Pypianoroll

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CONTENTS

Pypianoroll is an open source Python library for working with piano rolls. It provides essential tools for handling multitrack piano rolls, including efficient I/O as well as manipulation, visualization and evaluation tools.

CHAPTER

ONE

FEATURES

- Manipulate multitrack piano rolls intuitively
- Visualize multitrack piano rolls beautifully
- Save and load multitrack piano rolls in a space-efficient format
- Parse MIDI files into multitrack piano rolls
- Write multitrack piano rolls into MIDI files

CHAPTER

TWO

WHY PYPIANOROLL

Our aim is to provide convenient classes for piano-roll matrix and MIDI-like track information (program number, track name, drum track indicator). Pypianoroll is also designed to provide efficient I/O for piano rolls, since piano rolls have long been considered an inefficient way to store music data due to the sparse nature.

CHAPTER

THREE

INSTALLATION

To install Pypianoroll, please run `pip install pypianoroll`. To build Pypianoroll from source, please download the source and run `python setup.py install`.

CHAPTER

FOUR

DOCUMENTATION

Documentation is available here and as docstrings with the code.

CHAPTER

FIVE

CITING

Please cite the following paper if you use Pypianoroll in a published work:

Hao-Wen Dong, Wen-Yi Hsiao, and Yi-Hsuan Yang, "Pypianoroll: Open Source Python Package for Handling Multitrack Pianorolls," in *Late-Breaking Demos of the 19th International Society for Music Information Retrieval Conference (ISMIR)*, 2018.

[homepage] [paper] [poster] [code] [documentation]

CHAPTER

SIX

LAKH PIANOROLL DATASET

Lakh Pianoroll Dataset (LPD) is a new multitrack piano roll dataset using Pypianoroll for efficient data I/O and to save space, which is used as the training dataset in our MuseGAN project.

CHAPTER

SEVEN

CONTENTS

7.1 Getting Started

Welcome to Pypianoroll! We will go through some basic concepts in this tutorial.

Hint: Be sure you have Pypianoroll installed. To install Pypianoroll, please run `pip install pypianoroll`.

In the following example, we will use this MIDI file as an example.

First of all, let's import the Pypianoroll library.

```
import pypianoroll
```

Now, let's read the example MIDI file into a Multitrack object.

```
multitrack = pypianoroll.read("fur-elise.mid")
print(multitrack)
```

Here's what we got.

```
Multitrack(name=None, resolution=24, tempo=array(shape=(8976, 1)),␣
↪downbeat=array(shape=(8976, 1)), tracks=[StandardTrack(name='', program=0, is_
↪drum=False, pianoroll=array(shape=(8976, 128))), StandardTrack(name='', program=0,␣
↪is_drum=False, pianoroll=array(shape=(8976, 128)))])
```

You can use dot notation to assess the data. For example, `multitrack.resolution` returns the temporal resolution (in time steps per quarter note) and `multitrack.tracks[0].pianoroll` returns the piano roll for the first track.

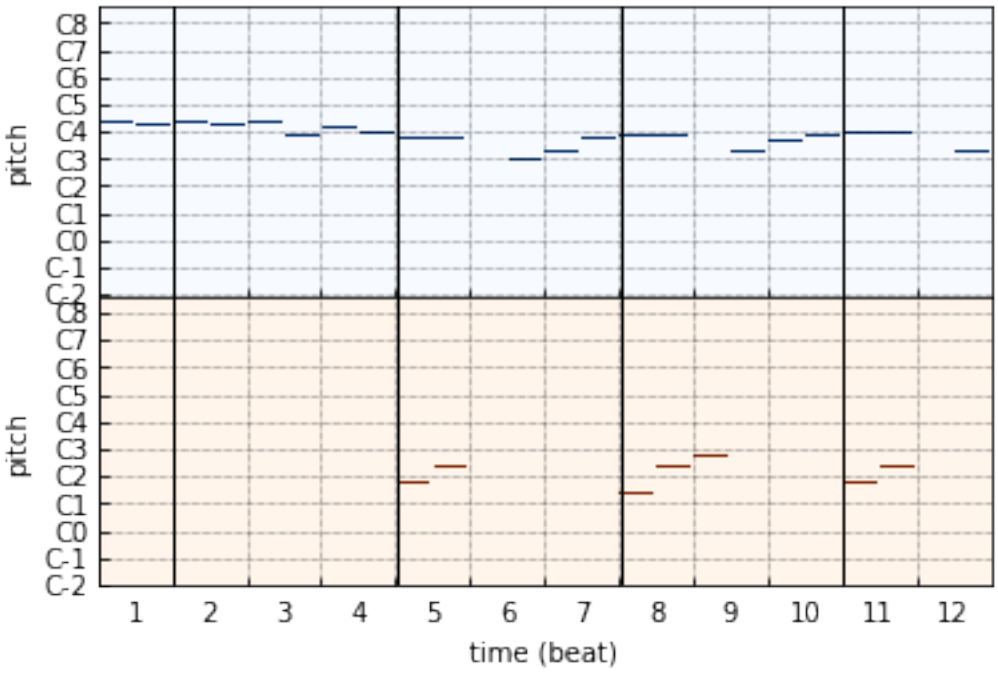
Pypianoroll provides some functions for manipulating the multitrack piano roll. For example, we can trim and binarize the multitrack as follows.

```
multitrack.trim(0, 12 * multitrack.resolution)
multitrack.binarize()
```

Pypianoroll also provides visualization supports.

```
multitrack.plot()
```

This will give us the following plot.



7.2 Pypianoroll Classes

We provide several classes for working with multitrack piano rolls.

- *pypianoroll.Multitrack*: A multitrack that stores track(s) along with global information.
- *pypianoroll.Track*: A track that stores the a piano roll along with track information.
- *pypianoroll.StandardTrack*: A standard track that holds a piano roll with velocity information.
- *pypianoroll.BinaryTrack*: A binary track that holds a piano roll without velocity information.

7.2.1 Multitrack Class

Attribute	Description	Type	Default
name	Name of the multitrack	str	
resolution	Time steps per quarter note	int	`pypianoroll.DEFAULT_RESOLUTION`
tempo	Tempo at each time step	NumPy array of dtype float	
downbeat	Downbeat positions	NumPy array of dtype bool	
tracks	Music tracks	list of *pypianoroll.Track*	[]

7.2.2 Track Class

Attribute	Description	Type	Default
name	Name of the track	str	
program	MIDI program number	int	`pypianoroll.DEFAULT_PROGRAM`
is_drum	If it is a drum track	bool	`pypianoroll.DEFAULT_IS_DRUM`
pianoroll	Downbeat positions	NumPy array	`np.zeros((0, 128))`

For *pypianoroll.StandardTrack*, the piano roll array must be of data type uint8 and take values in [0, 127]. For *pypianoroll.BinaryTrack*, the piano roll array must be of data type bool.

7.3 Save & Load

Pypianoroll supports efficient I/O for *pypianoroll.Multitrack* objects. The piano rolls will be first converted to sparse matrices (specifically, instances of `scipy.sparse.csc_matrix`) and then stored in a NPZ file.

7.3.1 Functions

`pypianoroll.`**`save`**(*path: Union[str, pathlib.Path]*, *multitrack: Multitrack*, *compressed: bool = True*)

Save a Multitrack object to a NPZ file.

Parameters

- **`path`** (*`str or Path`*) – Path to the NPZ file to save.
- **`multitrack`** (*pypianoroll.Multitrack*) – Multitrack to save.
- **`compressed`** (*`bool`*) – Whether to save to a compressed NPZ file. Defaults to True.

Notes

To reduce the file size, the piano rolls are first converted to instances of `scipy.sparse.csc_matrix`. The component arrays are then collected and saved to a npz file.

See also:

pypianoroll.load() Load a NPZ file into a Multitrack object.

pypianoroll.write() Write a Multitrack object to a MIDI file.

Note: The saved .npz file is basically a zip archive which contains the following files:

- component arrays of the piano rolls in compressed sparse column format:
  - `pianoroll_[index]_csc_data.npy`
  - `pianoroll_[index]_csc_indices.npy`
  - `pianoroll_[index]_csc_indptr.npy`
- `tempo.npy`: the tempo array
- `downbeat.npy`: the down beat array
- `info.json`: a JSON file that contains meta data and track information

pypianoroll.**load**(*path: Union[str, pathlib.Path]*) → pypianoroll.multitrack.Multitrack
Load a NPZ file into a Multitrack object.

Supports only files previously saved by *pypianoroll.save()*.

Parameters **path** (*str or Path*) – Path to the file to load.

See also:

pypianoroll.save() Save a Multitrack object to a NPZ file.

pypianoroll.read() Read a MIDI file into a Multitrack object.

7.4 Read & Write

Pypianoroll currently supports reading from and writing to MIDI files.

7.4.1 Functions

pypianoroll.**read**(*path: Union[str, pathlib.Path]*, ***kwargs*) → pypianoroll.multitrack.Multitrack
Read a MIDI file into a Multitrack object.

Parameters

- **path** (*str or Path*) – Path to the file to read.
- ****kwargs** – Keyword arguments to pass to *pypianoroll.from_pretty_midi()*.

See also:

pypianoroll.write() Write a Multitrack object to a MIDI file.

pypianoroll.load() Load a NPZ file into a Multitrack object.

pypianoroll.**write**(*path: str*, *multitrack: Multitrack*)
Write a Multitrack object to a MIDI file.

Parameters

- **path** (*str*) – Path to write the file.
- **multitrack** (*pypianoroll.Multitrack*) – Multitrack to save.

See also:

pypianoroll.read() Read a MIDI file into a Multitrack object.

pypianoroll.save() Save a Multitrack object to a NPZ file.

pypianoroll.**from_pretty_midi**(*midi: pretty_midi.pretty_midi.PrettyMIDI*, *resolution: int = 24*, *mode: str = 'max'*, *algorithm: str = 'normal'*, *collect_onsets_only: bool = False*, *first_beat_time: Optional[float] = None*) → pypianoroll.multitrack.Multitrack
Return a Multitrack object converted from a PrettyMIDI object.

Parse a pretty_midi.PrettyMIDI object. The data type of the resulting piano rolls is automatically determined (int if 'mode' is 'sum' and np.uint8 if *mode* is 'max').

Parameters

- **midi** (pretty_midi.PrettyMIDI) – PrettyMIDI object to parse.
- **mode** (*{'max', 'sum'}*) – Merging strategy for duplicate notes. Defaults to 'max'.
- **algorithm** (*{'normal', 'strict', 'custom'}*) – Algorithm for finding the location of the first beat (see Notes). Defaults to 'normal'.
- **collect_onsets_only** (*bool*) – True to collect only the onset of the notes (i.e. note on events) in all tracks, where the note off and duration information are discarded. False to parse regular piano rolls. Defaults to False.
- **first_beat_time** (*float, optional*) – Location of the first beat, in sec. Required and only effective when using 'custom' algorithm.

Returns Converted Multitrack object.

Return type *pypianoroll.Multitrack*

Notes

There are three algorithms for finding the location of the first beat:

- 'normal' : Estimate the location of the first beat using pretty_midi.PrettyMIDI.estimate_beat_start().
- 'strict' : Set the location of the first beat to the time of the first time signature change. Raise a RuntimeError if no time signature change is found.
- 'custom' : Set the location of the first beat to the value of argument *first_beat_time*. Raise a ValueError if *first_beat_time* is not given.

If an incomplete beat before the first beat is found, an additional beat will be added before the (estimated) beat starting time. However, notes before the (estimated) beat starting time for more than one beat are dropped.

pypianoroll.**to_pretty_midi**(*multitrack: Multitrack*, *default_tempo: Optional[float] = None*, *default_velocity: int = 64*) → pretty_midi.pretty_midi.PrettyMIDI

Return a Multitrack object as a PrettyMIDI object.

Parameters

- **default_tempo** (*int*) – Default tempo to use. Defaults to the first element of attribute *tempo*.
- **default_velocity** (*int*) – Default velocity to assign to binarized tracks. Defaults to 64.

Returns Converted PrettyMIDI object.

Return type pretty_midi.PrettyMIDI

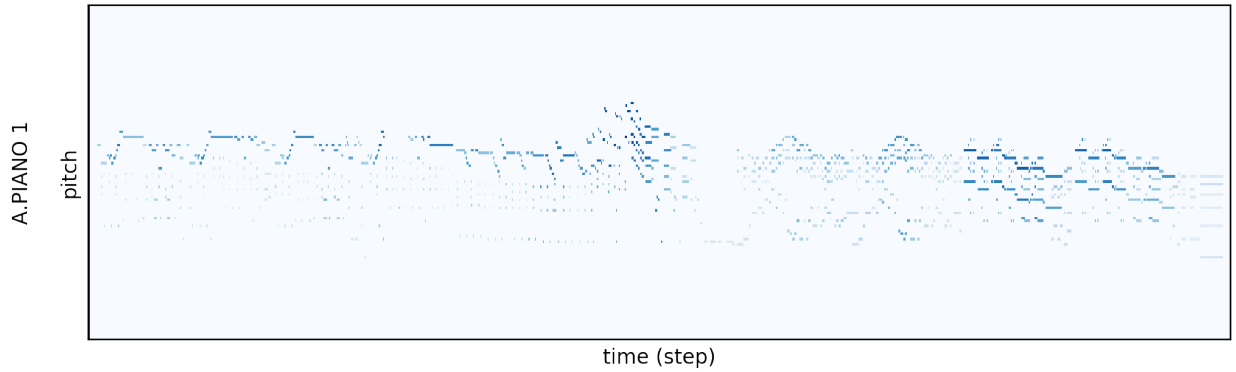
Notes

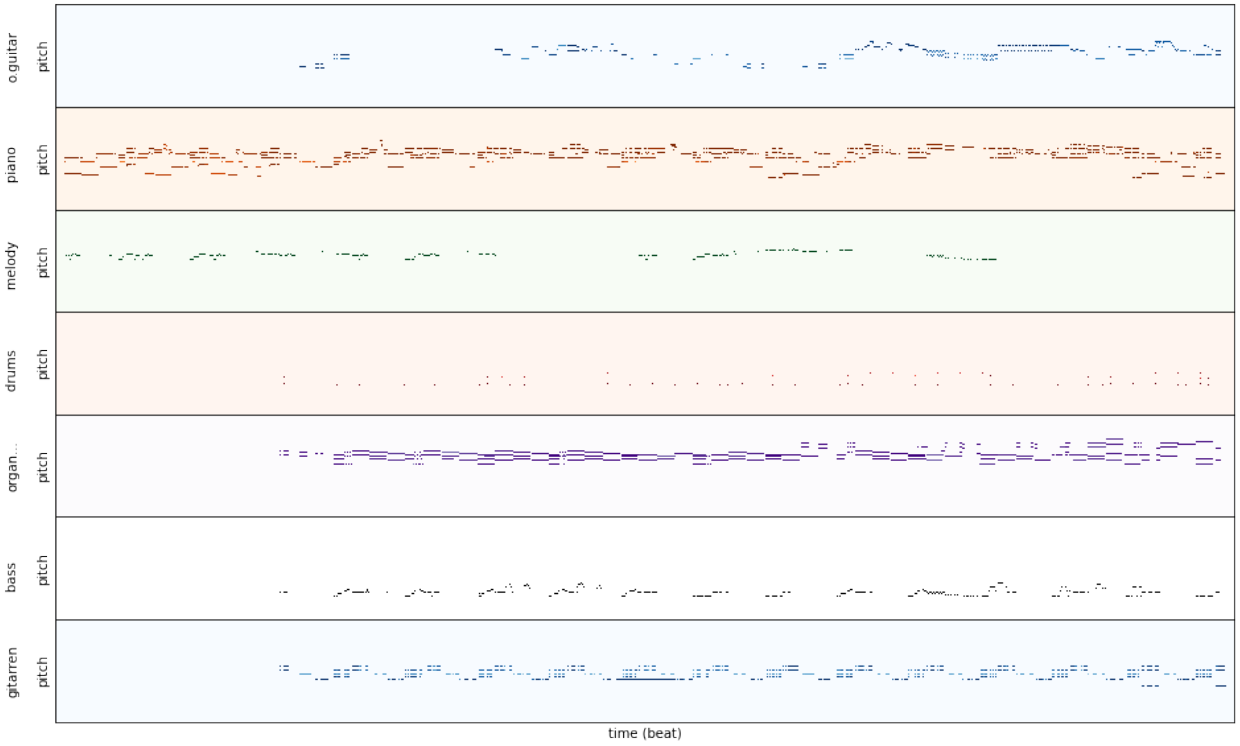
- Tempo changes are not supported.
- Time signature changes are not supported.
- The velocities of the converted piano rolls will be clipped to [0, 127].
- Adjacent nonzero values of the same pitch will be considered a single note with their mean as its velocity.

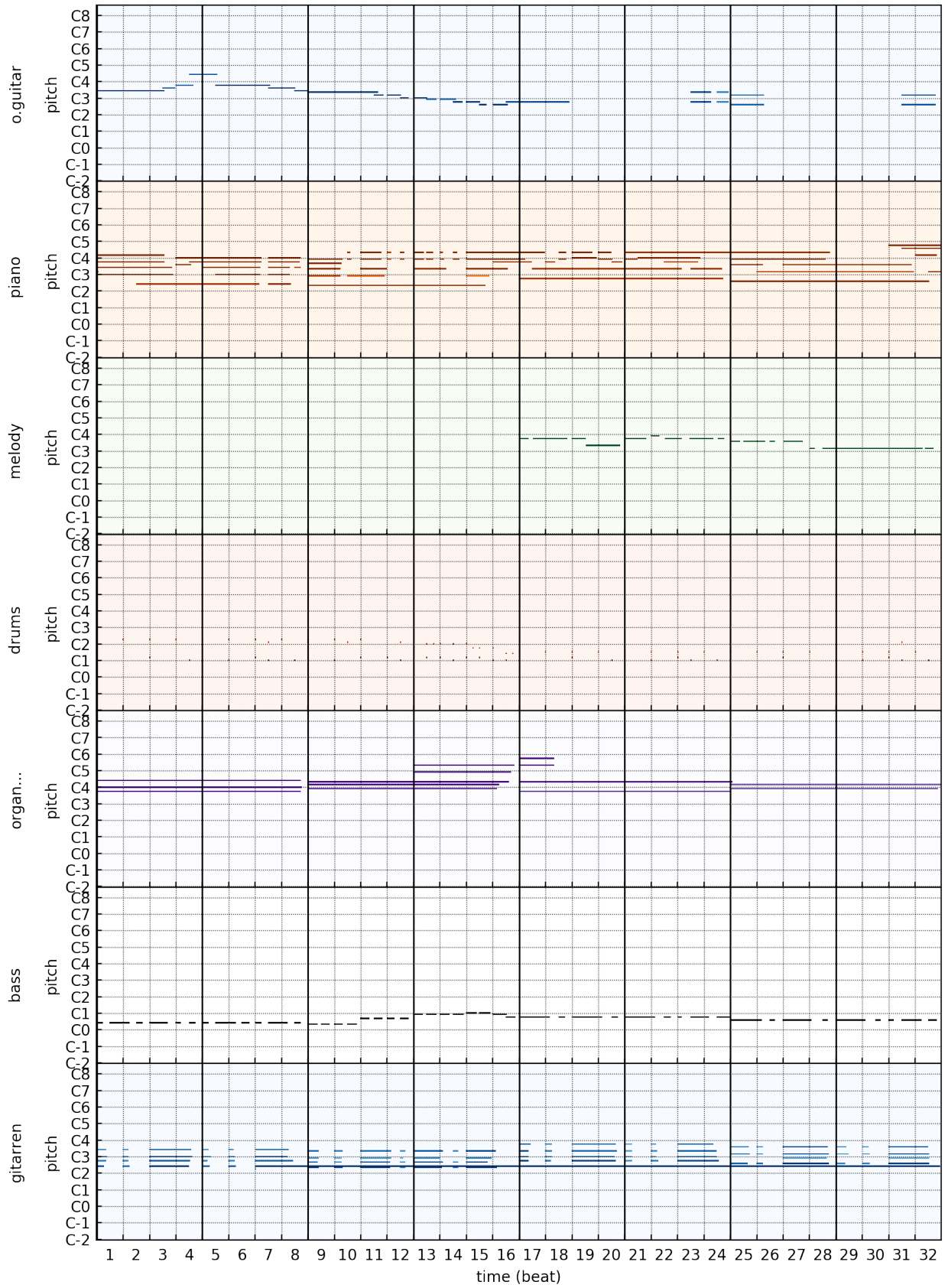
Note: Writing the tempo array and downbeat array to tempo change and time signature change events are not supported yet.

7.5 Visualization

Pypianoroll provides tools for visualizing piano rolls. Here are some examples.






o.guitar
piano
melody
drums
organ...
bass
gitarren
pitch
C8
C7
C6
C5
C4
C3
C2
C1
C0
C-1
C-2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
time (beat)

7.5.1 Functions

pypianoroll.**plot**(*obj: _MultitrackOrTrack*, ***kwargs*) → _MultitrackOrTrack
Plot the object.

See *pypianoroll.plot_multitrack()* and *pypianoroll.plot_track()* for full documentation.

pypianoroll.**plot_multitrack**(*multitrack: Multitrack*, *axs: Optional[Sequence[matplotlib.axes._axes.Axes]]*, *mode: str = 'separate'*, *track_label: str = 'name'*, *preset: str = 'full'*, *cmaps: Optional[Sequence[str]] = None*, *xtick: str = 'auto'*, *ytick: str = 'octave'*, *xticklabel: bool = True*, *yticklabel: str = 'auto'*, *tick_loc: Sequence[str] = ('bottom', 'left')*, *tick_direction: str = 'in'*, *label: str = 'both'*, *grid_axis: str = 'both'*, *grid_linestyle: str = ':'*, *grid_linewidth: float = 0.5*, ***kwargs*) → List[matplotlib.axes._axes.Axes]
Plot the multitrack.

Parameters

- **multitrack** (*pypianoroll.Multitrack*) – Multitrack to plot.
- **axs** (sequence of matplotlib.axes.Axes) – Axes to plot the tracks on.
- **mode** (*{'separate', 'blended', 'hybrid'}*) – Plotting strategy for visualizing multiple tracks. For 'separate' mode, plot each track separately. For 'blended', blend and plot the pianoroll as a colored image. For 'hybrid' mode, drum tracks are blended into a 'Drums' track and all other tracks are blended into an 'Others' track. Defaults to 'separate'.
- **track_label** (*{'name', 'program', 'family', 'off'}*) – Track label format. When *mode* is 'hybrid', all options other than 'off' will label the two track with 'Drums' and 'Others'.
- **preset** (*{'full', 'frame', 'plain'}*) – Preset theme to use. For 'full' preset, ticks, grid and labels are on. For 'frame' preset, ticks and grid are both off. For 'plain' preset, the x- and y-axis are both off. Defaults to 'full'.
- **cmaps** (*tuple or list*) – Colormaps. Will be passed to matplotlib.pyplot.imshow(). Only effective when *pianoroll* is 2D. Defaults to 'Blues'. If *mode* is 'separate', defaults to *('Blues', 'Oranges', 'Greens', 'Reds', 'Purples', 'Greys')*. If *mode* is 'blended', defaults to *('hsv')*. If *mode* is 'hybrid', defaults to *('Blues', 'Greens')*.
- ****kwargs** – Keyword arguments to pass to *pypianoroll.plot_pianoroll()*.

Returns (Created) list of Axes objects.

Return type list of matplotlib.axes.Axes

pypianoroll.**plot_track**(*track: Track*, *ax: Optional[matplotlib.axes._axes.Axes] = None*, ***kwargs*) → matplotlib.axes._axes.Axes
Plot a track.

Parameters

- **track** (*pypianoroll.Track*) – Track to plot.
- **ax** (matplotlib.axes.Axes) – Axes to plot the piano roll on. Defaults to call *plt.gca()*.
- ****kwargs** – Keyword arguments to pass to *pypianoroll.plot_pianoroll()*.

Returns (Created) Axes object.

Return type matplotlib.axes.Axes

pypianoroll.**plot_pianoroll**(*ax: matplotlib.axes._axes.Axes*, *pianoroll: numpy.ndarray*, *is_drum: bool = False*, *resolution: Optional[int] = None*, *downbeats: Optional[Sequence[int]] = None*, *preset: str = 'full'*, *cmap: str = 'Blues'*, *xtick: str = 'auto'*, *ytick: str = 'octave'*, *xticklabel: bool = True*, *yticklabel: str = 'auto'*, *tick_loc: Sequence[str] = ('bottom', 'left')*, *tick_direction: str = 'in'*, *label: str = 'both'*, *grid_axis: str = 'both'*, *grid_linestyle: str = ':'*, *grid_linewidth: float = 0.5*, ***kwargs*)

Plot a piano roll.

Parameters

- **ax** (matplotlib.axes.Axes) – Axes to plot the piano roll on.
- **pianoroll** (*ndarray, shape=(?, 128), (?, 128, 3) or (?, 128, 4)*) – Piano roll to plot. For a 3D piano-roll array, the last axis can be either RGB or RGBA.
- **is_drum** (*bool*) – Whether it is a percussion track. Defaults to False.
- **resolution** (*int*) – Time steps per quarter note. Required if *xtick* is 'beat'.
- **downbeats** (*list*) – Boolean array that indicates whether the time step contains a downbeat (i.e., the first time step of a bar).
- **preset** (*{'full', 'frame', 'plain'}*) – Preset theme. For 'full' preset, ticks, grid and labels are on. For 'frame' preset, ticks and grid are both off. For 'plain' preset, the x- and y-axis are both off. Defaults to 'full'.
- **cmap** (str or matplotlib.colors.Colormap) – Colormap. Will be passed to matplotlib.pyplot.imshow(). Only effective when *pianoroll* is 2D. Defaults to 'Blues'.
- **xtick** (*{'auto', 'beat', 'step', 'off'}*) – Tick format for the x-axis. For 'auto' mode, set to 'beat' if *resolution* is given, otherwise set to 'step'. Defaults to 'auto'.
- **ytick** (*{'octave', 'pitch', 'off'}*) – Tick format for the y-axis. Defaults to 'octave'.
- **xticklabel** (*bool*) – Whether to add tick labels along the x-axis.
- **yticklabel** (*{'auto', 'name', 'number', 'off'}*) – Tick label format for the y-axis. For 'name' mode, use pitch name as tick labels. For 'number' mode, use pitch number. For 'auto' mode, set to 'name' if *ytick* is 'octave' and 'number' if *ytick* is 'pitch'. Defaults to 'auto'.
- **tick_loc** (*sequence of {'bottom', 'top', 'left', 'right'}*) – Tick locations. Defaults to *('bottom', 'left')*.
- **tick_direction** (*{'in', 'out', 'inout'}*) – Tick direction. Defaults to 'in'.
- **label** (*{'x', 'y', 'both', 'off'}*) – Whether to add labels to x- and y-axes. Defaults to 'both'.
- **grid_axis** (*{'x', 'y', 'both', 'off'}*) – Whether to add grids to the x- and y-axes. Defaults to 'both'.
- **grid_linestyle** (*str*) – Grid line style. Will be passed to matplotlib.axes.Axes.grid().
- **grid_linewidth** (*float*) – Grid line width. Will be passed to matplotlib.axes.Axes.grid().
- ****kwargs** – Keyword arguments to be passed to matplotlib.axes.Axes.imshow().

7.6 Metrics

Pypianoroll provides several objective metrics proposed in the literature. These objective metrics could be used to evaluate a music generation system by comparing the statistical difference between the training data and the generated samples.

7.6.1 Functions

pypianoroll.**empty_beat_rate**(*pianoroll: numpy.ndarray*, *resolution: int*) → float
Return the ratio of empty beats.

The empty-beat rate is defined as the ratio of the number of empty beats (where no note is played) to the total number of beats. Return NaN if song length is zero.

$$empty\_beat\_rate = \frac{\#(empty\_beats)}{\#(beats)}$$

Parameters **pianoroll** (*ndarray*) – Piano roll to evaluate.

Returns Empty-beat rate.

Return type float

pypianoroll.**n_pitches_used**(*pianoroll: numpy.ndarray*) → int
Return the number of unique pitches used.

Parameters **pianoroll** (*ndarray*) – Piano roll to evaluate.

Returns Number of unique pitch classes used.

Return type int

See also:

pypianoroll.n_pitch_class_used() Compute the number of unique pitch classes used.

pypianoroll.**n_pitch_classes_used**(*pianoroll: numpy.ndarray*) → int
Return the number of unique pitch classes used.

Parameters **pianoroll** (*ndarray*) – Piano roll to evaluate.

Returns Number of unique pitch classes used.

Return type int

See also:

pypianoroll.n_pitches_used() Compute the number of unique pitches used.

pypianoroll.**pitch_range_tuple**(*pianoroll*) → Tuple[float, float]
Return the pitch range as a tuple *(lowest, highest)*.

Returns

- *int or nan* – Highest active pitch.
- *int or nan* – Lowest active pitch.

See also:

pypianoroll.pitch_range() Compute the pitch range.

pypianoroll.**pitch_range**(*pianoroll*) → float
Return the pitch range.

Returns Pitch range (in semitones), i.e., difference between the highest and the lowest active pitches.

Return type int or nan

See also:

pypianoroll.pitch_range_tuple() Return the pitch range as a tuple.

pypianoroll.**qualified_note_rate**(*pianoroll: numpy.ndarray*, *threshold: float = 2*) → float
Return the ratio of the number of the qualified notes.

The qualified note rate is defined as the ratio of the number of qualified notes (notes longer than *threshold*, in time steps) to the total number of notes. Return NaN if no note is found.

$$qualified\_note\_rate = \frac{\#(notes\_longer\_than\_the\_threshold)}{\#(notes)}$$

Parameters

- **pianoroll** (*ndarray*) – Piano roll to evaluate.
- **threshold** (*int*) – Threshold of note length to count into the numerator.

Returns Qualified note rate.

Return type float

References

1. Hao-Wen Dong, Wen-Yi Hsiao, Li-Chia Yang, and Yi-Hsuan Yang, "MuseGAN: Multi-track sequential generative adversarial networks for symbolic music generation and accompaniment," in Proceedings of the 32nd AAAI Conference on Artificial Intelligence (AAAI), 2018.

pypianoroll.**polyphonic_rate**(*pianoroll: numpy.ndarray*, *threshold: float = 2*) → float
Return the ratio of time steps where multiple pitches are on.

The polyphony rate is defined as the ratio of the number of time steps where multiple pitches are on to the total number of time steps. Drum tracks are ignored. Return NaN if song length is zero. This metric is used in [1], where it is called *polyphonicity*.

$$polyphony\_rate = \frac{\#(time\_steps\_where\_multiple\_pitches\_are\_on)}{\#(time\_steps)}$$

Parameters

- **pianoroll** (*ndarray*) – Piano roll to evaluate.
- **threshold** (*int*) – Threshold of number of pitches to count into the numerator.

Returns Polyphony rate.

Return type float

References

1. Hao-Wen Dong, Wen-Yi Hsiao, Li-Chia Yang, and Yi-Hsuan Yang, "MuseGAN: Multi-track sequential generative adversarial networks for symbolic music generation and accompaniment," in Proceedings of the 32nd AAAI Conference on Artificial Intelligence (AAAI), 2018.

pypianoroll.**drum_in_pattern_rate**(*pianoroll: numpy.ndarray*, *resolution: int*, *tolerance: float = 0.1*) → float

Return the ratio of drum notes in a certain drum pattern.

The drum-in-pattern rate is defined as the ratio of the number of notes in a certain scale to the total number of notes. Only drum tracks are considered. Return NaN if no drum note is found. This metric is used in [1].

$$drum\_in\_pattern\_rate = \frac{\#(drum\_notes\_in\_pattern)}{\#(drum\_notes)}$$

Parameters

- **pianoroll** (*ndarray*) – Piano roll to evaluate.
- **resolution** (*int*) – Time steps per beat.
- **tolerance** (*float*) – Tolerance. Defaults to 0.1.

Returns Drum-in-pattern rate.

Return type float

References

1. Hao-Wen Dong, Wen-Yi Hsiao, Li-Chia Yang, and Yi-Hsuan Yang, "MuseGAN: Multi-track sequential generative adversarial networks for symbolic music generation and accompaniment," in Proceedings of the 32nd AAAI Conference on Artificial Intelligence (AAAI), 2018.

pypianoroll.**in_scale_rate**(*pianoroll: numpy.ndarray*, *root: int = 3*, *mode: str = 'major'*) → float

Return the ratio of pitches in a certain musical scale.

The pitch-in-scale rate is defined as the ratio of the number of notes in a certain scale to the total number of notes. Drum tracks are ignored. Return NaN if no note is found. This metric is used in [1].

$$pitch\_in\_scale\_rate = \frac{\#(notes\_in\_scale)}{\#(notes)}$$

Parameters

- **pianoroll** (*ndarray*) – Piano roll to evaluate.
- **root** (*int*) – Root of the scale.
- **mode** (*str, {'major', 'minor'}*) – Mode of the scale.

Returns Pitch-in-scale rate.

Return type float

See also:

muspy.scale_consistency() Compute the largest pitch-in-class rate.

References

1. Hao-Wen Dong, Wen-Yi Hsiao, Li-Chia Yang, and Yi-Hsuan Yang, "MuseGAN: Multi-track sequential generative adversarial networks for symbolic music generation and accompaniment," in Proceedings of the 32nd AAAI Conference on Artificial Intelligence (AAAI), 2018.

pypianoroll.**tonal_distance**(*pianoroll_1: numpy.ndarray*, *pianoroll_2: numpy.ndarray*, *resolution: int*, *radii: Sequence[float] = (1.0, 1.0, 0.5)*) → float

Return the tonal distance [1] between the two input piano rolls.

Parameters

- **pianoroll_1** (*ndarray*) – First piano roll to evaluate.
- **pianoroll_2** (*ndarray*) – Second piano roll to evaluate.
- **resolution** (*int*) – Time steps per beat.
- **radii** (*tuple of float*) – Radii of the three tonal circles (see Equation 3 in [1]).

References

1. Christopher Harte, Mark Sandler, and Martin Gasser, "Detecting harmonic change in musical audio," in Proceedings of the 1st ACM workshop on Audio and music computing multimedia, 2006.

7.7 Technical Documentation

A Python library for handling multitrack pianorolls.

Pypianoroll is an open source Python library for working with piano rolls. It provides essential tools for handling multitrack piano rolls, including efficient I/O as well as manipulation, visualization and evaluation tools.

7.7.1 Features

- Manipulate multitrack piano rolls intuitively
- Visualize multitrack piano rolls beautifully
- Save and load multitrack piano rolls in a space-efficient format
- Parse MIDI files into multitrack piano rolls
- Write multitrack piano rolls into MIDI files

class pypianoroll.**BinaryTrack**(*name: Optional[str] = None*, *program: Optional[int] = None*, *is_drum: Optional[bool] = None*, *pianoroll: Optional[numpy.ndarray] = None*)

A container for single-track, binary piano rolls.

name

Track name.

Type str, optional

program

Program number according to General MIDI specification [1]. Defaults to 0 (Acoustic Grand Piano).

Type int, 0-127, optional

is_drum
Whether it is a percussion track. Defaults to False.

Type bool, optional

pianoroll
Piano-roll matrix. The first dimension represents time, and the second dimension represents pitch. Cast to bool if not of data type bool.

Type ndarray, dtype=bool, shape=(?, 128), optional

References

1. https://www.midi.org/specifications/item/gm-level-1-sound-set

set_nonzeros(*value: int*) → pypianoroll.track.StandardTrack
Assign a constant value to all nonzeros entries.

Parameters **value** (*int*) – Value to assign.

Returns

Return type Converted StandardTrack object.

class pypianoroll.**Multitrack**(*name: Optional[str] = None*, *resolution: Optional[int] = None*, *tempo: Optional[numpy.ndarray] = None*, *downbeat: Optional[numpy.ndarray] = None*, *tracks: Optional[Sequence[pypianoroll.track.Track]] = None*)
A container for multitrack piano rolls.

This is the core class of Pypianoroll.

name
Multitrack name.

Type str, optional

resolution
Time steps per quarter note.

Type int

tempo
Tempo (in qpm) at each time step. Length is the total number of time steps. Cast to float if not of data type float.

Type ndarray, dtype=float, shape=(?, 1), optional

downbeat
Boolean array that indicates whether the time step contains a downbeat (i.e., the first time step of a bar). Length is the total number of time steps.

Type ndarray, dtype=bool, shape=(?, 1), optional

tracks
Music tracks.

Type sequence of *pypianoroll.Track*, optional

append(*track: pypianoroll.track.Track*) → _Multitrack
Append a Track object to the track list.

Parameters **track** (*pypianoroll.Track*) – Track to append.

Returns

Return type Object itself.

binarize(*threshold: float = 0*) → _Multitrack
Binarize the piano rolls.

Parameters **threshold** (*int or float*) – Threshold to binarize the piano rolls. Defaults to zero.

Returns

Return type Object itself.

blend(*mode: Optional[str] = None*) → numpy.ndarray
Return the blended pianoroll.

Parameters **mode** (*{'sum', 'max', 'any'}, optional*) – Blending strategy to apply along the track axis. For 'sum' mode, integer summation is performed for binary piano rolls. Defaults to 'sum'.

Returns Blended piano roll.

Return type ndarray, shape=(?, 128)

clip(*lower: int = 0*, *upper: int = 127*) → _Multitrack
Clip (limit) the the piano roll into [*lower*, *upper*].

Parameters

- **lower** (*int*) – Lower bound. Defaults to 0.
- **upper** (*int*) – Upper bound. Defaults to 127.

Returns

Return type Object itself.

Note: Only affect StandardTrack instances.

---

copy()
Return a copy of the multitrack.

Returns

Return type A copy of the object itself.

Notes

Arrays are copied using `numpy.copy()`.

count_downbeat() → int
Return the number of downbeats.

Returns Number of downbeats.

Return type int

Note: Return value is calculated based only on the attribute *downbeat*.

---

get_downbeat_steps() → numpy.ndarray
Return the indices of time steps that contain downbeats.

Returns Indices of time steps that contain downbeats.

Return type ndarray, dtype=int

get_length() → int
Return the maximum active length of the piano rolls.

Returns Maximum active length (in time steps) of the piano rolls, where active length is the length of the piano roll without trailing silence.

Return type int

get_max_length() → int
Return the maximum length of the piano rolls.

Returns Maximum length (in time steps) of the piano rolls.

Return type int

is_valid(*attr: Optional[str] = None*) → bool
Return True if an attribute is valid.

Parameters **attr** (*str*) – Attribute to validate. Defaults to validate all attributes.

Returns Whether the attribute has a valid type and value.

Return type bool

is_valid_type(*attr: Optional[str] = None*) → bool
Return True if an attribute is of a valid type.

Parameters **attr** (*str*) – Attribute to validate. Defaults to validate all attributes.

Returns Whether the attribute is of a valid type.

Return type bool

pad(*pad_length*) → _Multitrack
Pad the piano rolls.

Notes

The lengths of the resulting piano rolls are not guaranteed to be the same.

Parameters **pad_length** (*int*) – Length to pad along the time axis.

Returns

Return type Object itself.

See also:

pypianoroll.Multitrack.pad_to_multiple() Pad the piano rolls so that their lengths are some multiples.

pypianoroll.Multitrack.pad_to_same() Pad the piano rolls so that they have the same length.

pad_to_multiple(*factor: int*) → _Multitrack
Pad the piano rolls so that their lengths are some multiples.

Pad the piano rolls at the end along the time axis of the minimum length that makes the lengths of the resulting piano rolls multiples of *factor*.

Parameters **factor** (*int*) – The value which the length of the resulting piano rolls will be a multiple of.

Returns

Return type Object itself.

Notes

Lengths of the resulting piano rolls are necessarily the same.

See also:

pypianoroll.Multitrack.pad() Pad the piano rolls.

pypianoroll.Multitrack.pad_to_same() Pad the piano rolls so that they have the same length.

pad_to_same() → _Multitrack
Pad the piano rolls so that they have the same length.

Pad shorter piano rolls at the end along the time axis so that the resulting piano rolls have the same length.

Returns

Return type Object itself.

See also:

pypianoroll.Multitrack.pad() Pad the piano rolls.

pypianoroll.Multitrack.pad_to_multiple() Pad the piano rolls so that their lengths are some multiples.

plot(*axs: Optional[Sequence[matplotlib.axes._axes.Axes]] = None*, ***kwargs*) → numpy.ndarray
Plot the multitrack piano roll.

Refer to *pypianoroll.plot_multitrack()* for full documentation.

remove_empty() → _Multitrack
Remove tracks with empty pianorolls.

save(*path: str*, *compressed: bool = True*)
Save to a NPZ file.

Refer to *pypianoroll.save()* for full documentation.

set_nonzeros(*value: int*) → _Multitrack
Assign a constant value to all nonzero entries.

Parameters **value** (*int*) – Value to assign.

Returns

Return type Object itself.

set_resolution(*resolution: int*, *rounding: Optional[str] = 'round'*) → _Multitrack
Set the resolution.

Parameters

- **resolution** (*int*) – Target resolution.
- **rounding** (*{'round', 'ceil', 'floor'}*) – Rounding mode. Defaults to 'round'.

Returns

Return type Object itself.

stack() → numpy.ndarray
Return the piano rolls stacked as a 3D tensor.

Returns Stacked piano roll, provided as *(track, time, pitch)*.

Return type ndarray, shape=(?, ?, 128)

to_pretty_midi(***kwargs*)
Return as a PrettyMIDI object.

Refer to *pypianoroll.to_pretty_midi()* for full documentation.

transpose(*semitone: int*) → _Multitrack
Transpose the piano rolls by a number of semitones.

Parameters **semitone** (*int*) – Number of semitones to transpose. A positive value raises the pitches, while a negative value lowers the pitches.

Returns

Return type Object itself.

Notes

Drum tracks are skipped.

trim(*start: Optional[int] = None*, *end: Optional[int] = None*) → _Multitrack
Trim the trailing silences of the piano rolls.

Parameters

- **start** (*int, optional*) – Start time. Defaults to 0.
- **end** (*int, optional*) – End time. Defaults to active length.

Returns

Return type Object itself.

validate(*attr=None*) → _Multitrack
Raise an error if an attribute has an invalid type or value.

Parameters **attr** (*str*) – Attribute to validate. Defaults to validate all attributes.

Returns

Return type Object itself.

validate_type(*attr=None*)
Raise an error if an attribute has an invalid type.

Parameters **attr** (*str*) – Attribute to validate. Defaults to validate all attributes.

Returns

Return type Object itself.

write(*path: str*)
Write to a MIDI file.

Refer to *pypianoroll.write()* for full documentation.

class pypianoroll.**StandardTrack**(*name: Optional[str] = None*, *program: Optional[int] = None*, *is_drum: Optional[bool] = None*, *pianoroll: Optional[numpy.ndarray] = None*)
A container for single-track piano rolls with velocities.

name
Track name.

Type str, optional

program
Program number according to General MIDI specification [1]. Defaults to 0 (Acoustic Grand Piano).

Type int, 0-127, optional

is_drum
Whether it is a percussion track. Defaults to False.

Type bool, optional

pianoroll
Piano-roll matrix. The first dimension represents time, and the second dimension represents pitch. Cast to uint8 if not of data type uint8.

Type ndarray, dtype=uint8, shape=(?, 128), optional

References

1. https://www.midi.org/specifications/item/gm-level-1-sound-set

clip(*lower: int = 0*, *upper: int = 127*) → _StandardTrack
Clip (limit) the the piano roll into [*lower*, *upper*].

Parameters

- **lower** (*int*) – Lower bound. Defaults to 0.
- **upper** (*int*) – Upper bound. Defaults to 127.

Returns

Return type Object itself.

set_nonzeros(*value: int*) → _StandardTrack
Assign a constant value to all nonzeros entries.

Parameters **value** (*int*) – Value to assign.

Returns

Return type Object itself.

class pypianoroll.**Track**(*name: Optional[str] = None*, *program: Optional[int] = None*, *is_drum: Optional[bool] = None*, *pianoroll: Optional[numpy.ndarray] = None*)
A generic container for single-track piano rolls.

name
Track name.

Type str, optional

program
Program number according to General MIDI specification [1]. Defaults to 0 (Acoustic Grand Piano).

Type int, 0-127, optional

is_drum
Whether it is a percussion track. Defaults to False.

Type bool, optional

pianoroll
Piano-roll matrix. The first dimension represents time, and the second dimension represents pitch.

Type ndarray, shape=(?, 128), optional

References

1. https://www.midi.org/specifications/item/gm-level-1-sound-set

binarize(*threshold: float = 0*) → pypianoroll.track.BinaryTrack
Binarize the track.

This will binarize the piano roll by the given threshold.

Parameters **threshold** (*int or float*) – Threshold. Defaults to 0.

Returns

Return type Converted BinaryTrack object.

copy()
Return a copy of the track.

Returns

Return type A copy of the object itself.

Notes

The piano-roll array is copied using `numpy.copy()`.

get_length() → int
Return the active length of the piano roll.

Returns Length (in time steps) of the piano roll without trailing silence.

Return type int

is_valid(*attr: Optional[str] = None*) → bool
Return True if an attribute is valid.

Parameters **attr** (*str*) – Attribute to validate. Defaults to validate all attributes.

Returns Whether the attribute has a valid type and value.

Return type bool

is_valid_type(*attr: Optional[str] = None*) → bool
Return True if an attribute is of a valid type.

Parameters **attr** (*str*) – Attribute to validate. Defaults to validate all attributes.

Returns Whether the attribute is of a valid type.

Return type bool

pad(*pad_length: int*) → _Track
Pad the piano roll.

Parameters **pad_length** (*int*) – Length to pad along the time axis.

Returns

Return type Object itself.

See also:

pypianoroll.Track.pad_to_multiple() Pad the piano roll so that its length is some multiple.

pad_to_multiple(*factor: int*) → _Track
Pad the piano roll so that its length is some multiple.

Pad the piano roll at the end along the time axis of the minimum length that makes the length of the resulting piano roll a multiple of *factor*.

Parameters **factor** (*int*) – The value which the length of the resulting piano roll will be a multiple of.

Returns

Return type Object itself.

See also:

pypianoroll.Track.pad() Pad the piano roll.

plot(*ax: Optional[matplotlib.axes._axes.Axes] = None*, ***kwargs*) → matplotlib.axes._axes.Axes
Plot the piano roll.

Refer to *pypianoroll.plot_track()* for full documentation.

standardize() → pypianoroll.track.StandardTrack
Standardize the track.

This will clip the piano roll to [0, 127] and cast to np.uint8.

Returns

Return type Converted StandardTrack object.

transpose(*semitone: int*) → _Track
Transpose the piano roll by a number of semitones.

Parameters **semitone** (*int*) – Number of semitones to transpose. A positive value raises the pitches, while a negative value lowers the pitches.

Returns

Return type Object itself.

trim(*start: Optional[int] = None*, *end: Optional[int] = None*) → _Track
Trim the piano roll.

Parameters

- **start** (*int, optional*) – Start time. Defaults to 0.

- **end** (*int, optional*) – End time. Defaults to active length.

Returns

Return type Object itself.

validate(*attr=None*)
Raise an error if an attribute has an invalid type or value.

Parameters **attr** (*str*) – Attribute to validate. Defaults to validate all attributes.

Returns

Return type Object itself.

validate_type(*attr=None*)
Raise an error if an attribute has an invalid type.

Parameters **attr** (*str*) – Attribute to validate. Defaults to validate all attributes.

Returns

Return type Object itself.

pypianoroll.**binarize**(*obj: Union[pypianoroll.multitrack.Multitrack, pypianoroll.track.StandardTrack]*, *threshold: int = 0*)
Binarize the piano roll(s).

Parameters

- **obj** (*pypianoroll.Multitrack* or *pypianoroll.StandardTrack*) – Object to binarize.
- **threshold** (*int*) – Threshold. Defaults to 0.

pypianoroll.**clip**(*obj: _StandardTrack*, *lower: int = 0*, *upper: int = 127*) → _StandardTrack
Clip (limit) the the piano roll(s) into [*lower*, *upper*].

Parameters

- **obj** (*pypianoroll.Multitrack* or *pypianoroll.StandardTrack*) – Object to clip.
- **lower** (*int*) – Lower bound. Defaults to 0.
- **upper** (*int*) – Upper bound. Defaults to 127.

Returns

Return type Object itself.

pypianoroll.**drum_in_pattern_rate**(*pianoroll: numpy.ndarray*, *resolution: int*, *tolerance: float = 0.1*) → float
Return the ratio of drum notes in a certain drum pattern.

The drum-in-pattern rate is defined as the ratio of the number of notes in a certain scale to the total number of notes. Only drum tracks are considered. Return NaN if no drum note is found. This metric is used in [1].

$$drum\_in\_pattern\_rate = \frac{\#(drum\_notes\_in\_pattern)}{\#(drum\_notes)}$$

Parameters

- **pianoroll** (*ndarray*) – Piano roll to evaluate.
- **resolution** (*int*) – Time steps per beat.
- **tolerance** (*float*) – Tolerance. Defaults to 0.1.

Returns Drum-in-pattern rate.

Return type float

References

1. Hao-Wen Dong, Wen-Yi Hsiao, Li-Chia Yang, and Yi-Hsuan Yang, "MuseGAN: Multi-track sequential generative adversarial networks for symbolic music generation and accompaniment," in Proceedings of the 32nd AAAI Conference on Artificial Intelligence (AAAI), 2018.

pypianoroll.**empty_beat_rate**(*pianoroll: numpy.ndarray*, *resolution: int*) → float

Return the ratio of empty beats.

The empty-beat rate is defined as the ratio of the number of empty beats (where no note is played) to the total number of beats. Return NaN if song length is zero.

$$empty\_beat\_rate = \frac{\#(empty\_beats)}{\#(beats)}$$

Parameters **pianoroll** (*ndarray*) – Piano roll to evaluate.

Returns Empty-beat rate.

Return type float

pypianoroll.**from_pretty_midi**(*midi: pretty_midi.pretty_midi.PrettyMIDI*, *resolution: int = 24*, *mode: str = 'max'*, *algorithm: str = 'normal'*, *collect_onsets_only: bool = False*, *first_beat_time: Optional[float] = None*) → pypianoroll.multitrack.Multitrack

Return a Multitrack object converted from a PrettyMIDI object.

Parse a pretty_midi.PrettyMIDI object. The data type of the resulting piano rolls is automatically determined (int if 'mode' is 'sum' and np.uint8 if *mode* is 'max').

Parameters

- **midi** (pretty_midi.PrettyMIDI) – PrettyMIDI object to parse.
- **mode** (*{'max', 'sum'}*) – Merging strategy for duplicate notes. Defaults to 'max'.
- **algorithm** (*{'normal', 'strict', 'custom'}*) – Algorithm for finding the location of the first beat (see Notes). Defaults to 'normal'.
- **collect_onsets_only** (*bool*) – True to collect only the onset of the notes (i.e. note on events) in all tracks, where the note off and duration information are discarded. False to parse regular piano rolls. Defaults to False.
- **first_beat_time** (*float, optional*) – Location of the first beat, in sec. Required and only effective when using 'custom' algorithm.

Returns Converted Multitrack object.

Return type *pypianoroll.Multitrack*

Notes

There are three algorithms for finding the location of the first beat:

- 'normal' : Estimate the location of the first beat using `pretty_midi.PrettyMIDI.estimate_beat_start()`.
- 'strict' : Set the location of the first beat to the time of the first time signature change. Raise a RuntimeError if no time signature change is found.
- 'custom' : Set the location of the first beat to the value of argument *first_beat_time*. Raise a ValueError if *first_beat_time* is not given.

If an incomplete beat before the first beat is found, an additional beat will be added before the (estimated) beat starting time. However, notes before the (estimated) beat starting time for more than one beat are dropped.

pypianoroll.**in_scale_rate**(*pianoroll: numpy.ndarray*, *root: int = 3*, *mode: str = 'major'*) → float
Return the ratio of pitches in a certain musical scale.

The pitch-in-scale rate is defined as the ratio of the number of notes in a certain scale to the total number of notes. Drum tracks are ignored. Return NaN if no note is found. This metric is used in [1].

$$pitch\_in\_scale\_rate = \frac{\#(notes\_in\_scale)}{\#(notes)}$$

Parameters

- **pianoroll** (*ndarray*) – Piano roll to evaluate.
- **root** (*int*) – Root of the scale.
- **mode** (*str, {'major', 'minor'}*) – Mode of the scale.

Returns Pitch-in-scale rate.

Return type float

See also:

muspy.scale_consistency() Compute the largest pitch-in-class rate.

References

1. Hao-Wen Dong, Wen-Yi Hsiao, Li-Chia Yang, and Yi-Hsuan Yang, "MuseGAN: Multi-track sequential generative adversarial networks for symbolic music generation and accompaniment," in Proceedings of the 32nd AAAI Conference on Artificial Intelligence (AAAI), 2018.

pypianoroll.**load**(*path: Union[str, pathlib.Path]*) → pypianoroll.multitrack.Multitrack
Load a NPZ file into a Multitrack object.

Supports only files previously saved by *pypianoroll.save()*.

Parameters **path** (*str or Path*) – Path to the file to load.

See also:

pypianoroll.save() Save a Multitrack object to a NPZ file.

pypianoroll.read() Read a MIDI file into a Multitrack object.

pypianoroll.**n_pitch_classes_used**(*pianoroll: numpy.ndarray*) → int
Return the number of unique pitch classes used.

Parameters **pianoroll** (*ndarray*) – Piano roll to evaluate.

Returns Number of unique pitch classes used.

Return type int

See also:

pypianoroll.n_pitches_used() Compute the number of unique pitches used.

pypianoroll.**n_pitches_used**(*pianoroll: numpy.ndarray*) → int
Return the number of unique pitches used.

Parameters **pianoroll** (*ndarray*) – Piano roll to evaluate.

Returns Number of unique pitch classes used.

Return type int

See also:

pypianoroll.n_pitch_class_used() Compute the number of unique pitch classes used.

pypianoroll.**pad**(*obj: _MultitrackOrTrack*, *pad_length: int*) → _MultitrackOrTrack
Pad the piano roll(s).

Notes

The lengths of the resulting piano rolls are not guaranteed to be the same. See *pypianoroll.Multitrack.pad_to_same()*.

Parameters

- **obj** (*pypianoroll.Multitrack* or *pypianoroll.Track*) – Object to pad.
- **pad_length** (*int*) – Length to pad along the time axis.

Returns

Return type Object itself.

See also:

pypianoroll.pad_to_same() Pad the piano rolls so that they have the same length.

pypianoroll.pad_to_multiple() Pad the piano rolls so that their lengths are some multiples.

pypianoroll.**pad_to_multiple**(*obj: _MultitrackOrTrack*, *factor: int*) → _MultitrackOrTrack
Pad the piano roll(s) so that their lengths are some multiples.

Pad the piano rolls at the end along the time axis of the minimum length that makes the lengths of the resulting piano rolls multiples of *factor*.

Parameters

- **obj** (*pypianoroll.Multitrack* or *pypianoroll.Track*) – Object to pad.
- **factor** (*int*) – The value which the length of the resulting pianoroll(s) will be a multiple of.

Returns

Return type Object itself.

Notes

Lengths of the resulting piano rolls are necessarily the same.

See also:

pypianoroll.pad() Pad the piano rolls.

pypianoroll.pad_to_same() Pad the piano rolls so that they have the same length.

pypianoroll.**pad_to_same**(*obj: _Multitrack*) → _Multitrack
Pad the piano rolls so that they have the same length.

Pad shorter piano rolls at the end along the time axis so that the resulting piano rolls have the same length.

Parameters **obj** (*pypianoroll.Multitrack*) – Object to pad.

Returns

Return type Object itself.

See also:

pypianoroll.pad() Pad the piano rolls.

pypianoroll.pad_to_multiple() Pad the piano rolls so that their lengths are some multiples.

pypianoroll.**pitch_range**(*pianoroll*) → float
Return the pitch range.

Returns Pitch range (in semitones), i.e., difference between the highest and the lowest active pitches.

Return type int or nan

See also:

pypianoroll.pitch_range_tuple() Return the pitch range as a tuple.

pypianoroll.**pitch_range_tuple**(*pianoroll*) → Tuple[float, float]
Return the pitch range as a tuple *(lowest, highest)*.

Returns

- *int or nan* – Highest active pitch.
- *int or nan* – Lowest active pitch.

See also:

pypianoroll.pitch_range() Compute the pitch range.

pypianoroll.**plot**(*obj: _MultitrackOrTrack*, ***kwargs*) → _MultitrackOrTrack
Plot the object.

See *pypianoroll.plot_multitrack()* and *pypianoroll.plot_track()* for full documentation.

pypianoroll.**plot_multitrack**(*multitrack: Multitrack, axs: Optional[Sequence[matplotlib.axes._axes.Axes]], mode: str = 'separate', track_label: str = 'name', preset: str = 'full', cmaps: Optional[Sequence[str]] = None, xtick: str = 'auto', ytick: str = 'octave', xticklabel: bool = True, yticklabel: str = 'auto', tick_loc: Sequence[str] = ('bottom', 'left'), tick_direction: str = 'in', label: str = 'both', grid_axis: str = 'both', grid_linestyle: str = ':', grid_linewidth: float = 0.5, **kwargs*) → List[matplotlib.axes._axes.Axes]

Plot the multitrack.

Parameters

- **multitrack** (*pypianoroll.Multitrack*) – Multitrack to plot.
- **axs** (sequence of matplotlib.axes.Axes) – Axes to plot the tracks on.
- **mode** (*{'separate', 'blended', 'hybrid'}*) – Plotting strategy for visualizing multiple tracks. For 'separate' mode, plot each track separately. For 'blended', blend and plot the pianoroll as a colored image. For 'hybrid' mode, drum tracks are blended into a 'Drums' track and all other tracks are blended into an 'Others' track. Defaults to 'separate'.
- **track_label** (*{'name', 'program', 'family', 'off'}*) – Track label format. When *mode* is 'hybrid', all options other than 'off' will label the two track with 'Drums' and 'Others'.
- **preset** (*{'full', 'frame', 'plain'}*) – Preset theme to use. For 'full' preset, ticks, grid and labels are on. For 'frame' preset, ticks and grid are both off. For 'plain' preset, the x- and y-axis are both off. Defaults to 'full'.
- **cmaps** (*tuple or list*) – Colormaps. Will be passed to matplotlib.pyplot.imshow(). Only effective when *pianoroll* is 2D. Defaults to 'Blues'. If *mode* is 'separate', defaults to *('Blues', 'Oranges', 'Greens', 'Reds', 'Purples', 'Greys')*. If *mode* is 'blended', defaults to *('hsv')*. If *mode* is 'hybrid', defaults to *('Blues', 'Greens')*.
- ****kwargs** – Keyword arguments to pass to *pypianoroll.plot_pianoroll()*.

Returns (Created) list of Axes objects.

Return type list of matplotlib.axes.Axes

pypianoroll.**plot_pianoroll**(*ax: matplotlib.axes._axes.Axes, pianoroll: numpy.ndarray, is_drum: bool = False, resolution: Optional[int] = None, downbeats: Optional[Sequence[int]] = None, preset: str = 'full', cmap: str = 'Blues', xtick: str = 'auto', ytick: str = 'octave', xticklabel: bool = True, yticklabel: str = 'auto', tick_loc: Sequence[str] = ('bottom', 'left'), tick_direction: str = 'in', label: str = 'both', grid_axis: str = 'both', grid_linestyle: str = ':', grid_linewidth: float = 0.5, **kwargs*)

Plot a piano roll.

Parameters

- **ax** (matplotlib.axes.Axes) – Axes to plot the piano roll on.
- **pianoroll** (*ndarray, shape=(?, 128), (?, 128, 3) or (?, 128, 4)*) – Piano roll to plot. For a 3D piano-roll array, the last axis can be either RGB or RGBA.
- **is_drum** (*bool*) – Whether it is a percussion track. Defaults to False.
- **resolution** (*int*) – Time steps per quarter note. Required if *xtick* is 'beat'.
- **downbeats** (*list*) – Boolean array that indicates whether the time step contains a downbeat (i.e., the first time step of a bar).

- **preset** (*{'full', 'frame', 'plain'}*) – Preset theme. For 'full' preset, ticks, grid and labels are on. For 'frame' preset, ticks and grid are both off. For 'plain' preset, the x- and y-axis are both off. Defaults to 'full'.
- **cmap** (str or matplotlib.colors.Colormap) – Colormap. Will be passed to matplotlib.pyplot.imshow(). Only effective when *pianoroll* is 2D. Defaults to 'Blues'.
- **xtick** (*{'auto', 'beat', 'step', 'off'}*) – Tick format for the x-axis. For 'auto' mode, set to 'beat' if *resolution* is given, otherwise set to 'step'. Defaults to 'auto'.
- **ytick** (*{'octave', 'pitch', 'off'}*) – Tick format for the y-axis. Defaults to 'octave'.
- **xticklabel** (*bool*) – Whether to add tick labels along the x-axis.
- **yticklabel** (*{'auto', 'name', 'number', 'off'}*) – Tick label format for the y-axis. For 'name' mode, use pitch name as tick labels. For 'number' mode, use pitch number. For 'auto' mode, set to 'name' if *ytick* is 'octave' and 'number' if *ytick* is 'pitch'. Defaults to 'auto'.
- **tick_loc** (*sequence of {'bottom', 'top', 'left', 'right'}*) – Tick locations. Defaults to *('bottom', 'left')*.
- **tick_direction** (*{'in', 'out', 'inout'}*) – Tick direction. Defaults to 'in'.
- **label** (*{'x', 'y', 'both', 'off'}*) – Whether to add labels to x- and y-axes. Defaults to 'both'.
- **grid_axis** (*{'x', 'y', 'both', 'off'}*) – Whether to add grids to the x- and y-axes. Defaults to 'both'.
- **grid_linestyle** (*str*) – Grid line style. Will be passed to matplotlib.axes.Axes.grid().
- **grid_linewidth** (*float*) – Grid line width. Will be passed to matplotlib.axes.Axes.grid().
- ****kwargs** – Keyword arguments to be passed to matplotlib.axes.Axes.imshow().

pypianoroll.**plot_track**(*track:* Track, *ax: Optional[matplotlib.axes._axes.Axes] = None*, ***kwargs*) → matplotlib.axes._axes.Axes

Plot a track.

Parameters

- **track** (*pypianoroll.Track*) – Track to plot.
- **ax** (matplotlib.axes.Axes) – Axes to plot the piano roll on. Defaults to call *plt.gca()*.
- ****kwargs** – Keyword arguments to pass to *pypianoroll.plot_pianoroll()*.

Returns (Created) Axes object.

Return type matplotlib.axes.Axes

pypianoroll.**polyphonic_rate**(*pianoroll:* *numpy.ndarray*, *threshold: float = 2*) → float

Return the ratio of time steps where multiple pitches are on.

The polyphony rate is defined as the ratio of the number of time steps where multiple pitches are on to the total number of time steps. Drum tracks are ignored. Return NaN if song length is zero. This metric is used in [1],

where it is called *polyphonicity*.

$$polyphony\_rate = \frac{\#(time\_steps\_where\_multiple\_pitches\_are\_on)}{\#(time\_steps)}$$

Parameters

- **pianoroll** (*ndarray*) – Piano roll to evaluate.
- **threshold** (*int*) – Threshold of number of pitches to count into the numerator.

Returns Polyphony rate.

Return type float

References

1. Hao-Wen Dong, Wen-Yi Hsiao, Li-Chia Yang, and Yi-Hsuan Yang, "MuseGAN: Multi-track sequential generative adversarial networks for symbolic music generation and accompaniment," in Proceedings of the 32nd AAAI Conference on Artificial Intelligence (AAAI), 2018.

pypianoroll.**qualified_note_rate**(*pianoroll: numpy.ndarray*, *threshold: float = 2*) → float

Return the ratio of the number of the qualified notes.

The qualified note rate is defined as the ratio of the number of qualified notes (notes longer than *threshold*, in time steps) to the total number of notes. Return NaN if no note is found.

$$qualified\_note\_rate = \frac{\#(notes\_longer\_than\_the\_threshold)}{\#(notes)}$$

Parameters

- **pianoroll** (*ndarray*) – Piano roll to evaluate.
- **threshold** (*int*) – Threshold of note length to count into the numerator.

Returns Qualified note rate.

Return type float

References

1. Hao-Wen Dong, Wen-Yi Hsiao, Li-Chia Yang, and Yi-Hsuan Yang, "MuseGAN: Multi-track sequential generative adversarial networks for symbolic music generation and accompaniment," in Proceedings of the 32nd AAAI Conference on Artificial Intelligence (AAAI), 2018.

pypianoroll.**read**(*path: Union[str, pathlib.Path]*, ***kwargs*) → pypianoroll.multitrack.Multitrack

Read a MIDI file into a Multitrack object.

Parameters

- **path** (*str or Path*) – Path to the file to read.
- ****kwargs** – Keyword arguments to pass to *pypianoroll.from_pretty_midi()*.

See also:

pypianoroll.write() Write a Multitrack object to a MIDI file.

pypianoroll.load() Load a NPZ file into a Multitrack object.

pypianoroll.**save**(*path: Union[str, pathlib.Path]*, *multitrack:* Multitrack, *compressed: bool = True*)
Save a Multitrack object to a NPZ file.

Parameters

- **path** (*str or Path*) – Path to the NPZ file to save.
- **multitrack** (*pypianoroll.Multitrack*) – Multitrack to save.
- **compressed** (*bool*) – Whether to save to a compressed NPZ file. Defaults to True.

Notes

To reduce the file size, the piano rolls are first converted to instances of `scipy.sparse.csc_matrix`. The component arrays are then collected and saved to a npz file.

See also:

pypianoroll.load() Load a NPZ file into a Multitrack object.

pypianoroll.write() Write a Multitrack object to a MIDI file.

pypianoroll.**set_nonzeros**(*obj: Union[pypianoroll.multitrack.Multitrack, pypianoroll.track.StandardTrack, pypianoroll.track.BinaryTrack]*, *value: int*)
Assign a constant value to all nonzeros entries.

Parameters

- **obj** (*pypianoroll.Multitrack*, *pypianoroll.StandardTrack* or *pypianoroll.BinaryTrack*) – Object to modify.
- **value** (*int*) – Value to assign.

pypianoroll.**set_resolution**(*obj: _Multitrack*, *resolution: int*, *rounding: Optional[str] = 'round'*) → _Multitrack
Downsample the piano rolls by a factor.

Parameters

- **obj** (*pypianoroll.Multitrack*) – Object to downsample.
- **resolution** (*int*) – Target resolution.
- **rounding** (*{'round', 'ceil', 'floor'}*) – Rounding mode. Defaults to 'round'.

Returns

Return type Object itself.

pypianoroll.**to_pretty_midi**(*multitrack:* Multitrack, *default_tempo: Optional[float] = None*, *default_velocity: int = 64*) → pretty_midi.pretty_midi.PrettyMIDI
Return a Multitrack object as a PrettyMIDI object.

Parameters

- **default_tempo** (*int*) – Default tempo to use. Defaults to the first element of attribute *tempo*.
- **default_velocity** (*int*) – Default velocity to assign to binarized tracks. Defaults to 64.

Returns Converted PrettyMIDI object.

Return type pretty_midi.PrettyMIDI

Notes

- Tempo changes are not supported.
- Time signature changes are not supported.
- The velocities of the converted piano rolls will be clipped to [0, 127].
- Adjacent nonzero values of the same pitch will be considered a single note with their mean as its velocity.

pypianoroll.**tonal_distance**(*pianoroll_1: numpy.ndarray*, *pianoroll_2: numpy.ndarray*, *resolution: int*, *radii: Sequence[float] = (1.0, 1.0, 0.5)*) → float

Return the tonal distance [1] between the two input piano rolls.

Parameters

- **pianoroll_1** (*ndarray*) – First piano roll to evaluate.
- **pianoroll_2** (*ndarray*) – Second piano roll to evaluate.
- **resolution** (*int*) – Time steps per beat.
- **radii** (*tuple of float*) – Radii of the three tonal circles (see Equation 3 in [1]).

References

1. Christopher Harte, Mark Sandler, and Martin Gasser, "Detecting harmonic change in musical audio," in Proceedings of the 1st ACM workshop on Audio and music computing multimedia, 2006.

pypianoroll.**transpose**(*obj: _MultitrackOrTrack*, *semitone: int*) → _MultitrackOrTrack

Transpose the piano roll(s) by a number of semitones.

Positive values are for a higher key, while negative values are for a lower key. Drum tracks are ignored.

Parameters

- **obj** (*pypianoroll.Multitrack* or *pypianoroll.Track*) – Object to transpose.
- **semitone** (*int*) – Number of semitones to transpose. A positive value raises the pitches, while a negative value lowers the pitches.

Returns

Return type Object itself.

pypianoroll.**trim**(*obj: _MultitrackOrTrack*, *start: Optional[int] = None*, *end: Optional[int] = None*) → _MultitrackOrTrack

Trim the trailing silences of the piano roll(s).

Parameters

- **obj** (*pypianoroll.Multitrack* or *pypianoroll.Track*) – Object to trim.
- **start** (*int, optional*) – Start time. Defaults to 0.
- **end** (*int, optional*) – End time. Defaults to active length.

Returns

Return type Object itself.

pypianoroll.**write**(*path: str*, *multitrack:* Multitrack)

Write a Multitrack object to a MIDI file.

Parameters

- **path** (*str*) – Path to write the file.
- **multitrack** (*pypianoroll.Multitrack*) – Multitrack to save.

See also:

pypianoroll.read() Read a MIDI file into a Multitrack object.

pypianoroll.save() Save a Multitrack object to a NPZ file.

PYTHON MODULE INDEX

p

INDEX

Q

R

S

T

V

W