoRhythms 1.0 colors
wavecolor = "0xAAAAEE"
textcolor = "black"
backgroundcolor = "0xCCCCCC"
set title "textmidicgm" textcolor rgb textcolor
set terminal jpeg background rgb backgroundcolor size 1024,1024
set grid xtics linetype rgb textcolor
set grid ytics linetype rgb textcolor
set border linetype rgb textcolor
set xtics textcolor rgb textcolor
set ytics textcolor rgb textcolor
set size 1.0,0.5
set multiplot layout 4,1
set size 1.0,0.25
set autoscale y
set title "Pitch Index" textcolor rgb textcolor
plot [] [] thefile every 1 index "pitch" with yerrorbars linecolor rgb wavecolor
set autoscale y
set title "Duration" textcolor rgb textcolor
plot [] [] thefile every 1 index "rhythm" with yerrorbars linecolor rgb wavecolor
set autoscale y
set title "Velocity" textcolor rgb textcolor
plot [] [] thefile every 1 index "dynamic" with yerrorbars linecolor rgb wavecolor
set autoscale y
set title "Complement" textcolor rgb textcolor
plot [] [] thefile every 1 index "texture" with yerrorbars linecolor rgb wavecolor

unset multiplot
```

8 Installation

This program was prepared for builds using GNU autoconf tools. Unpack the archive. Move to the directory created for the program. Run the configure script and run make.

```
./configure  
make
```

Make yourself superuser (root), or use sudo to run install targets:

```
make install  
make install-info
```

9 GNU Free Documentation License

Version 1.3, 3 November 2008 Copyright © 2000, 2001, 2002, 2007, 2008 Free Software Foundation, Inc. <https://fsf.org/> Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

9.1 PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document free in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or non-commercially. Secondly, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others. This License is a kind of “copyleft”, which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software. We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

9.2 APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The “Document”, below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as “you”. You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law. A “Modified Version” of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language. A “Secondary Section” is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document’s overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The “Invariant Sections” are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none. The “Cover Texts” are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words. A “Transparent” copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not “Transparent” is called “Opaque”. Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only. The “Title Page” means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, “Title Page” means the text near the most prominent appearance of the work’s title, preceding the beginning of the body of the text. The “publisher” means any person or entity that distributes copies of the Document to the public. A section “Entitled XYZ” means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as “Acknowledgements”, “Dedications”, “Endorsements”, or “History”.) To “Preserve the Title” of such a section when you modify the Document means that it remains a section “Entitled XYZ” according to this definition. The Document may include Warranty Disclaimers next to the notice which states that

this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

9.3 VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3. You may also lend copies, under the same conditions stated above, and you may publicly display copies.

9.4 COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects. If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages. If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public. It is requested, but not

required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

9.5 MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

- A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.
- B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.
- C. State on the Title page the name of the publisher of the Modified Version, as the publisher.
- D. Preserve all the copyright notices of the Document.
- E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.
- F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.
- G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.
- H. Include an unaltered copy of this License.
- I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.
- J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.
- K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or

dedications given therein. L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles. M. Delete any section Entitled “Endorsements”. Such a section may not be included in the Modified Version. N. Do not retitle any existing section to be Entitled “Endorsements” or to conflict in title with any Invariant Section. O. Preserve any Warranty Disclaimers. If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version’s license notice. These titles must be distinct from any other section titles. You may add a section Entitled “Endorsements”, provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard. You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one. The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

9.6 COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers. The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work. In the combination, you must combine any sections Entitled “History” in the various original documents, forming one section Entitled “History”; likewise combine

any sections Entitled “Acknowledgements”, and any sections Entitled “Dedications”. You must delete all sections Entitled “Endorsements.”

9.7 COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects. You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

9.8 AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an “aggregate” if the copyright resulting from the compilation is not used to limit the legal rights of the compilation’s users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document. If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document’s Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

9.9 TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail. If a section in the Document is

Entitled “Acknowledgements”, “Dedications”, or “History”, the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9.10 TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense, or distribute it is void, and will automatically terminate your rights under this License. However, if you cease all violation of this License, then your license from a particular copyright holder is reinstated (a) provisionally, unless and until the copyright holder explicitly and finally terminates your license, and (b) permanently, if the copyright holder fails to notify you of the violation by some reasonable means prior to 60 days after the cessation. Moreover, your license from a particular copyright holder is reinstated permanently if the copyright holder notifies you of the violation by some reasonable means, this is the first time you have received notice of violation of this License (for any work) from that copyright holder, and you cure the violation prior to 30 days after your receipt of the notice. Termination of your rights under this section does not terminate the licenses of parties who have received copies or rights from you under this License. If your rights have been terminated and not permanently reinstated, receipt of a copy of some or all of the same material does not give you any rights to use it.

9.11 FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See <https://www.gnu.org/copyleft/>. Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License “or any later version” applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation. If the Document specifies that a proxy can decide which future versions of this License can be used, that proxy’s public statement of acceptance of a version permanently authorizes you to choose that version for the Document.

9.12 RELICENSING

“Massive Multiauthor Collaboration Site” (or “MMC Site”) means any World Wide Web server that publishes copyrightable works and also provides prominent facilities for anybody to edit those works. A public wiki that anybody can edit is an example of such a server. A “Massive Multiauthor Collaboration” (or “MMC”) contained in the site means any set of copyrightable works thus published on the MMC site. “CC-BY-SA” means the Creative Commons Attribution-Share Alike 3.0 license published by Creative Commons Corporation, a not-for-profit corporation with a principal place of business in San Francisco, California, as well as future copyleft versions of that license published by that same organization. “Incorporate” means to publish or republish a Document, in whole or in part, as part of another Document. An MMC is “eligible for relicensing” if it is licensed under this License, and if all works that were first published under this License somewhere other than this MMC, and subsequently incorporated in whole or in part into the MMC, (1) had no cover texts or invariant sections, and (2) were thus incorporated prior to November 1, 2008. The operator of an MMC Site may republish an MMC contained in the site under CC-BY-SA on the same site at any time before August 1, 2009, provided the MMC is eligible for relicensing.

9.13 How to use this License for your documents

To use this License in a document you have written, include a copy of the License in the document and put the following copyright and license notices just after the title page: Copyright (C) year your name. Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.3 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts. A copy of the license is included in the section entitled “GNU Free Documentation License”. If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the “with. . . Texts.” line with this: with the Invariant Sections being list their titles, with the Front-Cover Texts being list, and with the Back-Cover Texts being list. If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation. If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.

10 Program and File Index

11 Bibliography

- *The Complete MIDI 1.0 Detailed Specification*. Document version 96.1. Second edition. 1995. Los Angeles. The MIDI Manufacturers Association.
- “AlgoRhythms: Real-Time Algorithmic Composition for a Microcomputer.” (1992) Thomas E. Janzen. *Readings in Computer-Generated Music*. Denis Baggi, ed. p. 199. 11pp. IEEE Computer Society Press. Los Alamitos, CA.
- *AlgoRhythms Version 1.0*. 1990. Thomas E. Janzen. Fish disk 356. Fred Fish. Mentioned in *Amazing Computing/Amiga* Sep. 1990 p. 95.
- *AlgoRhythms Version 2.0*. 1992. Thomas E. Janzen. Fish disk 606. Fred Fish.
- *AlgoRhythms Version 3.1* 1996. Thomas E. Janzen. *AMINET 12*. (DVD). Schatztruhe. Stefan Ossowskis Schatztruhe. Gesellschaft fur Software mbH. eronikastr. 33 D-45131 Essen Germany. GTI GmbH. Zimmersmuhlenweg 73 D-61440 Oberursel Germany.
- *SMUS.H; Definitions for Simple MUSical score*. Jerry Morrison, Steve Hayes. 1986. Amiga header file for C and C++. Commodore.
- *Experimental music; composition with an electronic computer*. Hiller, Lejaren A., Jr. Isaacson, Leonard M. 1959. New York. McGraw-Hill.
- *Formalized Music. Thought and Mathematics in Composition*. Xenakis, Iannis. 1971. Bloomington. Indiana University Press.
- *The March Meeting*. Bits and Bytes. April 1991. WCAUG: Worcester County Amiga Users group. A review of Thomas Janzen’s presentation of AlgoRhythms for the Amiga Computer.
- *Be Bach in a Moment. Music Making for the Non-Musician*. Michael Hanish. AMIGA World. April, 1992. IDG Communications.
- *Boost serialization documentation*. Robert Ramey. 2004. https://www.boost.org/doc/libs/1_74_0/libs/serialization/doc/index.html.

12 Concept Index

—

--dotted_rhythms	10
--instruments	6
--maxeventspertrack	10
--rhythmexpression	10
-textmidi	6
-e	10
-o, --textmidi	6
-t	10
-w	10

B

Bibliography	42
--------------------	----

D

duration	13
Duration	16
Duration Mean Sinusoid	16
Duration Range Sinusoid	16
Dynamic	16
dynamic	13
Dynamic Mean Sinusoid	16
Dynamic Range Sinusoid	16

E

Examples	12
Exploiting MIDI	3

F

form	4
------------	---

G

gnuplot	6
---------------	---

H

heaps	10
help	11
high_pitch;	14
history	3

I

identity	7
Installation	32
Invoking textmidicgm	4

L

len	14
low_pitch;	14

M

mean	13
melody probabilities	21
melody_probabilities;	14
Model of Musical Form	13
Musical style	3
Musical Turing Test	3

N

nextpermutation	8
-----------------------	---

O

Options	4
overview	2

P

pan;	14
period	13
phase	13
Pitch	16
pitch	13
Pitch Mean Sinusoid	16
Pitch Range Sinusoid	16
previouspermutation	8
pulse	14

R

random complement	5
random follow	6
random instrument	5
random pan	5
random pulse	5
random scale	5
random sinusoids	5
random walk	5
random xml_form_file_base	4
range	13
Range Sinusoid	16
reverse	8
rhythm	13
rotateleft	8
rotateright	7

S

scale.....	14
shuffle.....	9
skip.....	9
swappairs.....	9

T

textmidicgm.....	3
textmidicgm command line options.....	4
Texture.....	16
texture.....	14
The Gnuplot File.....	31
The Original Text Form File.....	16
The textmidi File.....	30
The XML Form File.....	21

U

update.....	4
Use of sinusoids.....	3
Use of statistical distributions.....	3

V

verbose.....	11
version.....	11
voice following.....	22
voice pan.....	22
voice program.....	21
voice program;.....	14
voices.....	14

X

xmlform.....	4
--------------	---