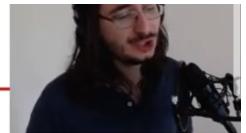


Music Theory

Melody



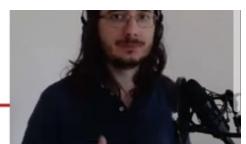
- Sequence of notes and rests



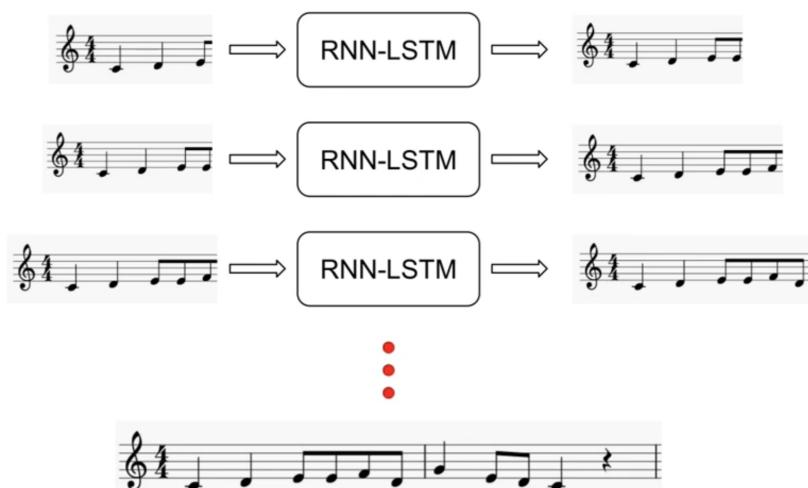
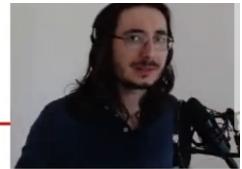
Melody generation problem

- Treat melody as a time series
- Time-series prediction problem
- Vocabulary of notes

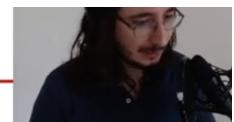
The melody generator (training)



The melody generator (inference)



Why do we use an RNN-LSTM?



Why do we use an RNN-LSTM?

- Melodies have long-term structural patterns
- **LSTMs capture long-term temporal dependencies**

Music Theory

In order to know how our models are doing we need to know some music concepts.t

Melody



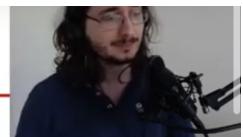
- Sequence of notes and rests

Note = Pitch + Duration

A musical staff in 4/4 time with a treble clef. It contains several notes of different pitches and durations. One note on the first line is highlighted with a red box. A red arrow points from the text "Note = Pitch + Duration" to this highlighted note.

The higher the frequency the higher the pitch of a note.

Pitch



- Indicates how high/low a note is

note names: C C# D D# E F F# G G# A A# B C

A musical staff showing a sequence of notes. Below the staff, the note names are listed: C, C#, D, D#, E, F, F#, G, G#, A, A#, B, C. The note G# is highlighted with a red box.

Pitch



- Indicates how high/low a note is

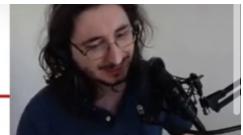
2 x frequency

note names: C C# D D# E F F# G G# A A# B C

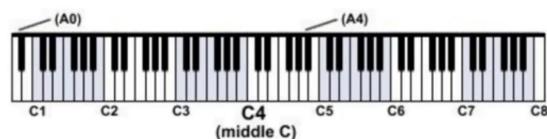
Scientific pitch notation

- Note name + octave
- E.g., C3, D4, A1

Scientific pitch notation



- Note name + octave
- E.g., C3, D4, A1



Melody



C4 D4 E4 E4 F4 D4 G4 E4 D4 C4

This is one great way for music notation but we mostly use midi format.

MIDI note notation

- MIDI is a protocol to play, edit and record music
- Map note names to numbers
- C4 = 60

MIDI note notation

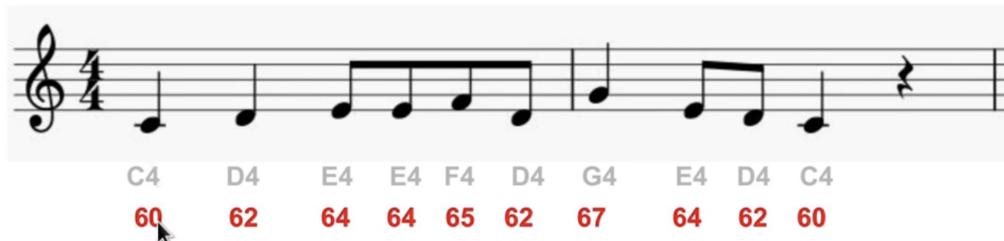
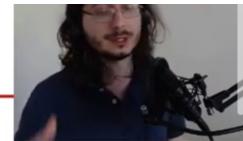


| Note name | Midi number | Note name | Midi number |
|-----------|-------------|-----------|-------------|
| A7# | 108 | C8 | |
| G7# | 106 | B7 | |
| F7# | 104 | A7 | |
| D7# | 102 | G7 | |
| C7# | 99 | F7 | |
| | 101 | E7 | |
| D7# | 99 | D7 | |
| C7# | 97 | C7 | |
| | 100 | B6 | |
| A6# | 94 | A6 | |
| G6# | 92 | G6 | |
| F6# | 90 | F6 | |
| D6# | 87 | E6 | |
| C6# | 85 | D6 | |
| | 86 | C6 | |
| B5 | 84 | B5 | |
| A5# | 82 | A5 | |
| G5# | 80 | G5 | |
| F5# | 78 | F5 | |
| | 77 | E5 | |
| D5# | 75 | D5 | |
| C5# | 73 | C5 | |
| | 74 | B4 | |
| A4# | 70 | A4 | |
| G4# | 68 | G4 | |
| F4# | 66 | F4 | |
| D4# | 63 | E4 | |
| C4# | 61 | D4 | |
| | 62 | C4 | |
| A3# | 58 | B3 | |
| G3# | 56 | A3 | |
| F3# | 54 | G3 | |
| | 55 | F3 | |
| D3# | 51 | E3 | |
| C3# | 49 | D3 | |
| | 50 | C3 | |
| A2# | 46 | B2 | |
| G2# | 44 | A2 | |
| F2# | 42 | G2 | |
| | 43 | F2 | |
| D2# | 39 | E2 | |
| C2# | 37 | D2 | |
| | 38 | C2 | |
| A1# | 34 | B1 | |
| G1# | 32 | A1 | |
| F1# | 30 | G1 | |
| | 31 | F1 | |
| D1# | 27 | E1 | |
| C1# | 25 | D1 | |
| | 26 | C1 | |
| A0# | 22 | B0 | |
| | 23 | A0 | |

Musical Instrument Digital Interface (MIDI) is a standard to **transmit and store music**, originally designed for digital music synthesizers.

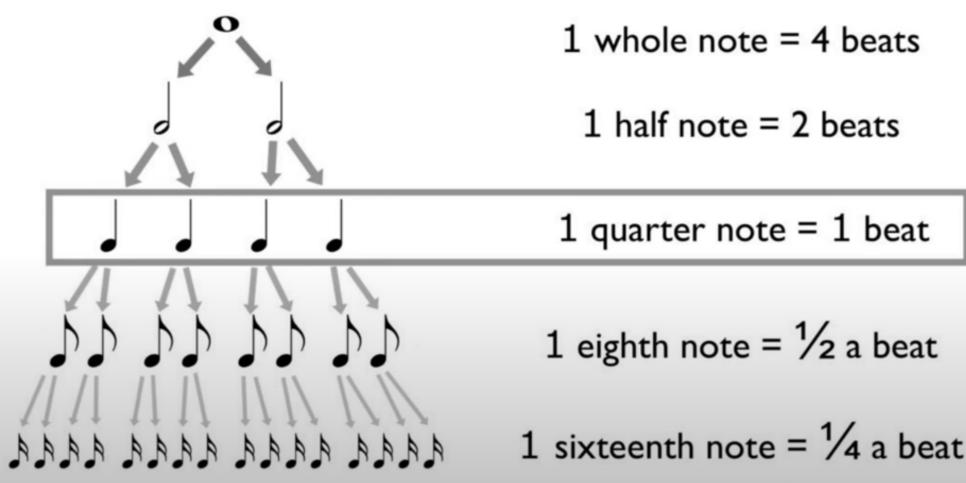
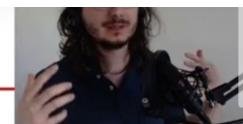
Here, every note name are mapped to a number.

Melody



Notes also have information about how long the note is pressed.

Note values



These are all symbols that express information about the note.

Melody



Here, we mapped the notes against the beats.

Also, musical notes are divided into bars and the end of the bar is represented by vertical lines. Each bar has its own structure.

Melody

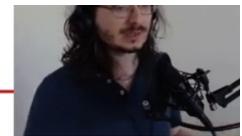


A musical staff in G clef and 4/4 time signature. The melody consists of eighth notes and sixteenth notes. Below the staff, red numbers indicate the duration of each note: 1, 1, 0.5, 0.5, 0.5, 0.5, 1, 0.5, 0.5, 1, 1.

Duration in # beats:

4 4

Time signature



beats in a bar

Type of note which equals 1 beat

A musical staff in G clef. The time signature 4/4 is highlighted with a purple box. The melody consists of eighth notes and sixteenth notes. A green box highlights a quarter note (eighth note beamed) with the text "Type of note which equals 1 beat".

Time signature

| Time Signature | Beat Duration | Number of Beats |
|----------------|-------------------------------------|--|
| $\frac{3}{2}$ | $\frac{2}{2} = \text{long note}$ | $\frac{3}{2} = \text{long note, short note, short note}$ |
| $\frac{3}{4}$ | $\frac{4}{4} = \text{short note}$ | $\frac{3}{4} = \text{short note, short note, short note}$ |
| $\frac{3}{8}$ | $\frac{8}{8} = \text{medium note}$ | $\frac{3}{8} = \text{medium note, medium note, medium note}$ |
| $\frac{3}{16}$ | $\frac{16}{16} = \text{short note}$ | $\frac{3}{16} = \text{short note, short note, short note}$ |

The most popular time signature is 4/4.

We learned all this stuff because after training our NN, we want to see whether or not it has learned all these concepts or not.

Key

- Group of pitches (i.e., *scale*) that forms the centre of a piece
- Tonic + mode
- E.g., C maj, D min

Tonic note

- Pitch that provides sense of arrival
- Centre of gravity
- Often found at the beginning/end of a piece

A note which feels like rest or the previous music was leading to that part only.

Major/minor scale



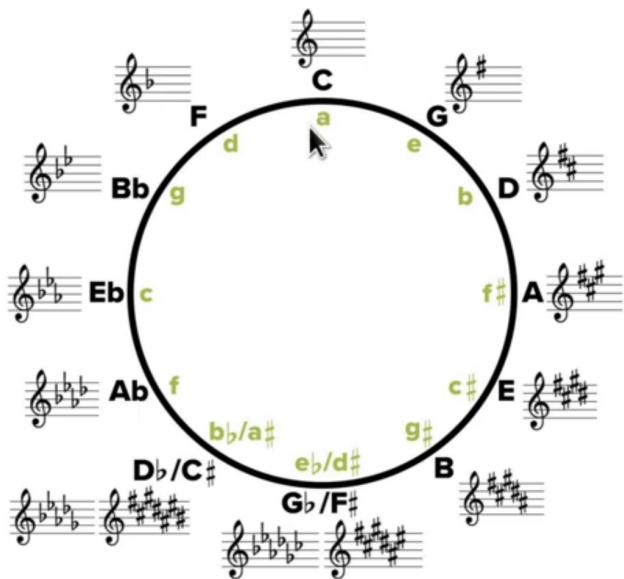
A musical staff with two staves. The top staff is labeled 'CM' and shows a C major scale (C, D, E, F#, G, A, B) with a treble clef. The bottom staff is labeled 'Cm' and shows a C minor scale (C, D, E, F, G, A, B) with a bass clef. Both staves have a common time signature.

keys



12 notes x 2 modes = 24 keys

keys



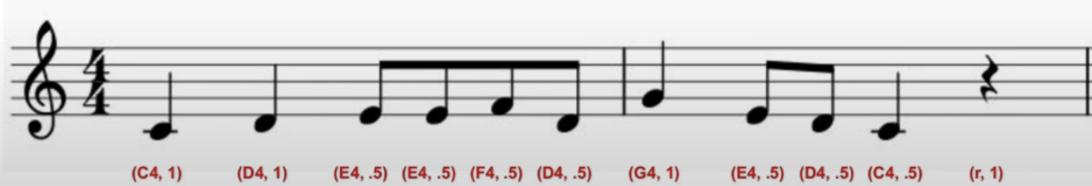
Transposition

- Moving collection notes up/down by a given interval
- Change key
- Musical content remains the same

Music representation: Idea 1



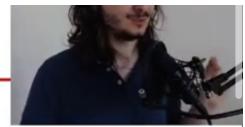
- Sequence
- Pitch/duration info for each note
- E.g., [(C4, 1), (D4, 1), ...]



Music representation: Idea 2

- Time series
- Sample melody at each 16th note
- Each step = 16th note
- Log MIDI note when note occurs
- Use “_” symbol for held notes
- Use “r” symbol for rest

Time series representation: Example



- 4/4 time signature
- 16 samples per bar
- 4 samples per quarter note



Time series representation: Example



```
[ "60", "_", "_", "_",
  "62", "_", "_", "_",
  "64", "_", "64", "_",
  "65", "_", "62", "_",
  ...]
```



time series is a data structure where samples are taken at evenly spaced intervals.

We represent the time series as beat-wise.

This is a time series representation.

Preparing melodies for LSTM ingestion

