LyMaker

Version 0.2

by Acoustic E

LyMaker is a program which was designed to generate Lilypond source files. It can generate basslines, harmonies and drumlines. LyMaker is written in Python and needs Python 2.6 or higher. It is not tested with Python 3.0 however.

Command line options

The parameters for the song generation have to be specified in an xml file. So, there are only a few command line options available. The name of the executable is LyMaker.py

-h prints a help screen

-f you need this to specify the name of the xml parameter file. Omit the extension!

-t writes a template xml file

The output file takes the name of the input xml file albeit with the extension ly instead of xml.

Example:
python LyMaker.py –ftest

The XML specification for LyMaker

LyMaker is controlled by song and part parameters. A song consists of parts which are repeated as requested by the user. Song and part parameters are read from an xml file. The program uses a threefold representation of a song. The song is the whole. It consists of part instances. Part instances are varied repetitions of parts. Hence, a part can be seen as description or definition holding meta information about the actual part instances. The generated lilypond source will consist of individual code snippets for each instrument in each part instance.

Song

Parameters, which are available for the whole song, include:

- Name – the name of the song. It also is used as the filename for the output.

- Tempo – tempo in beats[1] per minute. The tempo can be overwritten for each part in xml.

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[1] A beat is a quarter note, 4/4 time hence has four beats per bar.

- Quarters (2 -9) – at the moment we are limited to 2/4,3/4 4/4, 5/4, 6/4, 7/4 and 9/4 time signatures. This is no severe constraint since the only other often used time signature is 6/8 and 6/8 and ¾ are the same for our algorithms. They differ in real life only because of their harmonic/rhythmic content. The tool is primarily designed to create pop song accompaniments which happen to be in 4/4 most of the time.

- Onbeat - 0 = offbeat, 1 = onbeat. If you decide to generate an onbeat song then the bass and the drums will play only on the up- and downbeats (the pulse beats). If you opt for an offbeat song, bass and drums can also randomly play between the pulse beats,

- Downbeats - the downbeats are the beats on which the bass drum plays, the upbeats are usually marked by the snare drum. In all genres derived from the blues, the downbeats in 4/4 time are beat 1 and 3, the upbeats are 2 and 4. So, you should enter 1,3 in xml. Popular emphasises are:

2/4	1
3/4	1
4/4	1,3
5/4	1,3 or 1,4 (as in Take Five)
6/4	1,4
7/4	1,3,5 or 1,3,6
9/4	1,4,7

- Structure – see below.

- Key - the scale of the song, e,g, "c major"

The following scales are supported by Lilypond:

- All major scales (c, cis, d , dis, e, f, fis, g, gis, a, ais, b). Specify it as e.g. gis major. LyMaker uses the default Lilypond note names (which happen to be Dutch ones). Flat notations are also supported. So use ais (a-sharp in English) or bes (b-flat). The flat note names are des,es,ges,as, and bes, The differences some purists see between sharp and flat notation can be neglected, however, for midi generation. (notes = 1,3,5,6,8,10,12)

- All natural, melodic and harmonic minor scales. Specify as e.g. gis minor.

- All Aeolian, Dorian, Phyrgian, Lydian, Mixolydian and Locrian scales (modes). Specify as e.g. gis dorian.

All other scales can be treated as c major. Lilypond will generate the correct accidentals. Other possible scales include:

- Pentatonic scales

- o   Chinese / Major pentatonic (1,3,5,8,10)

- o   Japanese (1,2,6,8,11)

- •   Blues scales (1.4,5,6,7,8,11)

- •   Twelve-tone scale

- •   Special scales

- o   dim (1,3,4,6,7,9,11)

- o   aug (1,3,5,6,9,10,11)

- o   augmaj (1,3,5,6,9,10,12)

Structure

Each song in popular genres consists of parts which are repeated. The simplest example is a folk song which consists of a repetition of chorus and verse (older folk songs even had only one part which was repeated throughout). The parts are named alphabetically by single letters. So, in our example the verse is part A and the chorus is part B. If we like to repeat chorus and verse 3 times, we could write: ABABAB.

Note that the first part of the xml file is A in the structure, the second B, and so on till Z, regardless of their real names.

The program generates the different voices (tracks) by random but based on a lot of parameters. It does not generate melodic content. Trumpet, tenor sax, high synth and low synth parts are created empty. It does, however generate a bassline, a drumline consisting of bass drum, snare and highhat, and the lower voice of the piano which plays the chords. For the upper voice of the piano a riff is generated which is repeated throughout the song. This is something like a dummy which could be changed freely (but sometimes it sounds great by random). Orchestral arrangements are beyond the scope of the generator so far.

Parts

A part is a repeatable unit which is defined by certain parameters. It has a specific harmony structure which is based on the specific chord progressions (chord changes) which have to be described in the xml file and are stable for all repetitions. The chord progressions should be based on the key and the scale (mode) of the song.

The **partname** need not to match with the name(letter) used in structure. The first part, however, is always addressed as A in the structure.

Progressions

The **key** and scale has to be set for the whole song. It limits the notes you can use if you haven't decided to create a twelve-tone opus. If you have opted for a tonal composition the chords should reflect the chosen scale. Another parameter which influences the mood of the composition is voicing. Voicing[2] decides in which order the notes of the chords are used. You can simply write the chords in your favourite voicing inside of the **progressions** tag. There are two different approaches for a non-standard voicing. The chord notes can be reordered preserving the chord root or using an inversion.

Example: voicing of c major

Standard voicing	Open voicing	First inversion
c-e-g	c-g-e'	e-g-c'

The syntax for the chord progressions is *note,note,note[,note][;another chord]|another bar[|yet another bar].*

So, the different notes of a chord are separated by a comma. You do not have to care about octaves. The notes are automatically treated in ascending order.. So, the inversion example above, would simply be "e,g,c" without octave marker.

You can specify more than one chord for one bar. Chords are separated by a semicolon. As of now, the program considers only the first two chords per bar. The second chord is used from the second downbeat onwards. No chord change happens on an upbeat, so if you have only one downbeat (as for 3/4 time) even the second chord is useless.

Bars are separated by the pipe symbol (|). Omit the bar symbol behind the last bar!

There are different kind of basic chords:

- Tertian triads. These are chords based on thirds. These are the standard major or minor chords. If 0 is the chord root, major is 0- 4-7 and minor is 0-3-7. For instance, the c major chord consists of *c, e and g* and c minor of *c, dis,g*.

- Tertian sevenths. Same as above but they include a fourth note (another third), e.g. *c, e, g, and b*. These kinds of chords are often used in tonal jazz since the fourth note is a dissonance to the root and thus adds some tension to the harmony. Depending on the scale, the most used chord variations are 7,m7 or maj7. 7 is 0-4-7-10, m7 is 0-3-7-10 and maj7 is 0-4-7-11.

- Quartal chords. These are chords based on fourths. These are often used in modal

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[2] voicing is the instrumentation and vertical spacing and ordering of the pitches in a chord.

jazz. They always carry the tension note with them: e.g. *c, f, bes*. They should only be used in connection with modes (Dorian, Phyrgian etc.). Often they are extended with a fourth note which is another fourth. 7sus4 is 0-5-7-10 (e.g. *c-f-g-bes*), which is in a different voicing 0-5-10-15 (e.g. *g-c'-f'-bes'*). This variant is known as "so what" chords, named after the famous Miles Davis composition.

- (Quintal) Power chords e.g. c,g,c. These chords are base on fifths. Power chords are often used in Heavy Metal.

- see appendix for other chord variations.

The length of a part is determined by the number of the bars within the progressions tag. Parts are normally 8, 12 or 16 bars long. The intro can shorter.

A different tempo for the part can be specified by **ptempo**. If you switch the tempo in a song, the slower or faster part should somehow stand out. So it may use a harmony, a rhythm or a melody instrument that is distinct from the ones of adjoining parts because it otherwise sounds awkward.

Melody

Melodies in popular music (and in classical music as well) are usually based on variations of one or more motifs[3]. Our generator does not generate any melodic content as of now.

Harmony

LyMaker creates two harmony voices. The harmony voices will be generated based on the chord progressions. Only chord notes are used. The lower piano voice will in fact only play these chords. A counterpoint[4] option was considered but not implemented because a counter-melody without a melody is pointless. A riff[5] is generated for the whole song. The riff - as riffs usually do - ignores the harmonies. The riff is played by the upper piano voice. The second generated harmony voice is indeed the bass line.

Bass line

The bass line is controlled by the parameter **groove**. You can either generate a random bass which

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[3] a motif or motive is is a short musical idea, a salient recurring figure, musical fragment or succession of notes that has some special importance in or is characteristic of a composition.
[4] counterpoint is the relationship between voices that are harmonically interdependent (polyphony), but independent in rhythm and contour.
[5] riff refers to a brief, relaxed phrase repeated over changing melodies.

varies for each part instance or have an ostinato[6] bass. The bass line comes in a lot of flavours:

- 0 (offbeat) = funky bass. An off-beat bass line is generated consisting of eighth and sixteenth notes. Each bar is seen by the generator as a grid in the length of quarters multiplied by 4 (e.g. 16 slots for 4/4 time). Which slots and which note values are used is chosen randomly (based on the current chord of course). Hence, it can play between the beats. The generator, however, differentiates between down- and upbeats. For 4/4 time the downbeats should be slot 1 and 9 (beat 1 and 3) and the upbeats slot 5 and 13 (beat 2 and 4) but you can set the downbeats in the xml file. There is, however, never a rest on the one. The bass does not play on the first upbeat (slots 5-7). It plays eighth on the downbeats and sixteenths everywhere else. The last sixteenth before a downbeat (e.g. slot 8) is never a rest.

- 0 (onbeat) - an ostinato bass is generated. It plays the base note of the current chord on the downbeats only.

- 1 = walking bass. A walking bass is often used in jazz music, especially in tonal jazz. Usually it is played by an upright bass (contrabass). This bass line consists of quarter notes which always are chord notes and it runs on without rests and without variation of note durations.

- 2,3 (offbeat) as 0 but bass may play on slots 5-7.

- 2 (onbeat) = a normal time bass is generated. The bass plays the base note of the current chord at all down- and upbeats.

- 3 (onbeat) = a double time bass is generated. The bass plays the base note of the current chord at all down- and upbeats plus in the middle of the beats.

- 4 = shuffle bass. The shuffle bass line consists of triplets of 8ths but the first two 8ths are merged into a quarter. Since the whole triplet has the duration of a quarter this construction gives the piece a polyrhythmic feel. Shuffle bass was often used in Swing music.

- 5 = bass riff.

- 99 – mutes the bass.

Drums

Another important track is the drum line. It can be controlled by the parameter **drummode**:

- 0 (offbeat) = a random drum line consisting of snare, high-hat and bass drum. It uses a lot of high-hat. Basically, the bass drum can play between the downbeats and the upbeats and the snare in the rest of the bar. The high-hat can play throughout. The last sixteenth before a downbeat is always played by the bass drum.

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[6] an ostinato is a motif or phrase, that persistently repeats in the same musical voice, usually at the same pitch.

- 1 (offbeat)= like 0 but with less high-hat use.

- 0,1,4 (onbeat) = backbeat[7] as used in rock music (in 4/4 times). More generally speaking, it generates a drum line with bass drum on the downbeats and snare on the upbeats. The high-hats are only playing on the downbeats and between the downbeat and the upbeat (Charlie Watts's style).

- 2 = high-hat only.

- 3 = same as 0 but without bass drum.

- 4 (offbeat) - same as 0 but with funky feel, no snare on the first upbeat. Snare is shifted to the second downbeat instead and plays there together with the bass drum.

- 5 = drumpattern. A pattern is created according to the downbeats of the song. Arguably, you wouldn't need a generator to do this but it is there for completeness. Onbeat drumlines are not the preferred output from this program. The program is really designed to produce random drum- and basslines.

- 99 mutes the drums.

The drum line is always treated as a grid of 16th notes by the generator. It has a lower voice for the snare and the bass drum and a upper voice for the high-hats. This is done for convenience. You might decide to use only cymbals in one part while working on the lilypond source. The decision not to use a bass drum is a more general decision on the other hand.

The generator does not generate a closing cadence (Perfect authentic cadence[8]). This is necessary for the song end (otherwise you need a fade-out). Songs that do not end on the tonic are not perceived by listeners as having a real end.

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[7] A back beat, or backbeat, is an accentuation on the upbeats. In a simple 4/4 rhythm these are beats 2 and 4.
[8] A PAC is a progression from V to I in major keys, and V to i in minor keys. This strong cadence achieves complete harmonic and melodic closure.

Appendix

Chords & Scales & Grooves

0 is the root of the chord in the following:

Triads

major	0-4-7	
minor	0-3-7	
dim	0-3-6	
sus2	0-2-7	
aug	0-4-8	
sus4	0-5-7	
b5	0-4-6	

Sevenths

major 0-4

b13	0-4-7-8	
6	0-4-7-9	
7	0-4-7-10	
maj7	0-4-7-11	
add9	0-4-7-14	
add11	0-4-7-17	
7b13/5-	0-4-6-8	
7/5-	0-4-6-10	
maj7/5-	0-4-6-11	
6/5+	0-4-8-9	
7/5+	0-4-8-10	
maj7/5+	0-4-8-11	
6/9	0-4-9-14	

minor/dim 0-3

mb13	0-3-7-8	
m6	0-3-7-9	

m7	0-3-7-10	
mmaj7	0-3-7-11	
madd9	0-3-7-14	
madd11	0-3-7-17	
dim7	0-3-6-9	

sus4 0-5

b13sus4	0-5-7-8	
6sus4	0-5-7-9	
7sus4	0-5-7-10	
maj7sus4	0-5-7-11	
add9sus4	0-5-7-14	
add11sus4	0-5-7-17	

sus2 0-2

b13sus2	0-2-7-8	
6sus2	0-2-7-9	
7sus2	0-2-7-10	
maj7sus2	0-2-7-11	
add9sus2	0-2-7-14	
add11sus2	0-2-7-17	

Notes relative to c

c	0	12
c#	1	13
d	2	14
d#	3	15
e	4	16
f	5	17
f#	6	18
g	7	19
g#	8	20
a	9	21
a#	10	22
b	11	23

Scales

0 is the tonic of the scale in the following:

major	0	2	4	5	7	9	11	c = a minor
natural minor	0	2	3	5	7	8	10	a = c major
melodic minor	0	2	3	5	7	9	11	c = a dim
harmonic minor	0	2	3	5	7	8	11	c = e augmaj
aeolian	0	2	3	5	7	8	10	c = c minorN = a major
dorian	0	2	3	5	7	9	10	d = c major
phrygian	0	1	3	5	7	8	10	e = c major
lydian	0	2	4	6	7	9	11	f = c major
mixolydian	0	2	4	5	7	9	10	g = c major
locrian	0	1	3	5	6	8	10	b = c major
blues	0	3	4	5	6	7	10	
dim	0	2	3	5	6	8	10	a = c minorM
aug	0	2	4	5	8	9	10	
augmaj	0	2	4	5	8	9	11	e = c minorH
chinese	0	2	4	7	9			
japanese	0	1	5	7	10			

Instrument Ranges

Lilypond octaves:

Lilypond	Midi	Standard concert pitch	description
C,,,	0	C0	
C,,	12	C1	
C,	24	C2	Below bass staff
C	36	C3	Middle of bass staff
C'	48	C4	Below violin staff, above bass staff
C''	60	C5	Middle of violin staff
C'''	72	C6	Above violin staff

Bass guitar	e, (28) trans to e,, (16)	g' (55) notated
Double Bass	e, (28) trans to e,, (16)	dis" (63)
Soprano Sax (Bb instrument)	c' (48) trans to bes (46)	f''' (77)
Alto Sax (eb)	c' (48) trans to es (39)	f''' (77)
Tenor Sax (Bb)	c' (48) trans to bes (34)	f''' (77)
Trumpet in Bb	g (43) trans to f (41)	g" (67)
Trombone	g,(31)	g' (55)
Acoustic Guitar	e (40) trans to e, (28)	e''' (76)
E-Guitar	e (40) trans to e, (28)	g''' (79)
Violin	g (43)	g''' (79)
Viola	c (36)	c''' (72)
Cello	c, (24)	c" (60)

bass staff g, (31) - a (44)

violin staff e' (52) - f'' (65)

Grooves

1st row Bass

2nd row Snare Drum

3rd row Bass Drum

Default Backbeat

1				5				9				13			
x				x				x				x			
				x								x			
x						(x)	x								

R&B

1				5				9				13			
x					x	x		x							
				x								x		(x)	
x					x	x		x							

Motown

1				5				9				13			
x				x				x				x			
				x								x			
x							(x)	x						(x)	

Funk

1				5				9				13			
x							x	x		x			(x)	(x)	
								x				x			
x							x			x			(x)	(x)	

Disco

1				5				9				13			
x		x		x		x		x		x		x		x	
				x								x			
x				x				x				x			

Blues

1				5				9				13			
x		x		x		x		x		x		x		x	
				x								x			
x		x				x		x		x				x	

Fusion

1				5				9				13			
x	x	x	x				x	x		(x)	(x)	x	(x)		
			x									x	(x)		
x							x	x		(x)	(x)				

Hip Hop

1				5				9				13			
x				x		x		x	x				x	x	x
	(x)			x					x		x				x
x						x		x	x				x		x

Waltz

1				5				9			
x				(x)				(x)			
					x				x		
x											

Musical Forces Theory

- short durations only on upbeats

- half note on the second upbeat must be tied to the next measure

- chord notes only on downbeats

- leaps from downbeats only to an unstable pitch below or above the target pitch

- unstable pitches (not in chord) only on upbeats

- inertia: up-up or down-down rather than up-down or down-up (except after leap)

- grouping of notes of the same duration

Meter

Tempo	Description
< 20	Larghissimo
20 - 39	Grave
40 - 59	Largo
60 - 65	Larghetto
66 - 75	Adagio
76 - 79	Adagietto
80 - 107	Andante
108 - 119	Moderato
120 - 123	Allegro moderato

124 - 139	Allegro
140 - 167	Vivace
168 - 199	Presto
> 200	Prestissimo

Harmonies

- use chords with fourths for modal tunes.

- do not use the tonic (root) in the bass for the tonic chord for modal harmonies on the one.

- there are no harmonic and melodic minor scales! Minor scales are compounds of natural, melodic and harmonic minor. Minor scales have indeed 9 notes!

Guitar Layout

0	e,	a,	d	g	b	e'	0
1	f,	ais,	dis	gis	c'	f'	1
2	fis,	b,	e	a	cis'	fis'	2
3	g,	c	f	ais	d'	g'	3
4	gis,	cis	fis	b	dis'	gis'	4
5	a,	d	g	c'	e'	a'	5
6	ais,	dis	gis	cis'	f'	ais'	6
7	b,	e	a	d'	fis'	b'	7
8	c	f	ais	dis'	g'	c''	8
9	cis	fis	b	e'	gis'	cis''	9
10	d	g	c'	f'	a'	d''	10
11	dis	gis	cis'	fis'	ais'	dis''	11
12	-	a	d'	g'	b'	e''	12
13	-	ais	dis'	gis'	c''	f''	13
14	-	-	-	a'	cis''	fis''	14
15	-	-	-	-	d''	g''	15

Above table shows the actually sounding notes. Guitar is notated one octave higher than it sounds. Note that the frets higher than 12 are hard to play because of the joint of the neck to the body of the guitar. This may vary but for acoustic guitars the neck joins the body at fret 12.

Some Lilypond Guitar Chords

Lower Range

C major (1st fret)	< e c' e' g' c'' e'' >
D major (2nd fret)	< a d' a' d'' fis'' >
E major (1st fret)	< e b e' gis' b' e'' >
F major (1st barre)	< f c' f' a' c'' f''>
G major (2nd fret)	< g b d' g' b' g'' >
A major (2nd fret)	< e a e' a' cis'' e''>
B major (2nd fret)	< fis' b' dis'' fis''>
Dm (1st fret)	< a d' a' d'' f''>
Em (2nd fret)	<e b e' g' b' e''>
Fm (1st barre)	<f c' f' as' c'' f''>

Gm (3ʳᵈ barre)	< g d' g' bes' d" g">
Am (2ⁿᵈ fret)	< e a e' a' c" e">

Barré

Eb7 major (6ᵗʰ fret)	<bes es' bes' des" g" bes" >
E major (7ᵗʰ fret)	< b e' b' e" gis" b" >
Db6 major (6ᵗʰ fret)	<bes f' as' des" f" bes" >
Fm9 (4ᵗʰ fret)	<as c' f' c" es" as" >

Bass (Guitar) Layout

0	E,,	A,,	D,	G,	0
1	F,,	Ais,,	Dis,	Gis,	1
2	Fis,,	B,,	E,	A,	2
3	G,,	C,	F,	Ais,	3
4	Gis,,	Cis,	Fis,	B,	4
5	A,,	D,	G,	C	5
6	Ais,,	Dis,	Gis,	Cis	6
7	B,,	E,	A,	D	7
8	C,	F,	Ais,	Dis	8
9	Cis,	Fis,	B,	E	9
10	D,	G,	C	F	10
11	Dis,	Gis,	Cis	Fis	11
12	E,	A,	D	G	12
13	F,	Ais,	Dis	Gis	13
14	Fis,	B,	E	A	14
15	G,	C	F	Ais	15
16	Gis,	Cis	Fis	B	16
17	A,	D	G	C'	17
18	Ais,	Dis	Gis	Cis'	18

Above table shows the actually sounding notes. Bass (guitar) is notated one octave higher than it sounds. The electric bass guitar usually stops at g, the double bass has a wider range because the frets higher than 12 are hard to play on a bass guitar. The technique of playing is different on a (upright) double bass.