Making MIDI Music with Python

An Introduction to Music Theory

What we'll cover

Music theory

Notes and rhythms as strings

Notes and rhythms as Python objects

Using Pyknon to generate MIDI files

whoami

Evan Palmer

BM in Music Education, Portland State University ("Choir Nerd")

Full Stack Web Development, PDX Code Guild

Likes: Python, Django, Javascript, open source, and pop hits of the 15th c.

You'll need...

A way to play MIDI files
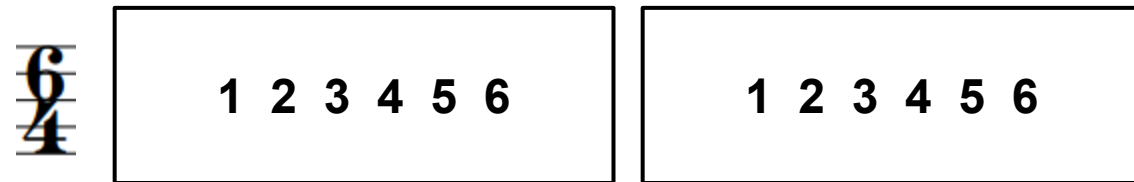
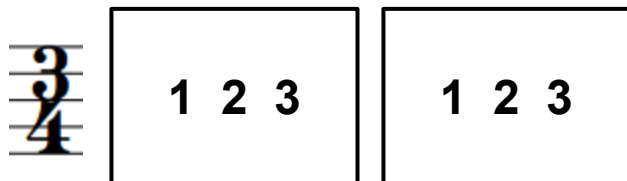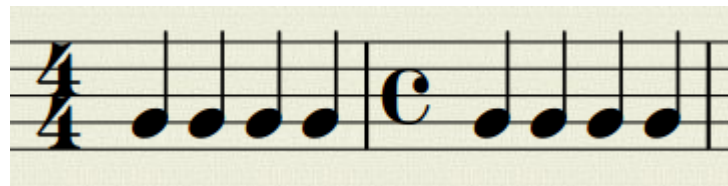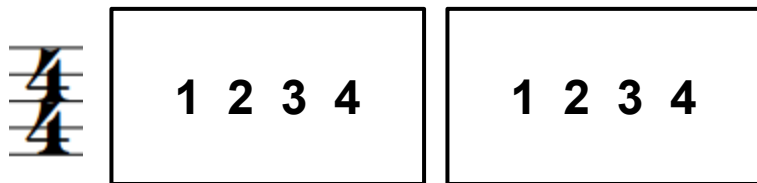Pyknon (available on github.com/palmerev/pyknon)

Extra goodies (github.com/palmerev/pydx15-music)

Music Theory

Rhythm and Meter

"the beat"

Rhythm and Meter, detail

1	2	3	4

1/4	1/4	1/4	1/4

.25	.25	.25	.25

Notes of different lengths

o	whole note	1
♩	half note	1/2
♩	quarter note	1/4
♪	eighth note	1/8
♬	sixteenth note	1/16

Notes of different lengths
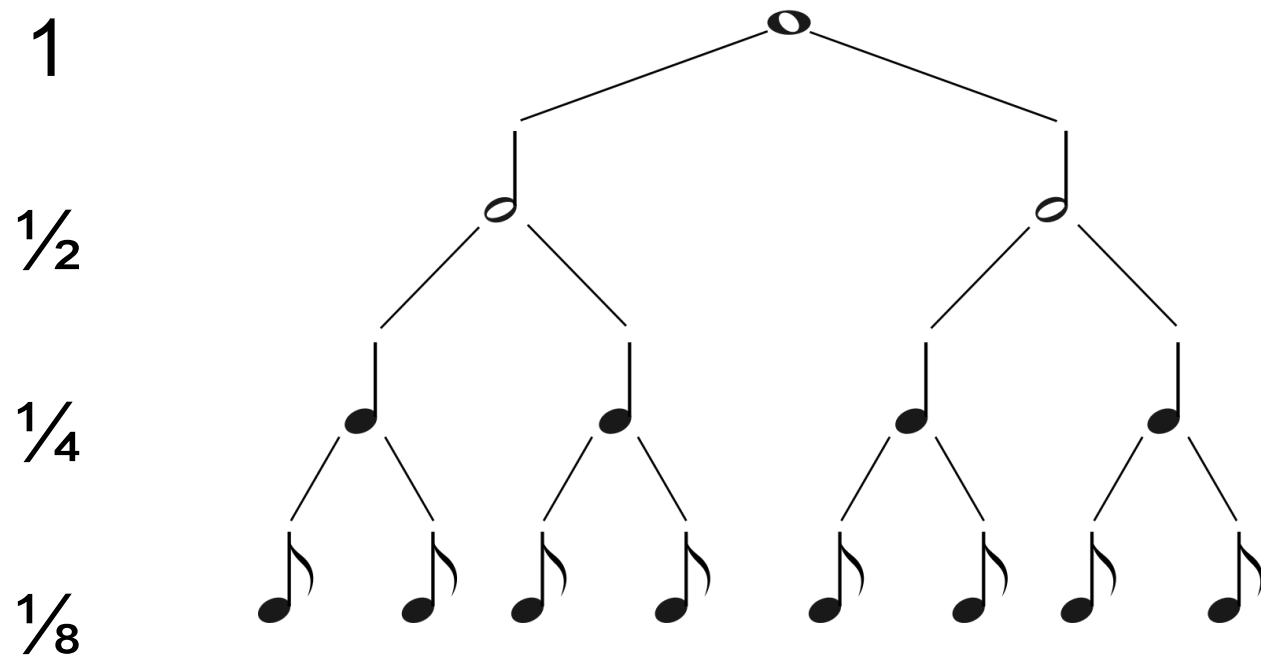
Notes of different lengths
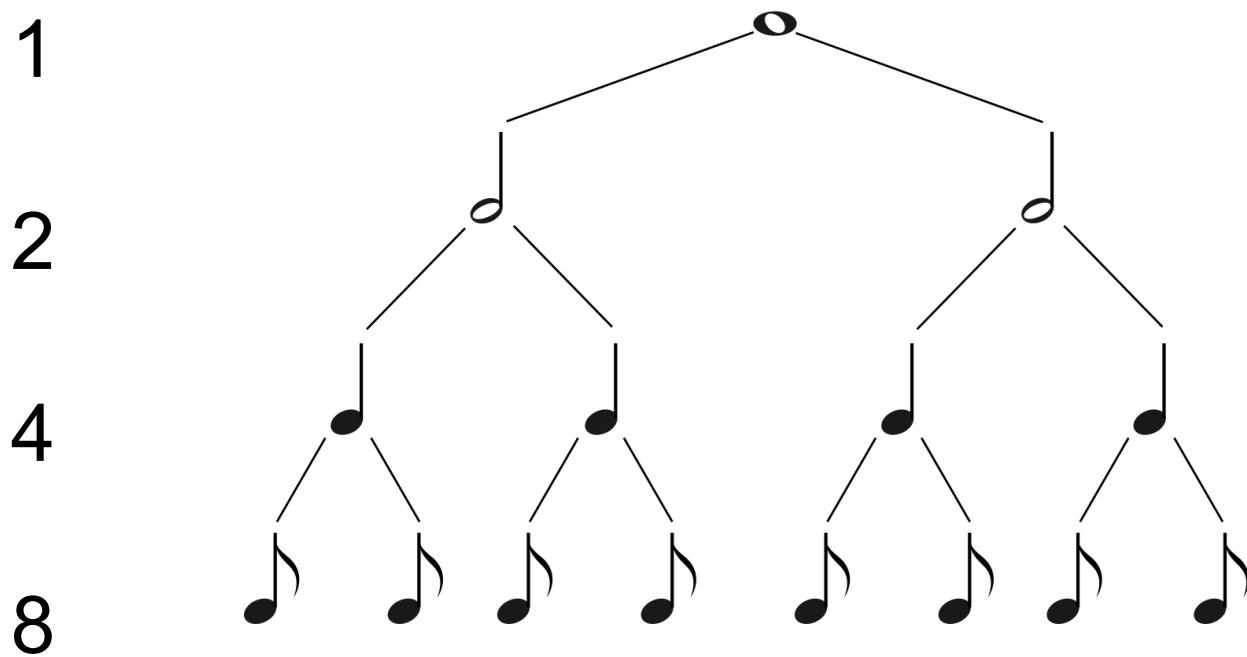
Notes of different lengths
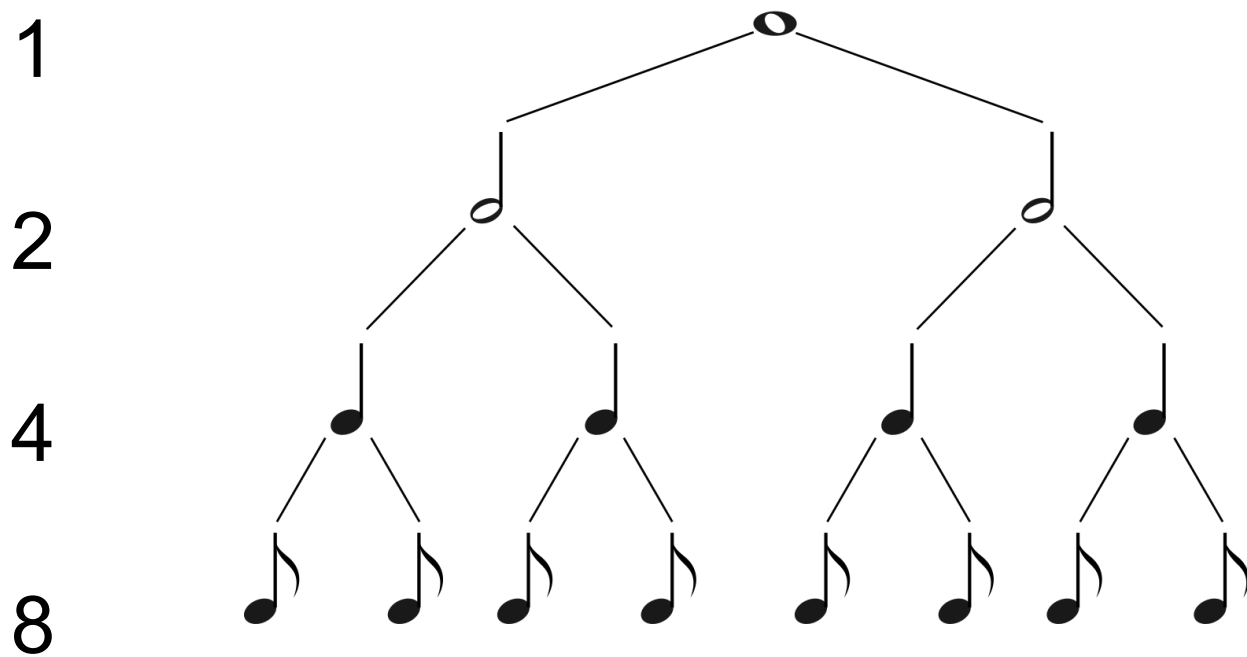
Silence (Rest)
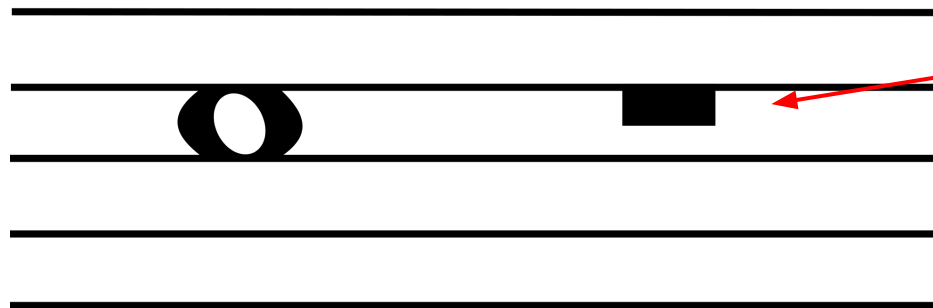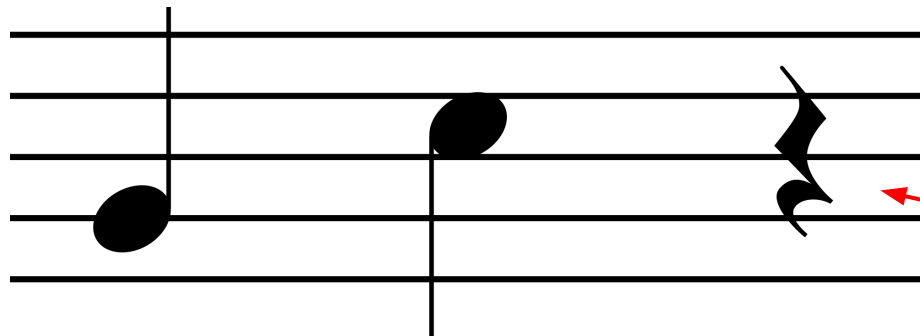
Rhythm in code

```python
class RhythmSeq:
    '''A sequence of rhythmic durations'''
    # implementation here
    pass


# "r" represents a rest
RhythmSeq("4 4 4 4") # four quarter notes
RhythmSeq("4 4 8 8 4")


RhythmSeq("4 8 8 4 4")
RhythmSeq("r4 4 4 r4")
```

Organizing Frequencies: Notes and Pitches
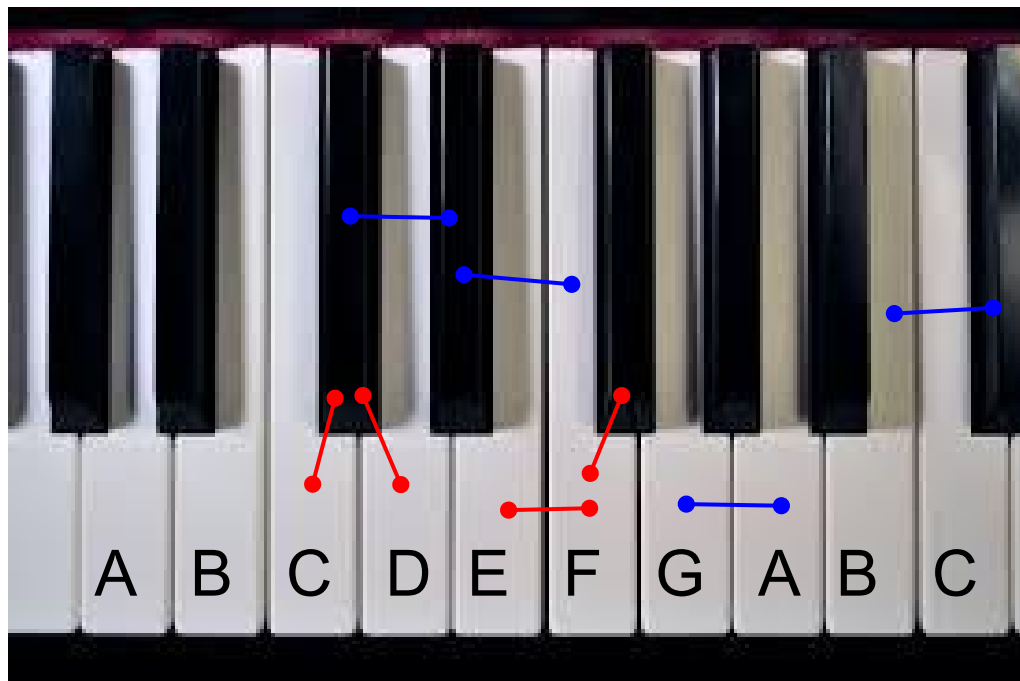
Simple note sequences in code

```python
class NoteSeq:
    '''A sequence of notes with rhythms'''
    # implementation here
    pass


# letter-name + rhythm
NoteSeq("C4 D4 E4 D4 C2")
# can include rests
NoteSeq("C4 r4 E4 D4 C2")
# same duration is applied until changed
NoteSeq("C4 r E D2 C") == NoteSeq("C4 r4 E4 D2 C2")
```

Getting all of the notes

Accidentals
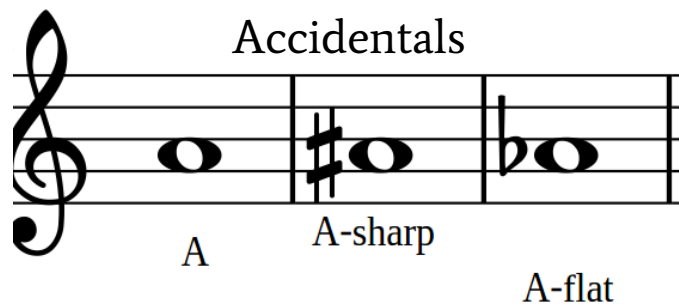
A   A-sharp   A-flat

sharp = # ("A#")

flat = b ("Ab")

Organizing Frequencies: Notes and Pitches

Pyknon default octave = 5

MIDI pitches 0 - 127
(lowest C = 0)

Central C is in the fifth octave
(MIDI pitch 60)

Organizing Frequencies: Notes and Pitches

Pyknon default octave = 5

Adjust the octave with upticks and downticks (apostrophes and commas)

"C'' C#'' D'' ...": +1 octave

"C' C#' D' ...": default (5)

"C C# D ... ": default (5)

"C, C#, D, ...": –1 octave

"C,, C#,, D,, ...": –2 octaves

Organizing Frequencies: Notes / Pitches

```
# name/value + rhythm + octave
NoteSeq("C4 C, C C' C''")
# octave 5   4   4 5   6

# same octave and duration applied until changed
NoteSeq("C#4'' D E A' C#''")

# octave  6     6 6 5   6
```

Notes and Rests as Python objects

```
class Rest

    dur: the duration as a floating point number

        (quarter is 0.25 since 1/4 = 0.25)

    stretch_dur(factor): multiplies the duration by factor

        and returns a new Rest with the new duration
```

Notes and Rests as Python objects

```
class Note

    value: integer value of a note from 0 to 11 (C to B)

    octave: octave value where central octave is 5

    midi_number: MIDI value for the pitch. Read-only.

    dur: rhythmic value as a floating-point number

    volume: MIDI volume value from 0 to 127

    verbose: returns a string <note_name>, <octave>, <dur>
```

Notes and Rests as Python objects

```
class Note

    Defaults:

        Note(value=0, octave=5, dur=0.25, volume=100)

        # Note() == moderately loud middle-C quarter note

    Shorthand:

        Note("<note_name><dur><octave>")

        Note("C4'")
```

Notes and Rests as Python objects

```
class Note

    Other Methods:

        transposition: moves notes up/down by n half-steps

            and returns a new Note

        inversion: takes a Note's value as distance from an

            index note (default is C), moves it to the other

            side of the index note, (e.g. D -> A#)
```

Notes and Rests as Python objects

```
class Note

    Other Methods:

        harmonize: Harmonize a single note in the context of

            a scale. Not very useful by itself, but it's used

            by NoteSeq.

        stretch_dur(factor): Multiplies the duration by factor

            and returns new Note with the resulting duration.
```

Notes and Rests as Python objects

```
class NoteSeq
```

- A list-like object that can hold Note and Rest objects
    - supports slicing, append, and insert
    - concatenation with the + operator
    - repetition with the * operator

    Can be instantiated with a string, list of objects, or
    read from a file.

Notes and Rests as Python objects

```
class NoteSeq

    MORE METHODS:

        retrograde, transposition, transposition_startswith,

        inversion, inversion_startswith, rotate, stretch_dur,

        stretch_interval, harmonize
```

Generating MIDI files

```python
from __future__ import division # python 2


def demo():
    notes1 = NoteSeq("D4 F#8 A Bb4")
    notes2 = NoteSeq([Note(2, dur=1/4), Note(6, dur=1/8),
                      Note(9, dur=1/8), Note(10, dur=1/4)])
    midi = Midi(number_tracks=2, tempo=90)
    midi.seq_notes(notes1, track=0)
    midi.seq_notes(notes2, track=1)
    midi.write("midi/demo.mid")
```

same notes!

Generating MIDI files

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    midi.write("midi/demo.mid")
```

Generating MIDI files

```
Midi.instrument: instrument 0 (piano) to 127
 -  search "MIDI instrument codes" for details
 -  support may vary depending on MIDI player

Midi.seq_chords([NoteSeq("C E G")])

Midi.seq_notes(time=0)
```

badly named parameter

Generating MIDI files

```python
# "Frere Jacques", a round in two tracks
filename = "frere-jacques-two-track.mid"
fj_notes1 = NoteSeq("C4' D E C C D E C E F G2 E4 F G2")
fj_notes2 = NoteSeq(
    "G8 A G F E4 C G8 A G F E4 C C G, C2' C4 G, C2'"
    )
all_notes = fj_notes1 + fj_notes2

fj_midi = Midi(2, tempo=120)
fj_midi.seq_notes(all_notes, track=0)
fj_midi.seq_notes(all_notes, track=1, time=8)
fj_midi.write(filename)
```

Resources

Used in this talk:

"Music for Geeks and Nerds" by Pedro Kroger (creator of Pyknon)

- chapter on Pyknon available for FREEEEEE at github.com/kroger/pyknon

"The Complete Idiot's Guide to Music Theory", 2nd ed. by Michael Miller

teoria.com (FREEEEEEE!)

Also good:

musictheory.net (FREEEEEE!), PythonInMusic wiki (WIKIIIIIII!)

Thank you!

twitter: @__evanpalmer__

linkedIn: /in/evanpalmer1

github: palmerev

slides and extras: github.com/palmerev/pydx15-music