dyntrack

Release 1.1.2

Louis Faure

Dec 01, 2021

CONTENTS

Python package for the study of particle dynamics from 2D tracks

CHAPTER

ONE

USAGE

```
import dyntrack as dt

DT = dt.ut.load_data("tracks.csv","Position X","Position Y","Parent","Time","background.
↪tiff")

dt.tl.vector_field(DT)
dt.pl.vector_field(DT)

dt.tl.FTLE(DT, 20000,5)
dt.pl.FTLE(DT)

dt.tl.fit_ppt(DT,seed=1)
dt.pl.fit_ppt(DT)
```

CHAPTER

TWO

WORKFLOW

2.1 Installation

2.1.1 PyPi (MacOS/Linux/Windows)

A pre-compiled version is available on pypi

```
pip install -U dyntrack
```

2.1.2 Building from source

```
git clone https://github.com/LouisFaure/dyntrack
pip install .
```

2.1.3 Windows issues

If missing DLL errors occurs while running *dyntrack.tl.vector_field()*, or gcc is not available while building from source please install MinGW-w64:

```
choco install mingw
```

2.2 API

Import dyntrack as:

```
import dyntrack as dt
```

dt.tl.load_data(csv_path, img_path, params)

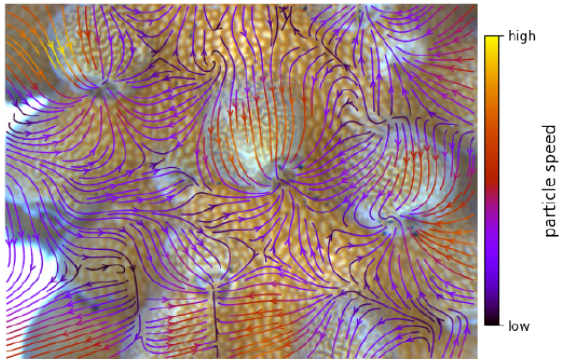
csv columns required:

Position X	Position Y	Parent	Time
x coord.	y coord.	track ID	frame

dt.pl.tracks()

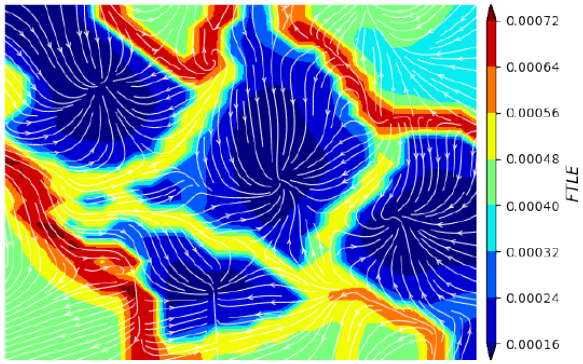
dt.tl.vector_field()

generates a grid vector field from tracks



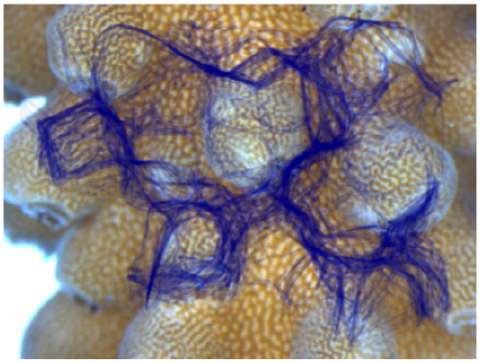
dt.tl.FTLE()

computes FTLE scalar field from vectors



dt.tl.fit_ppt()

learns a principal tree at each frame



2.2.1 Data loading and type

DynTrack(track_data[, img, X, Y, u, v, ...])	A python object containing the data used for dynamical tracks analysis.
ut.load_data(df, x_col, y_col, parent_col, ...)	Load data required for dynamical tracks analysis.

dyntrack.DynTrack

class dyntrack.**DynTrack**(*track_data*, *img=None*, *X=None*, *Y=None*, *u=None*, *v=None*, *ftle=None*, *ppts=None*)

A python object containing the data used for dynamical tracks analysis.

Parameters

- **track_data** (DataFrame) – DataFrame containing x and z coordinates, the track ID and the frame/time.
- **img** (Optional[ndarray]) – The background image from the field where particle were tracked can be included.
- **X** (Optional[ndarray]) – x coordinates of the grid vector field.
- **Y** (Optional[ndarray]) – y coordinates of the grid vector field.
- **u** (Optional[ndarray]) – x component of the vectors.
- **v** (Optional[ndarray]) – y component of the vectors.
- **ftle** (Optional[ndarray]) – scalar FTLE values calculated from vector field.
- **ppts** (Optional[Mapping[str, Any]]) – list of principal trees fitted for each frame of the tracking.

__init__(*track_data*, *img=None*, *X=None*, *Y=None*, *u=None*, *v=None*, *ftle=None*, *ppts=None*)

Methods

__init__(track_data[, img, X, Y, u, v, ...])	

dyntrack.ut.load_data

dyntrack.ut.**load_data**(*df*, *x_col*, *y_col*, *parent_col*, *time_col*, *img=None*)

Load data required for dynamical tracks analysis.

Parameters

- **df** (Union[DataFrame, str]) – Path of a csv file, or a pandas.DataFrame object.
- **x_col** (str) – Name of the x coordinate column.
- **x_col** – Name of the y coordinate column.
- **parent_col** (str) – Name of the track ID column.
- **time_col** (str) – Name of the time/frame ID column.
- **img** (Union[ndarray, str, None]) – Path of an img file, or a numpy.ndarray.

Returns A DynTrack object

Return type *dyntrack.DynTrack*

2.2.2 Analysis

tl.vector_field(DT[, gridRes, smooth, copy])	Generate a grid vector field from track data.
tl.FTLE(DT, integration_time, delta_t[, copy])	Generate a scalar FTLE field from vector data.
tl.fit_ppt(DT[, times, lam, sigma, copy])	Compute a principal tree from partical position at each frame.

dyntrack.tl.vector_field

dyntrack.tl.**vector_field**(*DT*, *gridRes=30*, *smooth=0.5*, *copy=False*)

Generate a grid vector field from track data.

Parameters

- **DT** (*DynTrack*) – A *dyntrack.DynTrack* object.
- **gridRes** (int) – grid resolution in both horizontal and vertical axis.
- **smooth** (float) – Smooth parameter of the vfkm algorithm.
- **copy** (float) – Return a copy instead of writing to DT.

Returns

DT – if *copy=True* it returns or else add fields to *DT*:

.X x coordinates of the grid.

.Y y coordinates of the grid.

.u x component of the vectors.

.v y component of the vectors.

Return type *dyntrack.DynTrack*

dyntrack.tl.FTLE

dyntrack.tl.**FTLE**(*DT*, *integration_time*, *delta_t*, *copy=False*)

Generate a scalar FTLE field from vector data.

Parameters

- **DT** (*DynTrack*) – A *dyntrack.DynTrack* object.
- **integration_time** (float) – Overall integration time for sampling the vector field.
- **delta_t** (float) – Delta t used during the integration.
- **copy** (bool) – Return a copy instead of writing to DT.

Returns

DT – if *copy=True* it returns or else add fields to *DT*:

.ftle FTLE scalar values of the vector field.

Return type *dyntrack.DynTrack*

dyntrack.tl.fit_ppt

dyntrack.tl.**fit_ppt**(*DT*, *times=None*, *lam=10*, *sigma=10*, *copy=False*, ***kwargs*)

Compute a principal tree from partical position at each frame.

Parameters

- **DT** (*DynTrack*) – A *dyntrack.DynTrack* object.
- **times** (Optional[Sequence]) – set of timepoints/frames to use for the fitting, by default uses all.
- **lam** (float) – Lambda parameter from SimplePPT algorithm.
- **sigma** (float) – Sigma parameter from SimplePPT algorithm.
- **copy** (bool) – Return a copy instead of writing to DT.
- ****kwargs** – Additional parameters to be passed to simpleppt.ppt()

Returns

DT – if *copy=True* it returns or else add fields to *DT*:

.ppts List of principal trees calculated per frame.

Return type *dyntrack.DynTrack*

2.2.3 Plotting

pl.tracks(DT[, figsize, ax, show])	Plotting all single tracks.
pl.vector_field(DT[, density, linewidth, ...])	Plotting counterpart of *tl.vector_field*.
pl.FTLE(DT[, cmap, density, linewidth, ...])	Plotting counterpart of *tl.FTLE*.
pl.fit_ppt(DT[, times, figsize, ax, show])	Plotting counterpart of *tl.fit_ppt*.

dyntrack.pl.tracks

dyntrack.pl.**tracks**(*DT*, *figsize=(7, 4)*, *ax=None*, *show=True*, ***kwargs*)

Plotting all single tracks.

Parameters

- **DT** (*DynTrack*) – A *dyntrack.DynTrack* object.
- **figsize** (tuple) – Figure size.
- **ax** (Optional[Axes]) – A matplotlib axes object.
- **show** (bool) – Show the plot, do not return axis.
- ****kwargs** – Arguments passed to matplotlib.pyplot.plot().

Returns

Return type matplotlib.axes.Axes if *show=True*

dyntrack.pl.vector_field

dyntrack.pl.**vector_field**(*DT*, *density=2*, *linewidth=1*, *arrowsize=1*, *arrowstyle='->'*, *cmap='gnuplot'*, *figsize=(7, 4)*, *show=True*, ***kwargs*)

Plotting counterpart of *tl.vector_field*.

Parameters

- **DT** (*DynTrack*) – A *dyntrack.DynTrack* object.
- **cmap** – Colormap used by `matplotlib.pyplot.countourf()`.
- **density** (`float`) – Density of arrows used by `matplotlib.pyplot.streamplot()`.
- **linewidth** (`float`) – Arrow line width used by `matplotlib.pyplot.streamplot()`.
- **arrowsize** (`float`) – Arrow size used by `matplotlib.pyplot.streamplot()`.
- **arrowstyle** – Arrow style used by `matplotlib.pyplot.streamplot()`.
- **color** – Arrow color used by `matplotlib.pyplot.streamplot()`.
- **figsize** (`tuple`) – Figure size.
- **show** (`bool`) – Show the plot, do not return axis.
- **save** – Save plot to file
- ****kwargs** – Arguments passed to `matplotlib.pyplot.streamplot()`.

Returns

Return type `matplotlib.axes.Axes` if *show=True*

dyntrack.pl.FTLE

dyntrack.pl.**FTLE**(*DT*, *cmap='jet'*, *density=2*, *linewidth=0.75*, *arrowsize=1*, *arrowstyle='->'*, *color='white'*, *figsize=(7, 4)*, *show=True*, *kwargs_for_countourf={}*, *kwargs_for_streamplot={}*)

Plotting counterpart of *tl.FTLE*.

Parameters

- **DT** (*DynTrack*) – A *dyntrack.DynTrack* object.
- **cmap** – Colormap used by `matplotlib.pyplot.countourf()`.
- **density** (`float`) – Density of arrows used by `matplotlib.pyplot.streamplot()`.
- **linewidth** (`float`) – Arrow line width used by `matplotlib.pyplot.streamplot()`.
- **arrowsize** (`float`) – Arrow size used by `matplotlib.pyplot.streamplot()`.
- **arrowstyle** (`str`) – Arrow style used by `matplotlib.pyplot.streamplot()`.
- **color** – Arrow color used by `matplotlib.pyplot.streamplot()`.
- **figsize** – Figure size.
- **show** (`bool`) – Show the plot, do not return axis.
- ****kwargs_for_contourf** – Arguments passed to `matplotlib.pyplot.contourf()`.
- ****kwargs_for_streamplot** – Arguments passed to `matplotlib.pyplot.streamplot()`.

Returns

Return type matplotlib.axes.Axes if *show=True*

dyntrack.pl.fit_ppt

dyntrack.pl.**fit_ppt**(*DT*, *times=None*, *figsize=(7, 4)*, *ax=None*, *show=True*)

Plotting counterpart of *tl.fit_ppt*.

Display all principal trees to reveal structure in trajectories.

Parameters

- **DT** (*DynTrack*) – A *dyntrack.DynTrack* object.
- **times** (Optional[Sequence]) – set of timepoints/frames to plot, by default uses all.
- **figsize** (tuple) – Figure size.
- **show** (bool) – Show the plot, do not return axis.

Returns

Return type matplotlib.axes.Axes if *show=True*

2.3 Citations and used works

2.3.1 Vector field building

The function *dyntrack.tl.vector_field()* uses vfkm to generate vector fields (see license), please cite the related study if you use it:

```
Ferreira, N., Klosowski, J. T., Scheidegger, C. & Silva, C.
Vector Field k-Means: Clustering Trajectories by Fitting Multiple Vector Fields.
Comput. Graph. Forum 32, 201-210 (2012).
```

2.3.2 FTLE scalar field generation

Code from *dyntrack.tl.FTLE()* have been adapted and optimized from Richard Galvez's notebook

2.3.3 Principal tree fitting with SimplePPT

Code from *dyntrack.tl.fit_ppt()* uses SimplePPT algorithm to fit principal trees on each frames. SimplePPT has been described in the following paper:

```
Mao et al. (2015), SimplePPT: A simple principal tree algorithm
SIAM International Conference on Data Mining.
```

PYTHON MODULE INDEX

INDEX

Symbols

D

F

L

M

T

V