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

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Full Stack Web Development, PDX Code Guild

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

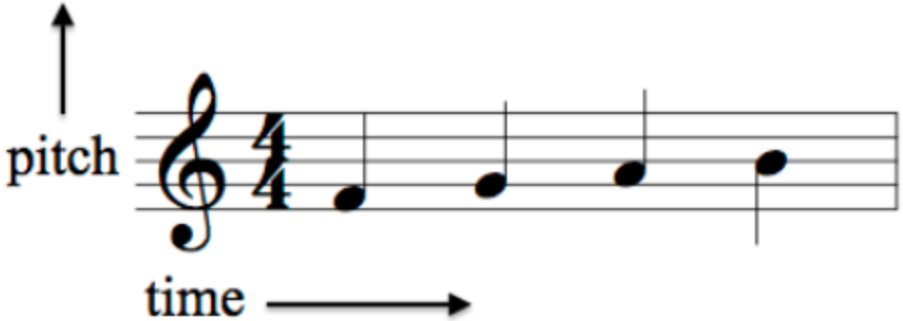
You'll need...

A way to play MIDI files

Pyknon (available on github.com/palmerev/pyknon)

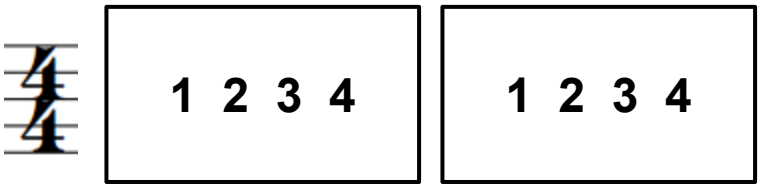
Extra goodies (github.com/palmerev/pydx15-music)

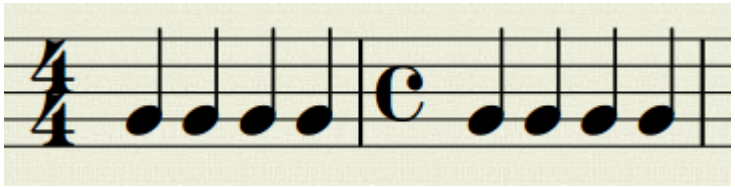
Music Theory

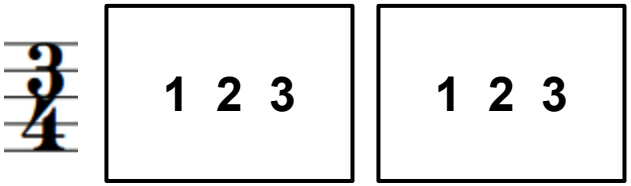


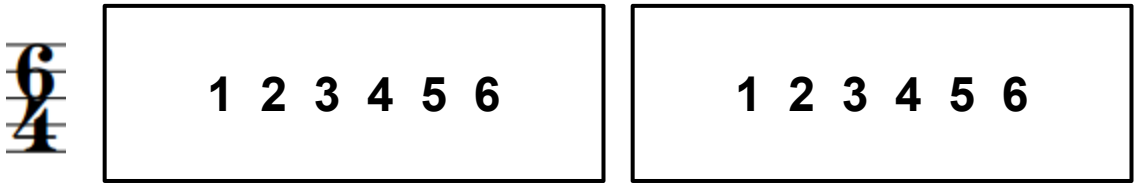
Rhythm and Meter

"the beat"

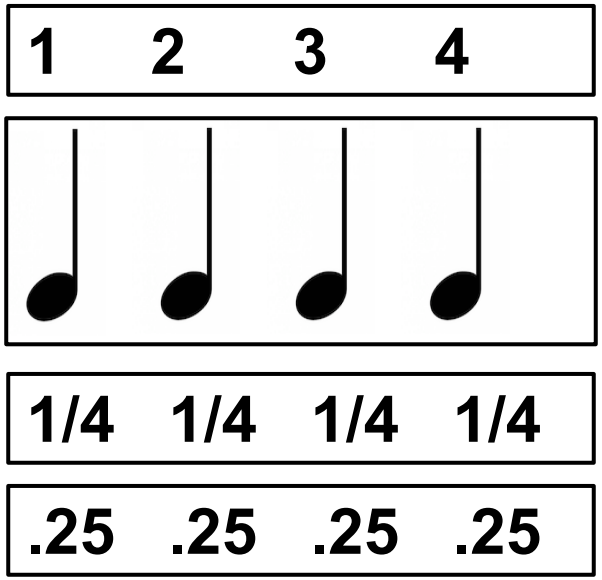








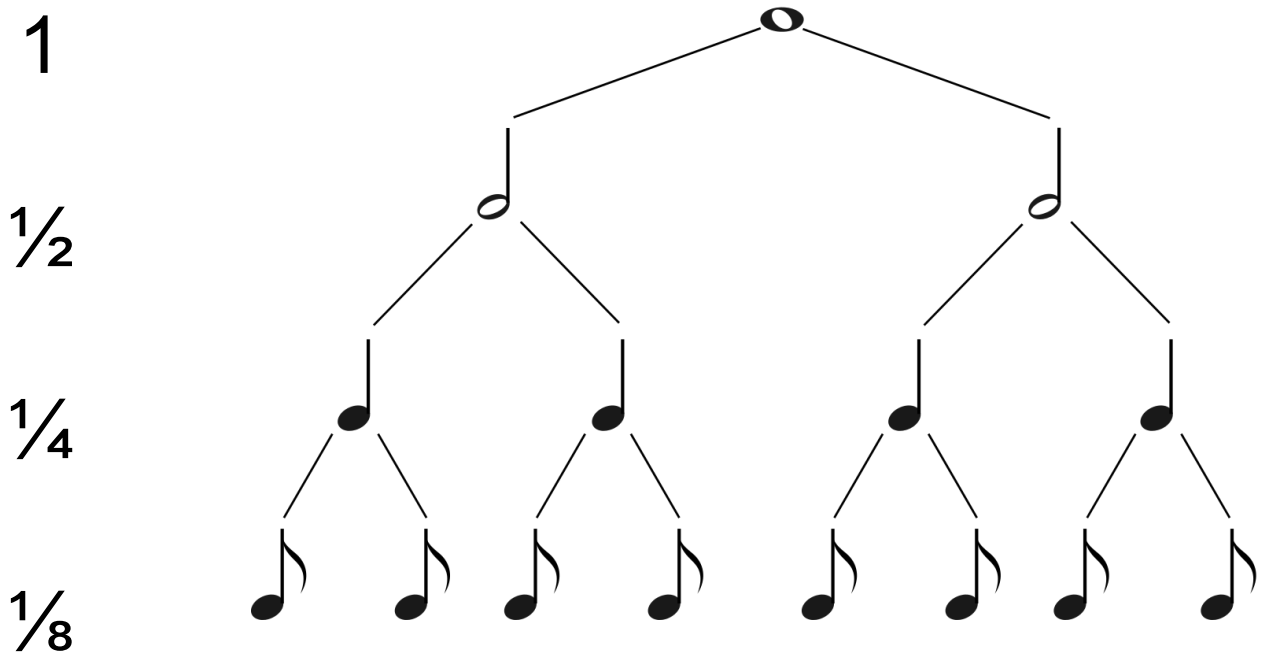
Rhythm and Meter, detail



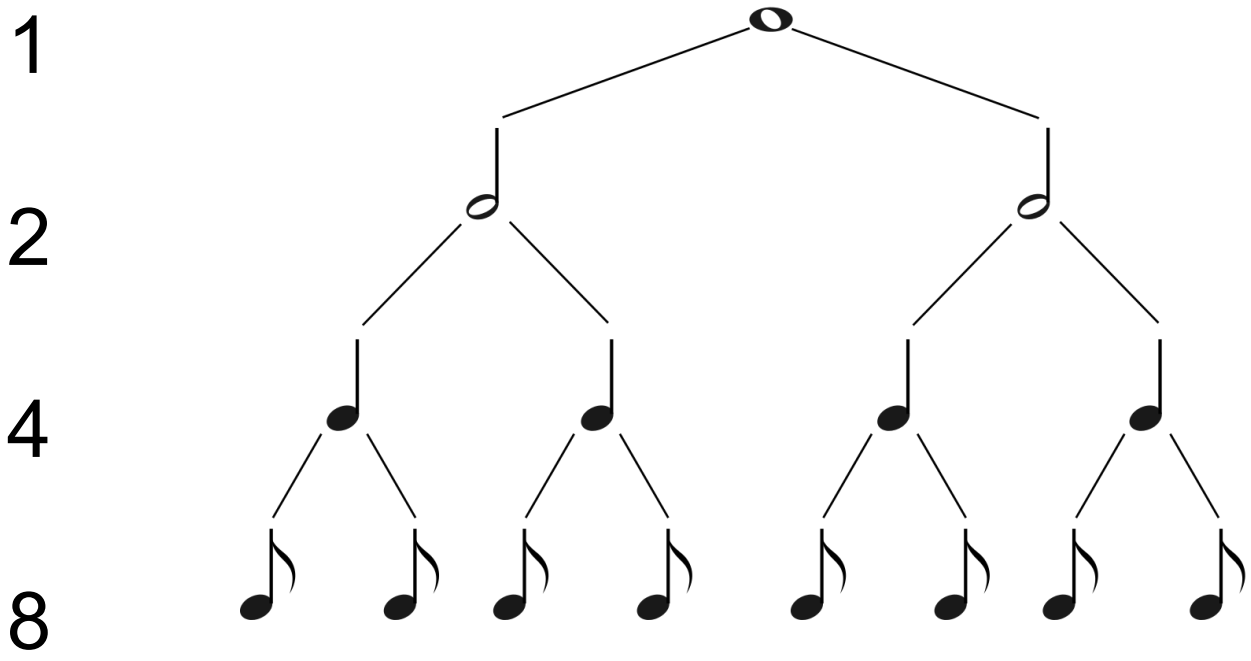
Notes of different lengths

	whole note	1
	half note	1/2
	quarter note	1/4
	eighth note	1/8
	sixteenth note	1/16

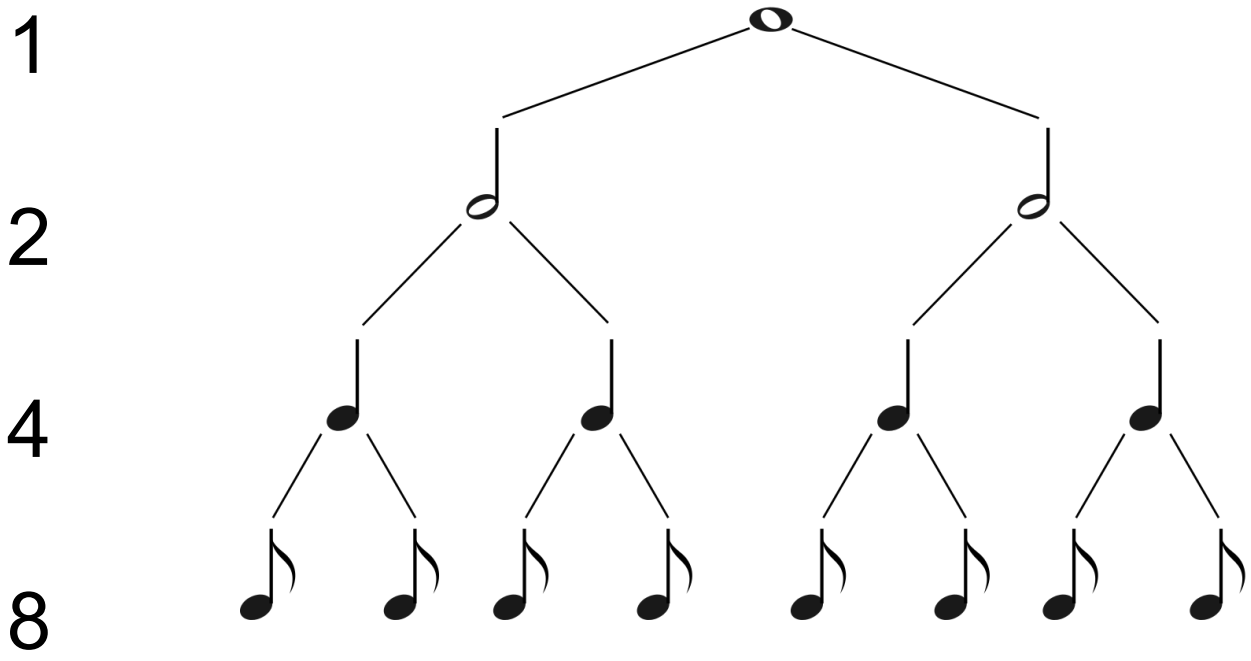
Notes of different lengths



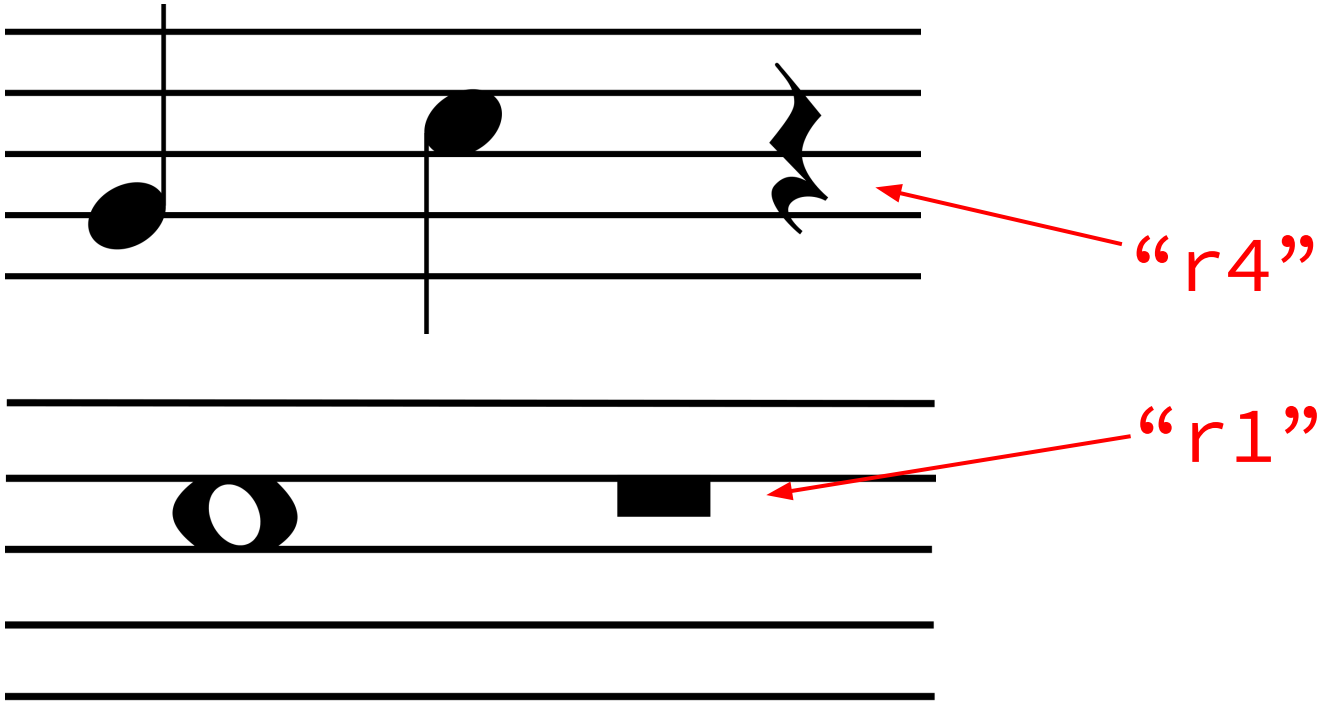
Notes of different lengths



Notes of different lengths



Silence (Rest)



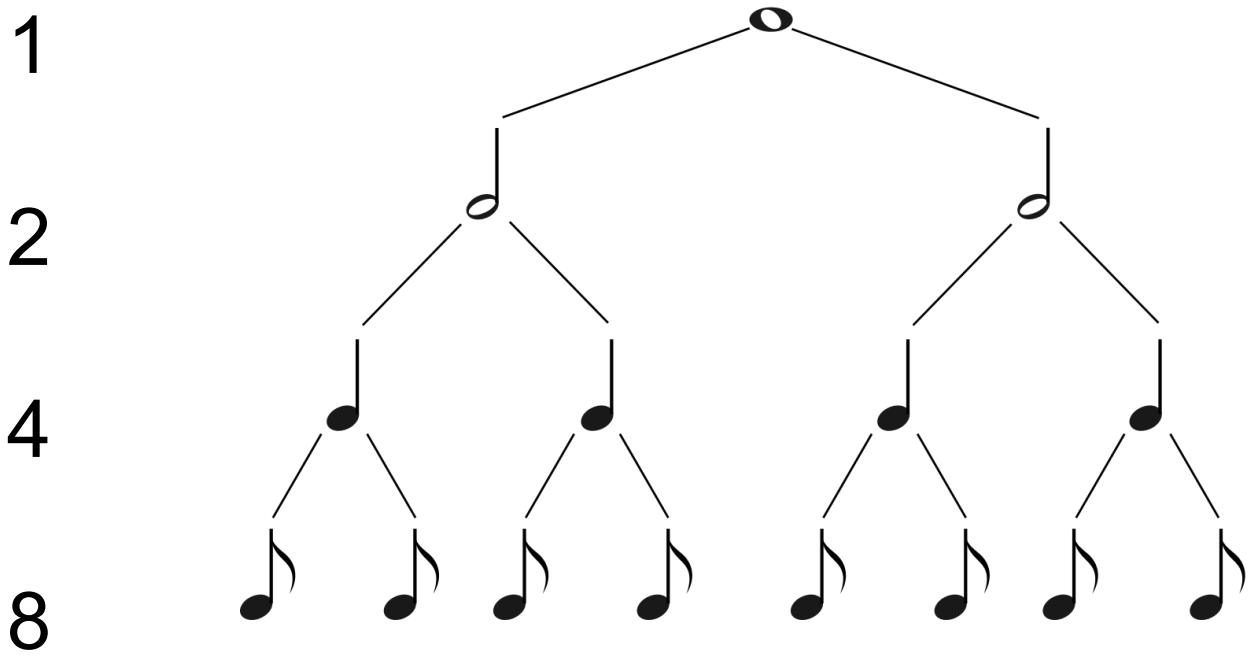
Rhythm in code

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

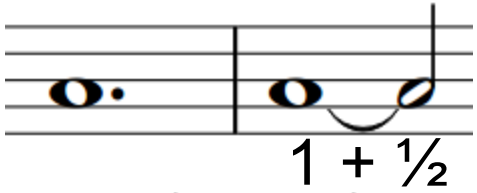
# "r" represents a rest
RhythmSeq("4 4 4 4") # four quarter notes
RhythmSeq("4 4 8 8 4")

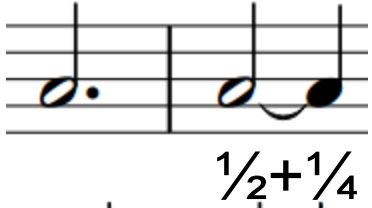
RhythmSeq("4 8 8 4 4")
RhythmSeq("r4 4 4 r4")
```

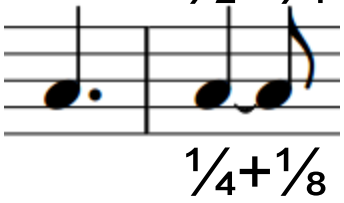
MORE Notes of different lengths

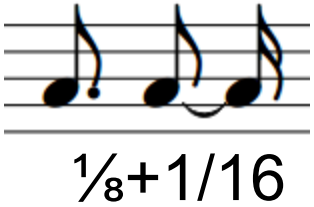


MORE Notes of different lengths

1. 

2. 

4. 

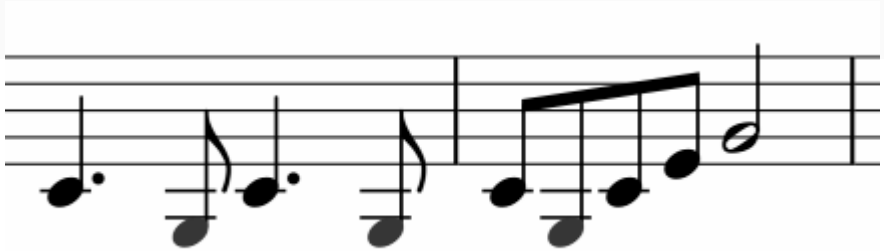
8. 

MORE Notes of different lengths

1.

```
#  dotted rhythm example
NoteSeq("C4.' G8, C4.' G8, C8' G, C' E G2")
```

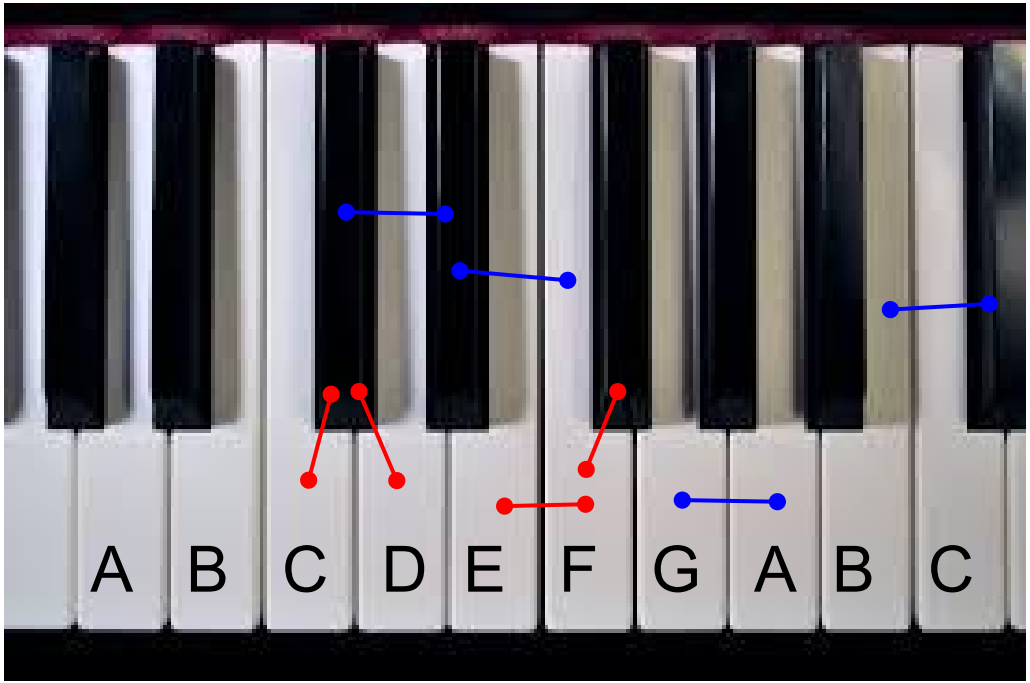
2.



4.

8.

Organizing Frequencies: Notes and Pitches

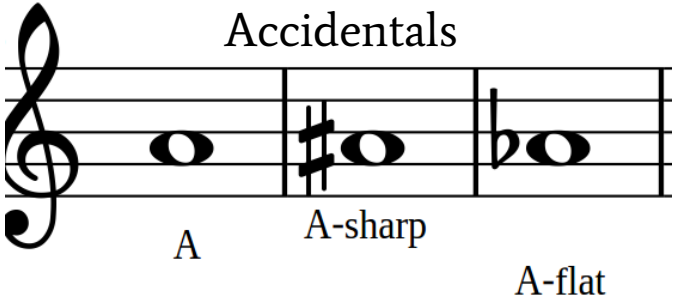


Simple note sequences in code

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

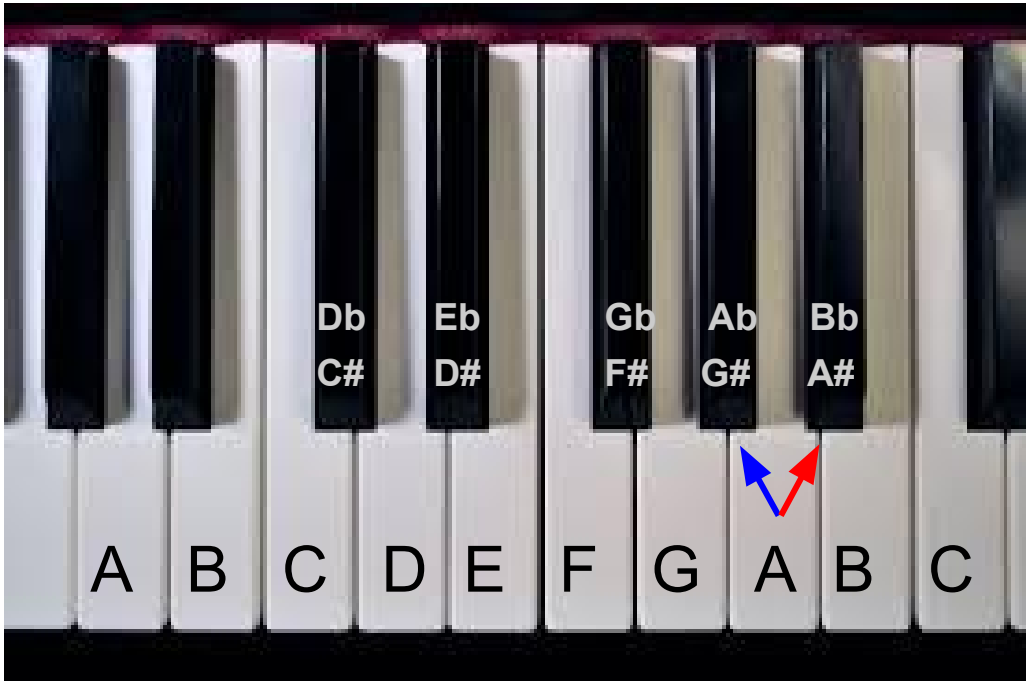
# letter-name + rhythm
NoteSeq("C4 D4 E4 D4 C2")
# can include rests
NoteSeq("C4 r4 E4 D4 C2")
# same duration is applied until changed
NoteSeq("C4 r E D2 C") == NoteSeq("C4 r4 E4 D2 C2")
```

Getting all of the notes



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

```
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")
```

Generating MIDI files

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    midi = Midi(number_tracks=2, tempo=90)
    midi.seq_notes(notes1, track=0)
    midi.seq_notes(notes2, track=1)
    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)
```

Generating MIDI files

```
# "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