In [ ]:
```
from PIL import Image
from IPython.display import display
```

Single Imputer Report

Overview

Completed several operations working on single daphnia tracking:

- Created a class `NPZer` which unzips and unpacks `.npz` files, the output from TRex, for imputation and transformation.
- Created a class `TRexDataCleaner` which removes disjoint data points, such as large jumps in position and missing data.
- Created a class `TRexImputer` which provides a framework for applying different imputation strategies to missing daphnia tracking data, currently using only an `avgValue` function.
- Developed `plotDetail`: an easy to use and standardized plotting function for displaying daphnia tracking.
- Established `avgVelocity` a framework for estimating maximum daphnia velocity used in data cleaning and imputation.

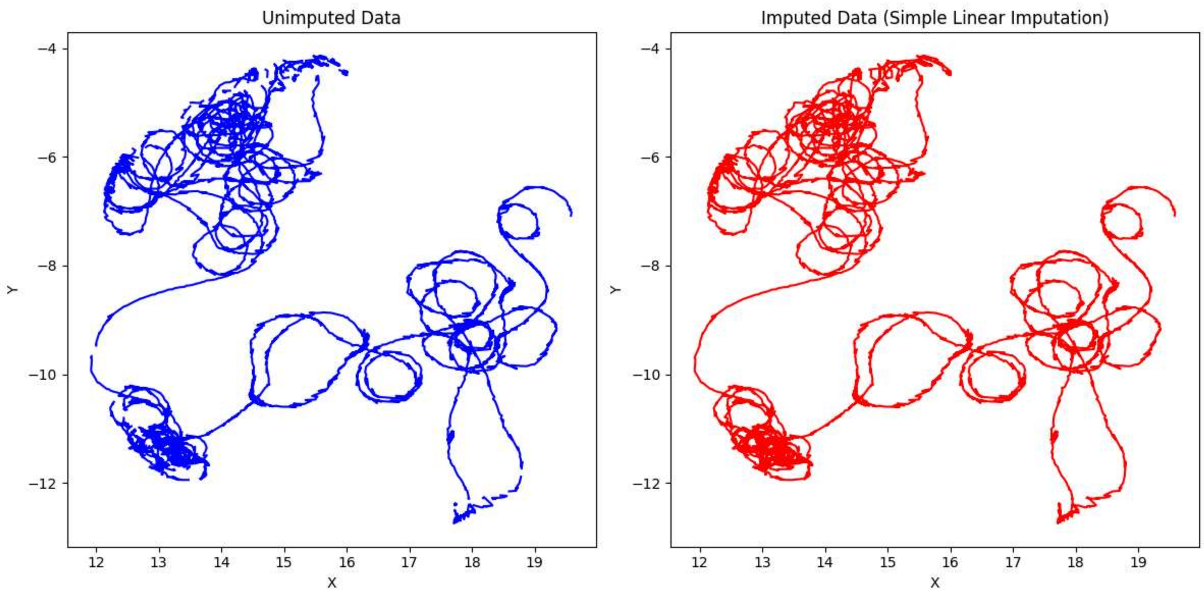
Walkthrough of Imputation Process

This process occurs *POST* TRex animal tracking for a single daphnia:

1. **Unzipping and Preparation**
    - Use a standardized unzipping function.
    - Include functionality to flip axes for plotting if necessary.
2. **Data Cleaning**
    - Remove discontinuities in the data.
    - Focus on critical clean-up, such as removing data where the tracker has jumped to the edge of the dish.
3. **Imputation**
    - Apply an imputation function with modular strategies.
    - Ensure the function can accommodate various imputation methods as they are developed.
4. **Standardized Plotting**
    - Implement consistent plotting of the daphnia tracking data.

- Ensure plots accurately reflect cleaned and imputed data.

In [ ]:
```
from PIL import Image
from IPython.display import display
#display output output\email_update_single_imputer\output_images\side_by_side_input
display(Image.open('output_images/side_by_side_imputation.png'))
```



NPZer.py

`NPZer.py` contains the class `NPZer`, which unzips a `.npz` file (output of TRex tracking). This data can be directly converted to a pandas table and subsequently to a `.csv` file or plotted.

Example Usage:

```
# Import necessary tools
import pandas as pd
import numpy as np
from src.data_manipulation.NPZer import NPZer

NPZer = NPZer()

# Set desired parameters
SOURCE_DIR = 'data/clean_fish_data/fish_data_clean.csv'
INVERT_Y = True
PARAMS = ['time', 'X', 'Y']

# Unzip and turn data into a pandas table
unzippedData = NPZer.pandafy(source_dir=SOURCE_DIR, invertY=INVERT_Y,
params=PARAMS)

# Print data in the form of a pandas table
print('TRex Data:\n', unzippedData)
```

Output

In [ ]:
```
display(Image.open('output_images/NPZer_output.png'))
```

```
TRex Data:
             time          X         Y
0        0.000000  23.536650 -1.792803
1        0.016949  23.517750 -1.792841
2        0.033898  23.517750 -1.792841
3        0.050847  23.517750 -1.792841
4        0.067796  23.517750 -1.792841
...           ...        ...       ...
10817  183.338989  19.579285 -6.965172
10818  183.355927  19.569004 -6.989434
10819  183.372879  19.588287 -7.017863
10820  183.389832  19.577187 -7.083682
10821  183.406784  19.577187 -7.083682

[10822 rows x 3 columns]
```

TRexDataCleaner.py

`TRexDataCleaner.py` contains the class `TRexDataCleaner`, which is used to clean disjoint data in TRex tracking data for later imputation. Disjoint data points are rendered as np.inf.

Example Usage:

```
# Import necessary tools
from src.data_manipulation.TRexDataCleaner import TRexDataCleaner

dataCleaner = TRexDataCleaner()

# Set desired parameters
VMAX = 1

# Set sample of original data
originalData = unzippedData[:25]
```

```
# Print sample of original data
print('Original Data:\n', originalData)

# Clean data
cleanedData, removedData =
dataCleaner.renderDiscontinuities(data=originalData, vmax=25)

# Print cleaned data
print('Cleaned Data:\n', cleanedData)
```

TRexImputer.py

`TRexImputer.py` holds the class `TRexImputer` which is used to impute/fill in discontinuous TRex data with a desired `impute` function. This should be used with data already cleaned with `TRexDataCleaner`

Example Usage

```
# Import necessary tools
from src.data_manipulation.TRexImputer import TRexImputer

imputer = TRexImputer()

# Set desired parameters
DATA = cleanedData
FUNCTION = 'avgValue'

# Print original data
print('Original Data:\n', cleanedData)


# Impute data
imputedData = imputer.impute(data=DATA, function=FUNCTION)

# Print imputed data
print('Imputed Data:\n', imputedData)
```

In [ ]:
```
display(Image.open('output_images/TRexImputer_output.png'))
```

```
Original Data:
        time          X         Y
0   0.000000  23.536650 -1.792803
1   0.016949        inf       inf
2   0.033898  23.517750 -1.792841
3   0.050847  23.517750 -1.792841
4   0.067796  23.517750 -1.792841
5   0.084745  23.529652 -1.792807
6   0.101694  23.525852 -1.792829
7   0.118644  23.525852 -1.792829
8   0.135593  23.525852 -1.792829
9   0.152542  23.529652 -1.792807
10  0.169491  23.525852 -1.792829
11  0.186440  23.529652 -1.792807
12  0.203389  23.529652 -1.792807
13  0.220338  23.529652 -1.792807
14  0.237288  23.529652 -1.792807
15  0.254237        inf       inf
16  0.271186  23.529652 -1.792807
17  0.288135        inf       inf
18  0.305084  23.529652 -1.792807
19  0.322033  23.529652 -1.792807
20  0.338983        inf       inf
21  0.355932  23.525852 -1.792829
22  0.372881  23.529652 -1.792807
23  0.389830  23.536650 -1.792803
24  0.406779  23.540424 -1.792785
Imputing with: avgValue()
Imputed Data:
        time          X         Y
0   0.000000  23.536650 -1.792803
1   0.016949  23.527200 -1.792822
2   0.033898  23.517750 -1.792841
3   0.050847  23.517750 -1.792841
```

4	0.067796	23.517750	-1.792841
5	0.084745	23.529652	-1.792807
6	0.101694	23.525852	-1.792829
7	0.118644	23.525852	-1.792829
8	0.135593	23.525852	-1.792829
9	0.152542	23.529652	-1.792807
10	0.169491	23.525852	-1.792829
11	0.186440	23.529652	-1.792807
12	0.203389	23.529652	-1.792807
13	0.220338	23.529652	-1.792807
14	0.237288	23.529652	-1.792807
15	0.254237	23.529652	-1.792807
16	0.271186	23.529652	-1.792807
17	0.288135	23.529652	-1.792807
18	0.305084	23.529652	-1.792807
19	0.322033	23.529652	-1.792807
20	0.338983	23.491658	-1.793025
21	0.355932	23.525852	-1.792829
22	0.372881	23.529652	-1.792807
23	0.389830	23.536650	-1.792803
24	0.406779	23.540424	-1.792785

avgValue.py

`avgValue.py` holds the `impute` function which imputes data in between gaps of discontinuous points. The function calculates the velocity between each gap of data, and imputes the respective points according it.

Example usage

Usage is shown in above example as `FUNCTION = 'avgValue'`

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plotDetail.py

`plotDetail.py` contains the `plotDetail` function, which:

- Accepts a CSV or NPZ file.
- Requires declarations of X, Y, and time values.
- Plots a graph representing the path of the Daphnia's movements with placeholder labels.

Example Usage

```
# Import necessary tools
from src.data_manipulation.plotDetail import plotDetail
import pandas as pd
from matplotlib import pyplot as plt
import numpy as np

# Copy the path of the NPZ file
npz_path =
r"/Users/ibrahimrahat/Documents/GitHub/daphnia/data/npz_file/single_7_9_fish1

# Use np.load to load the npz file
data = np.load(npz_path)
```

---

avg_velocity.py

`avg_velocity.py` contains:

- The `all_velocity` function, which calculates the average velocities between consecutive coordinates and stores them in a vector.
- The `plot_histogram` function, which creates and plots a histogram showing the frequency of each average velocity.

Example Usage

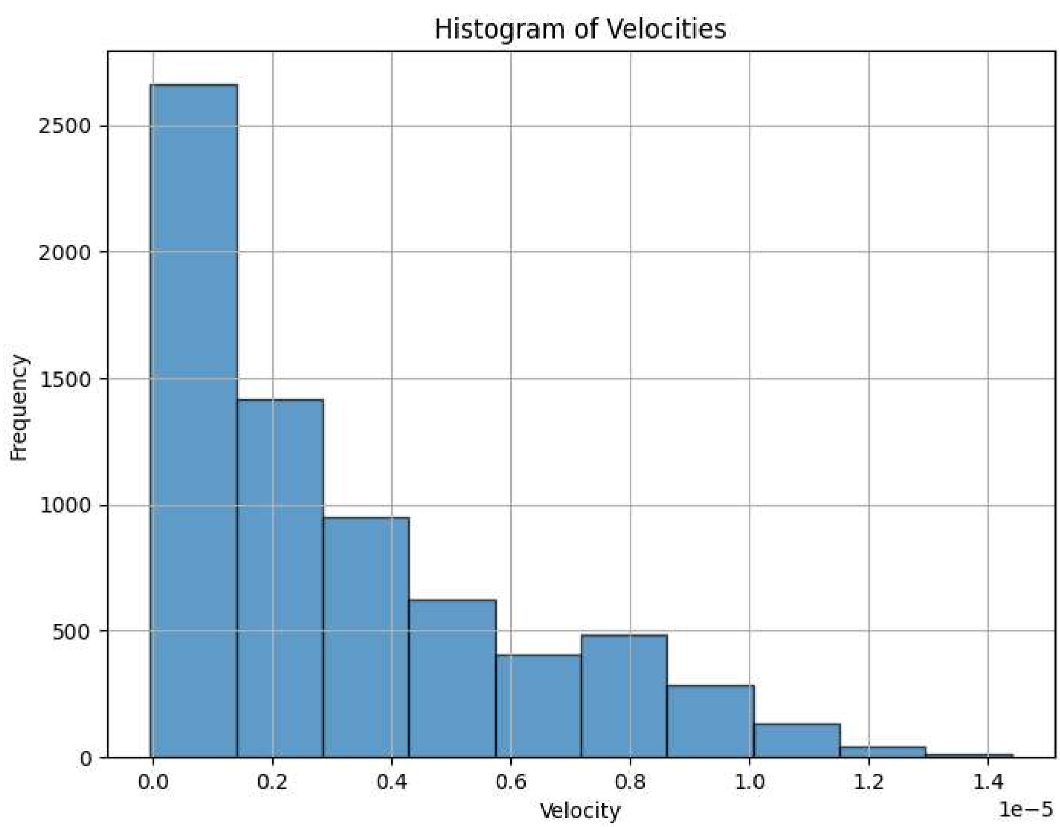
Usage

Use the `all_velocity` function to compute average velocities and the `plot_histogram` function to visualize the distribution of these velocities.

```
# Import necessary tools
import pytest
import numpy as np
import os
import pandas as pd
import matplotlib.pyplot as plt
from missing_data_dev.max_velocity.avg_velocity import calc_velocity,
avg_velocity, all_velocity, plot_histogram
```

```
# Create and declare the directory for all the CSV files
#direct_path =
"/Users/ibrahimrahat/Documents/GitHub/daphnia/data/table_data"
relative_path = "data/table_data"
all_files = os.listdir(relative_path)

# Create an empty dataframe
dataframes = []

# Loop through and have pandas read each CSV file
for file in all_files:
    file_path = os.path.join(relative_path, file)
    df = pd.read_csv(file_path)
    dataframes.append(df)



# Use the function all_velocity and store all the velocities into a
variable
all_velo = all_velocity(dataframes)

# Plot the velocities in a histogram
plot_histogram(all_velo)
```

In [ ]:
```
display(Image.open('output_images/histogram of daphnia velocities.png'))
```



Visualizing an Edge Discontinuity

- **Original Data**: Displays synthetic daphnia movement with edge discontinuities.
- **After Cleaning**: Data cleaned using TRexCleaner to address discontinuities.
- **After Imputation**: Data imputed with TRexImputer to smooth out gaps and improve continuity.

In [ ]:
```
display(Image.open('output_images/side by side discontinuity example_highlighted.pn
```