devicely

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CONTENTS

The devicely package is made for reading, writing and de-identifying health sensor data from several sensors:

- Empatica E4 is a wearable device that offers real-time physiological data acquisition such as blood volume pulse, electrodermal activity (EDA), heart rate, interbeat intervals, 3-axis acceleration and skin temperature.
- Biovotion Everion is a wearable device used for the continuous monitoring of vital signs. Currently, it measures the following vital signs: heart rate, blood pulse wave, heart rate variability, activity, SPO2, blood perfusion, respiration rate, steps, energy expenditure, skin temperature, EDA / galvanic skin response (GSR), barometric pressure and sleep.
- 1-lead ECG monitor Faros 180 from Bittium is a one channel ECG monitor with sampling frequency up to 1000 Hz and a 3D acceleration sampling up to 100Hz.
- Spacelabs (SL 90217) is an oscillometric blood pressure (BP) monitor which can be used to automatically track a person's BP in specificed time intervals.
- TimeStamp for Android allows you to record the timestamp of an event at the time it occurs. It also allows you to create specific tags such as "Running" or "Walking" and timestamp those specific activities.
- Shimmer Consensys GSR is a device that is used to collect sensor data in real time and it contains sensors such as GSR / EDA, photoplethysmography (PPG), 3-axis accelerometer, 3-axis gyroscope, 3-axis magnetometer & integrated altimeter.
- Muse S is a consumer grade headband consisting of 4 electrodes electroencephalography (EEG) sensors, 3-axis accelerometer (ACC), gyroscope, and photoplethysmography (PPG) sensors.

devicely makes it easy to read sensor data and access it in common formats such as dataframes.

We provide a custom reader class for each sensor which has three core methods: read, timeshift and write. The timeshift method changes the time of measurement, thereby automatically helping to de-identify the data.

After timeshifting, you can write the data in the original data format. Now you have one more safety measure in place that will facilitate data sharing.

CHAPTER

ONE

USAGE

- *Start guide for the devicely package*
- *Module reference*
- Example notebook and data

CHAPTER

TWO

ABOUT DEVICELY

- GitHub
- PyPi
- *How to contribute*

2.1 Start guide for the devicely package

To install devicely locally just run `pip install devicely`

2.2 Use devicely

[43]:
```
import os

import devicely

write_dir = 'New'

if not os.path.isdir(write_dir):
    os.makedirs(write_dir)
```

2.2.1 Empatica E4

The Empatice E4 wristband can be used to obtain data from inter-beat intervals, electrodermal activity, heart rate, temperature and blood volume pulse. The wristband uses this directory structure for its measurement data.

Read the data

Create an EmpaticaReader object:

[44]:
```
empatica_reader = devicely.EmpaticaReader('Empatica')
```

Access the sampling frequencies and starting times for all signals:

[45]:
```
empatica_reader.start_times
```

```
[45]: {'ACC': Timestamp('2020-10-16 17:04:29'),
       'BVP': Timestamp('2020-10-16 17:04:29'),
       'EDA': Timestamp('2020-10-16 17:04:29'),
       'HR': Timestamp('2020-10-16 17:04:39'),
       'TEMP': Timestamp('2020-10-16 17:04:29'),
       'IBI': Timestamp('2020-10-16 17:04:29')}
```

```
[46]: empatica_reader.sample_freqs
```

```
[46]: {'ACC': 32.0, 'BVP': 64.0, 'EDA': 4.0, 'HR': 1.0, 'TEMP': 4.0}
```

Access the individual dataframes via the attributes ACC, BVP, EDA, HR, TEMP, IBI and tags:

```
[47]: empatica_reader.HR.head()
```

```
[47]: 2020-10-16 17:04:39    51.00
      2020-10-16 17:04:40    51.50
      2020-10-16 17:04:41    51.00
      2020-10-16 17:04:42    52.75
      2020-10-16 17:04:43    64.00
      Name: HR, dtype: float64
```

Access a joined dataframe of all signals:

```
[48]: empatica_reader.data.head()
```

```
[48]:                            ACC_X  ACC_Y  ACC_Z  BVP  EDA  HR   TEMP
      2020-10-16 17:04:29.000000   -3.0   11.0   60.0 -0.0  0.0 NaN  31.13
      2020-10-16 17:04:29.015625    NaN    NaN    NaN -0.0  NaN NaN    NaN
      2020-10-16 17:04:29.031250   -3.0   11.0   60.0 -0.0  NaN NaN    NaN
      2020-10-16 17:04:29.046875    NaN    NaN    NaN -0.0  NaN NaN    NaN
      2020-10-16 17:04:29.062500   -2.0   11.0   60.0 -0.0  NaN NaN    NaN
```

The dataframe contains nan values because the individual signals have different sampling frequencies.

Timeshift the data

Apply a timeshift:

```
[49]: empatica_reader.timeshift()
      empatica_reader.start_times
```

```
[49]: {'ACC': Timestamp('2019-05-18 22:02:53.817793664'),
       'BVP': Timestamp('2019-05-18 22:02:53.817793664'),
       'EDA': Timestamp('2019-05-18 22:02:53.817793664'),
       'HR': Timestamp('2019-05-18 22:03:03.817793664'),
       'TEMP': Timestamp('2019-05-18 22:02:53.817793664'),
       'IBI': Timestamp('2019-05-18 22:02:53.817793664')}
```

By providing no parameter to `timeshift` the data is shifted by a random time interval between one month and two years to the past. You can also provide a `pandas.Timedelta` object to shift the data by that timedelta or a `pandas.Timestamp` object to shift the data such that this timestamp is the earliest entry.

Write the data

```
[50]: empatica_write_path = os.path.join(write_dir, 'Empatica')
      empatica_reader.write(empatica_write_path)
      os.listdir(empatica_write_path)
```

```
[50]: ['EDA.csv', 'HR.csv', 'IBI.csv', 'TEMP.csv', 'tags.csv', 'BVP.csv', 'ACC.csv']
```

2.2.2 Spacelabs Blood Pressure Monitor

Spacelabs uses a single file to output its metadata as well as the actual signals.

Read the data

Create a SpacelabsReader object:

```
[51]: spacelabs_reader = devicely.SpacelabsReader(os.path.join('Spacelabs', 'spacelabs.abp'))
```

Acess the metadata:

```
[52]: spacelabs_reader.subject
```

```
[52]: '001V0'
```

```
[53]: spacelabs_reader.metadata
```

```
[53]: {'PATIENTINFO': {'DOB': None, 'RACE': None},
       'REPORTINFO': {'PHYSICIAN': None,
        'NURSETECH': 'admin',
        'STATUS': 'NOTCONFIRMED',
        'CALIPERSUMMARY': {'COUNT': '0'}}}
```

Access the signal dataframe:

```
[54]: spacelabs_reader.data.head()
```

```
[54]:                          date      time  SYS(mmHg)  DIA(mmHg)  UNKNOW_1  \
      timestamp
      2019-03-01 16:18:00  2019-03-01  16:18:00        107         76      78.0
      2019-03-01 16:19:00  2019-03-01  16:19:00         96         62      63.0
      2019-03-01 16:22:00  2019-03-01  16:22:00        100         68      64.0
      2019-03-01 16:23:00  2019-03-01  16:23:00        103         68      68.0
      2019-03-01 16:25:00  2019-03-01  16:25:00        101         67      65.0

                           UNKNOW_2  UNKNOW_3 CODE
      timestamp
      2019-03-01 16:18:00      78.0       NaN  NaN
      2019-03-01 16:19:00      63.0       NaN  NaN
      2019-03-01 16:22:00      64.0       NaN  NaN
      2019-03-01 16:23:00      68.0       NaN  NaN
      2019-03-01 16:25:00      65.0       NaN  NaN
```

Timeshift the data

Apply a timeshift:

[55]:
```
spacelabs_reader.timeshift()
spacelabs_reader.data.head()
```

[55]:
```
                          date      time  SYS(mmHg)  DIA(mmHg)  UNKNOW_1  \
timestamp
2018-02-28 18:14:00  2018-02-28  18:14:00        107         76      78.0
2018-02-28 18:15:00  2018-02-28  18:15:00         96         62      63.0
2018-02-28 18:18:00  2018-02-28  18:18:00        100         68      64.0
2018-02-28 18:19:00  2018-02-28  18:19:00        103         68      68.0
2018-02-28 18:21:00  2018-02-28  18:21:00        101         67      65.0

                     UNKNOW_2  UNKNOW_3 CODE
timestamp
2018-02-28 18:14:00      78.0       NaN  NaN
2018-02-28 18:15:00      63.0       NaN  NaN
2018-02-28 18:18:00      64.0       NaN  NaN
2018-02-28 18:19:00      68.0       NaN  NaN
2018-02-28 18:21:00      65.0       NaN  NaN
```

By providing no parameter to `timeshift` the data is shifted by a random time interval between one month and two years to the past. You can also provide a `pandas.Timedelta` object to shift the data by that timedelta or a `pandas.Timestamp` object to shift the data such that this timestamp is the earliest entry.

Remove metadata

[56]:
```
spacelabs_reader.deidentify('001')
spacelabs_reader.metadata
```

[56]:
```
{'PATIENTINFO': {'DOB': '', 'RACE': ''},
 'REPORTINFO': {'PHYSICIAN': '',
  'NURSETECH': '',
  'STATUS': '',
  'CALIPERSUMMARY': {'COUNT': ''}}}
```

Write the data

[57]:
```
spacelabs_write_path = os.path.join(write_dir, 'Spacelabs')

if not os.path.isdir(spacelabs_write_path):
    os.makedirs(spacelabs_write_path)

spacelabs_reader.write(os.path.join(spacelabs_write_path, 'spacelabs.abp'))
os.listdir(spacelabs_write_path)
```

[57]:
```
['spacelabs.abp']
```

2.2.3 Bittium Faros

The Faros device outpus data in EDF files. These are specifically made for health sensor data and not human-readable.

Read the data

[58]:
```
faros_reader = devicely.FarosReader(os.path.join('Faros', 'faros.EDF'))
```

Access metadata:

[59]:
```
faros_reader.start_time
```

[59]:
```
Timestamp('2019-03-01 16:12:43')
```

[60]:
```
faros_reader.sample_freqs
```

[60]:
```
{'ECG': 1000.0, 'ACC': 100.0, 'Marker': 1.0, 'HRV': 5.0}
```

[61]:
```
faros_reader.units
```

[61]:
```
{'ECG': 'uV', 'ACC': 'mg', 'HRV': 'ms'}
```

You can access the individual signals via the `ECG`, `ACC`, `HRV` and `Marker` attributes:

[62]:
```
faros_reader.ACC.head()
```

[62]:
```
                            X      Y       Z
2019-03-01 16:12:43.000  164.0   23.0 -1172.0
2019-03-01 16:12:43.010  152.0   23.0 -1172.0
2019-03-01 16:12:43.020  152.0  -24.0 -1079.0
2019-03-01 16:12:43.030  117.0   11.0  -985.0
2019-03-01 16:12:43.040  -47.0  246.0 -1125.0
```

Join the dataframes:

[63]:
```
faros_reader.join_dataframes()
faros_reader.data.head()
```

[63]:
```
                          ECG  ACC_X ACC_Y   ACC_Z ACC_mag Marker  HRV
2019-03-01 16:12:43.000  26.0  164.0  23.0 -1172.0     NaN    0.0  0.0
2019-03-01 16:12:43.001  -6.0    NaN   NaN     NaN     NaN    NaN  NaN
2019-03-01 16:12:43.002 -31.0    NaN   NaN     NaN     NaN    NaN  NaN
2019-03-01 16:12:43.003 -39.0    NaN   NaN     NaN     NaN    NaN  NaN
2019-03-01 16:12:43.004 -17.0    NaN   NaN     NaN     NaN    NaN  NaN
```

Timeshift the data

Apply a timeshift:

[64]:
```
faros_reader.timeshift()
faros_reader.data.head()
```

[64]:
```
                           ECG  ACC_X ACC_Y   ACC_Z ACC_mag Marker  HRV
2018-02-22 09:32:12.000  26.0  164.0  23.0 -1172.0     NaN    0.0  0.0
2018-02-22 09:32:12.001  -6.0    NaN   NaN     NaN     NaN    NaN  NaN
2018-02-22 09:32:12.002 -31.0    NaN   NaN     NaN     NaN    NaN  NaN
2018-02-22 09:32:12.003 -39.0    NaN   NaN     NaN     NaN    NaN  NaN
2018-02-22 09:32:12.004 -17.0    NaN   NaN     NaN     NaN    NaN  NaN
```

By providing no parameter to `timeshift` the data is shifted by a random time interval between one month and two years to the past. You can also provide a `pandas.Timedelta` object to shift the data by that timedelta or a `pandas.Timestamp` object to shift the data such that this timestamp is the earliest entry.

Write the data

You can write back the data in the original EDF format or to a directory of individual signal files. Writing to a directory is the preferred method. You can find out why this is the case in our module reference.

[65]:
```
faros_write_path = os.path.join(write_dir, 'Faros')
faros_reader.write(faros_write_path)
os.listdir(faros_write_path)
```

[65]:
```
['Marker.csv', 'ECG.csv', 'HRV.csv', 'faros.edf', 'meta.json', 'ACC.csv']
```

You can also create a FarosReader from a written directory:

[66]:
```
new_faros_reader = devicely.FarosReader(faros_write_path)
new_faros_reader.ECG.head()
```

[66]:
```
2019-03-01 16:12:43.000    26.0
2019-03-01 16:12:43.001    -6.0
2019-03-01 16:12:43.002   -31.0
2019-03-01 16:12:43.003   -39.0
2019-03-01 16:12:43.004   -17.0
Freq: L, Name: ECG, dtype: float64
```

You can also save files as EDF if the necessary metadata are still present.

[67]:
```
faros_write_new_path = os.path.join(write_dir, 'Faros', 'faros.edf')
faros_reader.write(faros_write_new_path, file_format='edf')
os.listdir(faros_write_path)
```

[67]:
```
['Marker.csv', 'ECG.csv', 'HRV.csv', 'faros.edf', 'meta.json', 'ACC.csv']
```

2.2.4 Biovotion Everion

The Everion device outputs data in multiple csv files. Each csv file has a `tag` column which specifies the type of measurement. You can see the different tags and what they mean by looking at `EverionReader.SIGNAL_TAGS`, `EverionReader.SENSOR_TAGS` and `EverionReader.FEATURE_TAGS`.

[68]:
```
devicely.EverionReader.FEATURE_TAGS
```

[68]:
```
{14: 'inter_pulse_interval',
 17: 'pis',
 18: 'pid',
```

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```
 77: 'inter_pulse_deviation',
 78: 'pis_quality',
 79: 'pid_quality'}
```

Read the data

[69]:
```
everion_reader = devicely.EverionReader('Everion')
```

If you would like to specify which tags to keep, you can specify this when initializing the reader.

Access the individual dataframes via aggregates, analytics_events, attributes_dailys, everion_events, features, sensors and signals attributes:

[70]:
```
everion_reader.signals.head()
```

[70]:

	count	streamType	tag	time	values	quality
0	806132	2	71	2019-03-01 15:39:58	0.000000	NaN
1	806132	2	13	2019-03-01 15:39:58	21.864220	100.0
2	806132	2	6	2019-03-01 15:39:58	65.000000	85.0
3	806132	2	66	2019-03-01 15:39:58	1.568628	NaN
4	806132	2	12	2019-03-01 15:39:58	18.000000	93.0

Access a joined dataframe of all signals:

[71]:
```
everion_reader.data.head()
```

[71]:

time	heart_rate	heart_rate_quality	oxygen_saturation	oxygen_saturation_quality	heart_rate_variability	heart_rate_variability_quality
2019-03-01 13:23:05.000000000	NaN	NaN	NaN	NaN	NaN	
2019-03-01 13:23:05.019607808	NaN	NaN	NaN	NaN	NaN	
2019-03-01 13:23:05.039215872	NaN	NaN	NaN	NaN	NaN	
2019-03-01 13:23:05.058823680	NaN	NaN	NaN	NaN	NaN	
2019-03-01 13:23:05.078431488	NaN	NaN	NaN	NaN	NaN	

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```
2019-03-01 13:23:05.000000000                          NaN
2019-03-01 13:23:05.019607808                          NaN
2019-03-01 13:23:05.039215872                          NaN
2019-03-01 13:23:05.058823680                          NaN
2019-03-01 13:23:05.078431488                          NaN

                            respiration_rate  respiration_rate_quality  \
time
2019-03-01 13:23:05.000000000              NaN                       NaN
2019-03-01 13:23:05.019607808              NaN                       NaN
2019-03-01 13:23:05.039215872              NaN                       NaN
2019-03-01 13:23:05.058823680              NaN                       NaN
2019-03-01 13:23:05.078431488              NaN                       NaN

                            ctemp  ctemp_quality  ...  \
time                                              ...
2019-03-01 13:23:05.000000000   NaN            NaN  ...
2019-03-01 13:23:05.019607808   NaN            NaN  ...
2019-03-01 13:23:05.039215872   NaN            NaN  ...
2019-03-01 13:23:05.058823680   NaN            NaN  ...
2019-03-01 13:23:05.078431488   NaN            NaN  ...

                            inter_pulse_interval  \
time
2019-03-01 13:23:05.000000000                 NaN
2019-03-01 13:23:05.019607808                 NaN
2019-03-01 13:23:05.039215872                 NaN
2019-03-01 13:23:05.058823680                 NaN
2019-03-01 13:23:05.078431488                 NaN

                            inter_pulse_interval_deviation  led1_data  \
time
2019-03-01 13:23:05.000000000                          NaN     3028.0
2019-03-01 13:23:05.019607808                          NaN     3309.0
2019-03-01 13:23:05.039215872                          NaN     3454.0
2019-03-01 13:23:05.058823680                          NaN     3207.0
2019-03-01 13:23:05.078431488                          NaN     3079.0

                            led2_data  led3_data  led4_data  accx_data  \
time
2019-03-01 13:23:05.000000000     2989.0     2924.0     3340.0      368.0
2019-03-01 13:23:05.019607808     3336.0     3231.0     3417.0      256.0
2019-03-01 13:23:05.039215872     3443.0     3390.0     3492.0      144.0
2019-03-01 13:23:05.058823680     3217.0     3126.0     3543.0       96.0
2019-03-01 13:23:05.078431488     3092.0     2994.0     3538.0        0.0

                            accy_data  accz_data      acc_mag
time
2019-03-01 13:23:05.000000000     2096.0    -3536.0  4126.976617
2019-03-01 13:23:05.019607808     2016.0    -3808.0  4316.324362
2019-03-01 13:23:05.039215872     2288.0    -3728.0  4376.489918
2019-03-01 13:23:05.058823680     2352.0    -3600.0  4301.292829
```

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```
2019-03-01 13:23:05.078431488     2384.0    -3904.0  4574.349353

[5 rows x 25 columns]
```

Timeshift the data

Apply a timeshift:

[72]:
```
everion_reader.timeshift()
everion_reader.data.head()
```

[72]:
```
                            heart_rate  heart_rate_quality  \
time
2017-04-01 20:53:51.000000000        NaN                 NaN
2017-04-01 20:53:51.019607808        NaN                 NaN
2017-04-01 20:53:51.039215872        NaN                 NaN
2017-04-01 20:53:51.058823680        NaN                 NaN
2017-04-01 20:53:51.078431488        NaN                 NaN

                            oxygen_saturation  oxygen_saturation_quality  \
time
2017-04-01 20:53:51.000000000               NaN                        NaN
2017-04-01 20:53:51.019607808               NaN                        NaN
2017-04-01 20:53:51.039215872               NaN                        NaN
2017-04-01 20:53:51.058823680               NaN                        NaN
2017-04-01 20:53:51.078431488               NaN                        NaN

                            heart_rate_variability  \
time
2017-04-01 20:53:51.000000000                   NaN
2017-04-01 20:53:51.019607808                   NaN
2017-04-01 20:53:51.039215872                   NaN
2017-04-01 20:53:51.058823680                   NaN
2017-04-01 20:53:51.078431488                   NaN

                            heart_rate_variability_quality  \
time
2017-04-01 20:53:51.000000000                            NaN
2017-04-01 20:53:51.019607808                            NaN
2017-04-01 20:53:51.039215872                            NaN
2017-04-01 20:53:51.058823680                            NaN
2017-04-01 20:53:51.078431488                            NaN

                            respiration_rate  respiration_rate_quality  \
time
2017-04-01 20:53:51.000000000              NaN                       NaN
2017-04-01 20:53:51.019607808              NaN                       NaN
2017-04-01 20:53:51.039215872              NaN                       NaN
2017-04-01 20:53:51.058823680              NaN                       NaN
2017-04-01 20:53:51.078431488              NaN                       NaN
```

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```
                             ctemp  ctemp_quality  ...  \
time                                                ...
2017-04-01 20:53:51.000000000   NaN            NaN  ...
2017-04-01 20:53:51.019607808   NaN            NaN  ...
2017-04-01 20:53:51.039215872   NaN            NaN  ...
2017-04-01 20:53:51.058823680   NaN            NaN  ...
2017-04-01 20:53:51.078431488   NaN            NaN  ...

                             inter_pulse_interval  \
time
2017-04-01 20:53:51.000000000                  NaN
2017-04-01 20:53:51.019607808                  NaN
2017-04-01 20:53:51.039215872                  NaN
2017-04-01 20:53:51.058823680                  NaN
2017-04-01 20:53:51.078431488                  NaN

                             inter_pulse_interval_deviation  led1_data  \
time
2017-04-01 20:53:51.000000000                            NaN     3028.0
2017-04-01 20:53:51.019607808                            NaN     3309.0
2017-04-01 20:53:51.039215872                            NaN     3454.0
2017-04-01 20:53:51.058823680                            NaN     3207.0
2017-04-01 20:53:51.078431488                            NaN     3079.0

                             led2_data  led3_data  led4_data  accx_data  \
time
2017-04-01 20:53:51.000000000     2989.0     2924.0     3340.0      368.0
2017-04-01 20:53:51.019607808     3336.0     3231.0     3417.0      256.0
2017-04-01 20:53:51.039215872     3443.0     3390.0     3492.0      144.0
2017-04-01 20:53:51.058823680     3217.0     3126.0     3543.0       96.0
2017-04-01 20:53:51.078431488     3092.0     2994.0     3538.0        0.0

                             accy_data  accz_data      acc_mag
time
2017-04-01 20:53:51.000000000     2096.0    -3536.0  4126.976617
2017-04-01 20:53:51.019607808     2016.0    -3808.0  4316.324362
2017-04-01 20:53:51.039215872     2288.0    -3728.0  4376.489918
2017-04-01 20:53:51.058823680     2352.0    -3600.0  4301.292829
2017-04-01 20:53:51.078431488     2384.0    -3904.0  4574.349353

[5 rows x 25 columns]
```

By providing no parameter to `timeshift` the data is shifted by a random time interval between one month and two years to the past. You can also provide a `pandas.Timedelta` object to shift the data by that timedelta or a `pandas.Timestamp` object to shift the data such that this timestamp is the earliest entry.

Write the data

Write the data to a directory while keeping the same format as the original. If you used only a subset of tags when initializing the reader, only these tags will be written.

[73]:
```
everion_write_path = os.path.join(write_dir, 'Everion')
everion_reader.write(everion_write_path)
os.listdir(everion_write_path)
```

[73]:
```
['sensor_data.csv',
 'analytics_events.csv',
 'aggregates.csv',
 'everion_events.csv',
 'attributes_dailys.csv',
 'signals.csv',
 'features.csv']
```

2.2.5 Shimmer

Shimmer uses a single CSV file, indexed by time of measurement.

Read the data

[74]:
```
shimmer_reader = devicely.ShimmerPlusReader(os.path.join('Shimmer', 'shimmer.csv'))
shimmer_reader.data.head()
```

[74]:
```
  Shimmer_40AC_Timestamp_Unix_CAL  Shimmer_40AC_Accel_LN_X_CAL  \
0         2020-07-28 10:56:50.034                    -1.434783
1         2020-07-28 10:56:50.057                    -1.402174
2         2020-07-28 10:56:50.074                    -1.434783
3         2020-07-28 10:56:50.099                    -1.413043
4         2020-07-28 10:56:50.111                    -1.445652

   Shimmer_40AC_Accel_LN_Y_CAL  Shimmer_40AC_Accel_LN_Z_CAL  \
0                         10.0                     0.554348
1                         10.0                     0.554348
2                         10.0                     0.554348
3                         10.0                     0.521739
4                         10.0                     0.510870

   Shimmer_40AC_Accel_WR_X_CAL  Shimmer_40AC_Accel_WR_Y_CAL  \
0                    -3.930580                     8.421305
1                    -3.923399                     8.442849
2                    -3.897068                     8.428486
3                    -3.932974                     8.421305
4                    -3.944943                     8.428486

   Shimmer_40AC_Accel_WR_Z_CAL  Shimmer_40AC_Battery_CAL  \
0                    -1.620586               4139.194139
1                    -1.599042               4137.728938
2                    -1.603830               4111.355311
3                    -1.589467               4140.659341
```

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```
4                    -1.661281               4134.798535

   Shimmer_40AC_Ext_Exp_A15_CAL  Shimmer_40AC_GSR_Range_CAL  ...  \
0                   1684.981685                          2.0  ...
1                   1673.260073                          2.0  ...
2                   1901.098901                          2.0  ...
3                   1722.344322                          2.0  ...
4                   1678.388278                          2.0  ...

   Shimmer_40AC_Gyro_X_CAL  Shimmer_40AC_Gyro_Y_CAL  Shimmer_40AC_Gyro_Z_CAL  \
0                 0.137405                 1.877863                -0.183206
1                 0.183206                 1.328244                -0.412214
2                 0.274809                 1.282443                -0.198473
3                 0.229008                 1.450382                -0.122137
4                 0.137405                 1.511450                -0.473282

   Shimmer_40AC_Int_Exp_A12_CAL  Shimmer_40AC_Mag_X_CAL  \
0                   1680.586081               -0.112444
1                   1703.296703               -0.109445
2                   1687.179487               -0.107946
3                   1650.549451               -0.106447
4                   1701.831502               -0.113943

   Shimmer_40AC_Mag_Y_CAL  Shimmer_40AC_Mag_Z_CAL  \
0               -0.916042               -0.047976
1               -0.913043               -0.047976
2               -0.910045               -0.049475
3               -0.901049               -0.050975
4               -0.904048               -0.037481

   Shimmer_40AC_Pressure_BMP280_CAL  Shimmer_40AC_Temperature_BMP280_CAL  \
0                        100.435379                             33.365878
1                        100.429731                             33.365878
2                        100.441027                             33.365878
3                        100.441027                             33.365878
4                        100.438203                             33.365878

   Shimmer_40AC_Accel_LN_mag
0                  10.117604
1                  10.113031
2                  10.117604
3                  10.112809
4                  10.116862

[5 rows x 22 columns]
```

Timeshift the data

Apply a timeshift:

[75]:
```
shimmer_reader.timeshift()
shimmer_reader.data.head()
```

[75]:
```
  Shimmer_40AC_Timestamp_Unix_CAL  Shimmer_40AC_Accel_LN_X_CAL  \
0         2019-06-20 19:45:55.894                    -1.434783
1         2019-06-20 19:45:55.917                    -1.402174
2         2019-06-20 19:45:55.934                    -1.434783
3         2019-06-20 19:45:55.959                    -1.413043
4         2019-06-20 19:45:55.971                    -1.445652

   Shimmer_40AC_Accel_LN_Y_CAL  Shimmer_40AC_Accel_LN_Z_CAL  \
0                         10.0                     0.554348
1                         10.0                     0.554348
2                         10.0                     0.554348
3                         10.0                     0.521739
4                         10.0                     0.510870

   Shimmer_40AC_Accel_WR_X_CAL  Shimmer_40AC_Accel_WR_Y_CAL  \
0                    -3.930580                     8.421305
1                    -3.923399                     8.442849
2                    -3.897068                     8.428486
3                    -3.932974                     8.421305
4                    -3.944943                     8.428486

   Shimmer_40AC_Accel_WR_Z_CAL  Shimmer_40AC_Battery_CAL  \
0                    -1.620586               4139.194139
1                    -1.599042               4137.728938
2                    -1.603830               4111.355311
3                    -1.589467               4140.659341
4                    -1.661281               4134.798535

   Shimmer_40AC_Ext_Exp_A15_CAL  Shimmer_40AC_GSR_Range_CAL  ...  \
0                   1684.981685                         2.0  ...
1                   1673.260073                         2.0  ...
2                   1901.098901                         2.0  ...
3                   1722.344322                         2.0  ...
4                   1678.388278                         2.0  ...

   Shimmer_40AC_Gyro_X_CAL  Shimmer_40AC_Gyro_Y_CAL  Shimmer_40AC_Gyro_Z_CAL  \
0                 0.137405                 1.877863                -0.183206
1                 0.183206                 1.328244                -0.412214
2                 0.274809                 1.282443                -0.198473
3                 0.229008                 1.450382                -0.122137
4                 0.137405                 1.511450                -0.473282

   Shimmer_40AC_Int_Exp_A12_CAL  Shimmer_40AC_Mag_X_CAL  \
0                   1680.586081               -0.112444
1                   1703.296703               -0.109445
2                   1687.179487               -0.107946
3                   1650.549451               -0.106447
```

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```
4                   1701.831502               -0.113943

   Shimmer_40AC_Mag_Y_CAL  Shimmer_40AC_Mag_Z_CAL  \
0               -0.916042               -0.047976
1               -0.913043               -0.047976
2               -0.910045               -0.049475
3               -0.901049               -0.050975
4               -0.904048               -0.037481

   Shimmer_40AC_Pressure_BMP280_CAL  Shimmer_40AC_Temperature_BMP280_CAL  \
0                         100.435379                            33.365878
1                         100.429731                            33.365878
2                         100.441027                            33.365878
3                         100.441027                            33.365878
4                         100.438203                            33.365878

   Shimmer_40AC_Accel_LN_mag
0                  10.117604
1                  10.113031
2                  10.117604
3                  10.112809
4                  10.116862

[5 rows x 22 columns]
```

By providing no parameter to `timeshift` the data is shifted by a random time interval between one month and two years to the past. You can also provide a `pandas.Timedelta` object to shift the data by that timedelta or a `pandas.Timestamp` object to shift the data such that this timestamp is the earliest entry.

Write the data

[76]:
```
shimmer_write_path = os.path.join(write_dir, 'Shimmer')

if not os.path.isdir(shimmer_write_path):
    os.makedirs(shimmer_write_path)

shimmer_reader.write(os.path.join(shimmer_write_path, 'shimmer_write.csv'))
os.listdir(shimmer_write_path)
```

[76]:
```
['shimmer_write.csv']
```

2.2.6 Muse

The devicely.MuseReader can be used for reading data generated by the Muse S headband.

Read the data

[77]:
```
muse_reader = devicely.MuseReader(os.path.join('Muse', 'data.csv'))
muse_reader.data.head()
```

[77]:

TimeStamp	Delta_TP9	Delta_AF7	Delta_AF8	Delta_TP10	\
2021-05-24 20:26:20.103	0.735186	0.752212	0.714283	1.023466	
2021-05-24 20:26:20.588	NaN	NaN	NaN	NaN	
2021-05-24 20:26:21.161	1.063671	0.915956	0.734191	1.023466	
2021-05-24 20:26:22.174	1.226523	0.791329	0.685841	0.550056	
2021-05-24 20:26:23.184	1.009649	0.822014	0.677420	0.801944	

TimeStamp	Theta_TP9	Theta_AF7	Theta_AF8	Theta_TP10	\
2021-05-24 20:26:20.103	0.251417	0.205159	0.208760	0.428435	
2021-05-24 20:26:20.588	NaN	NaN	NaN	NaN	
2021-05-24 20:26:21.161	1.120400	0.367509	0.303293	0.428435	
2021-05-24 20:26:22.174	1.289343	0.647703	0.187995	0.070321	
2021-05-24 20:26:23.184	1.035277	0.500738	-0.049515	0.673528	

TimeStamp	Alpha_TP9	Alpha_AF7	...	Gyro_X	Gyro_Y	\
			...			
2021-05-24 20:26:20.103	0.493829	0.269544	...	3.416901	0.605621	
2021-05-24 20:26:20.588	NaN	NaN	...	NaN	NaN	
2021-05-24 20:26:21.161	0.974990	0.348580	...	4.643097	2.355194	
2021-05-24 20:26:22.174	0.726045	0.420135	...	4.239349	0.635529	
2021-05-24 20:26:23.184	0.805443	0.446498	...	4.366455	-0.052338	

TimeStamp	Gyro_Z	HeadBandOn	HSI_TP9	HSI_AF7	HSI_AF8	\
2021-05-24 20:26:20.103	3.768311	1.0	2.0	1.0	1.0	
2021-05-24 20:26:20.588	NaN	NaN	NaN	NaN	NaN	
2021-05-24 20:26:21.161	2.026215	1.0	1.0	1.0	1.0	
2021-05-24 20:26:22.174	3.484192	1.0	1.0	1.0	1.0	
2021-05-24 20:26:23.184	1.525269	1.0	1.0	1.0	1.0	

TimeStamp	HSI_TP10	Battery	Elements
2021-05-24 20:26:20.103	2.0	100.0	NaN
2021-05-24 20:26:20.588	NaN	NaN	/muse/elements/blink
2021-05-24 20:26:21.161	1.0	100.0	NaN
2021-05-24 20:26:22.174	1.0	100.0	NaN
2021-05-24 20:26:23.184	1.0	100.0	NaN

[5 rows x 38 columns]

Timeshift the data

Apply a random timeshift:

[78]:
```
muse_reader.timeshift()
muse_reader.data.head()
```

[78]:
```
                           Delta_TP9  Delta_AF7  Delta_AF8  Delta_TP10  \
TimeStamp
2020-05-30 05:03:58.183587364   0.735186   0.752212   0.714283    1.023466
2020-05-30 05:03:58.668587364        NaN        NaN        NaN         NaN
2020-05-30 05:03:59.241587364   1.063671   0.915956   0.734191    1.023466
2020-05-30 05:04:00.254587364   1.226523   0.791329   0.685841    0.550056
2020-05-30 05:04:01.264587364   1.009649   0.822014   0.677420    0.801944

                           Theta_TP9  Theta_AF7  Theta_AF8  Theta_TP10  \
TimeStamp
2020-05-30 05:03:58.183587364   0.251417   0.205159   0.208760    0.428435
2020-05-30 05:03:58.668587364        NaN        NaN        NaN         NaN
2020-05-30 05:03:59.241587364   1.120400   0.367509   0.303293    0.428435
2020-05-30 05:04:00.254587364   1.289343   0.647703   0.187995    0.070321
2020-05-30 05:04:01.264587364   1.035277   0.500738  -0.049515    0.673528

                           Alpha_TP9  Alpha_AF7  ...    Gyro_X    Gyro_Y  \
TimeStamp                                        ...
2020-05-30 05:03:58.183587364   0.493829   0.269544  ...  3.416901  0.605621
2020-05-30 05:03:58.668587364        NaN        NaN  ...       NaN       NaN
2020-05-30 05:03:59.241587364   0.974990   0.348580  ...  4.643097  2.355194
2020-05-30 05:04:00.254587364   0.726045   0.420135  ...  4.239349  0.635529
2020-05-30 05:04:01.264587364   0.805443   0.446498  ...  4.366455 -0.052338

                             Gyro_Z  HeadBandOn  HSI_TP9  HSI_AF7  \
TimeStamp
2020-05-30 05:03:58.183587364  3.768311         1.0      2.0      1.0
2020-05-30 05:03:58.668587364       NaN         NaN      NaN      NaN
2020-05-30 05:03:59.241587364  2.026215         1.0      1.0      1.0
2020-05-30 05:04:00.254587364  3.484192         1.0      1.0      1.0
2020-05-30 05:04:01.264587364  1.525269         1.0      1.0      1.0

                           HSI_AF8  HSI_TP10  Battery  \
TimeStamp
2020-05-30 05:03:58.183587364      1.0       2.0    100.0
2020-05-30 05:03:58.668587364      NaN       NaN      NaN
2020-05-30 05:03:59.241587364      1.0       1.0    100.0
2020-05-30 05:04:00.254587364      1.0       1.0    100.0
2020-05-30 05:04:01.264587364      1.0       1.0    100.0

                                        Elements
TimeStamp
2020-05-30 05:03:58.183587364                NaN
2020-05-30 05:03:58.668587364  /muse/elements/blink
2020-05-30 05:03:59.241587364                NaN
2020-05-30 05:04:00.254587364                NaN
2020-05-30 05:04:01.264587364                NaN
```

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```
[5 rows x 38 columns]
```

Write the data

[79]:
```
muse_write_path = os.path.join(write_dir, 'muse_write_data.csv')

if os.path.isfile(muse_write_path):
    os.remove(muse_write_path)

muse_reader.write(muse_write_path)
os.listdir(write_dir)
```

[79]:
```
['Spacelabs',
 'Everion',
 'muse_write_data.csv',
 'Empatica',
 'Faros',
 'Tags',
 'Shimmer']
```

2.2.7 Tags

You can use the TimeStampReader to read data created by the Android app TimeStamp. Researchers use this app to mark important times during experiments. The format simple, as can be seen in this example file.

Read the data

[80]:
```
timestamp_reader = devicely.TimeStampReader(os.path.join('Tags', 'tags.csv'))
timestamp_reader.data.head()
```

[80]:
```
                     tag_number             tag
time
2019-03-01 16:16:37           1           Shake
2019-03-01 16:17:43           2           Start
2019-03-01 16:18:20           3  BP Measurement
2019-03-01 16:19:51           4  BP Measurement
2019-03-01 16:22:00           5  BP Measurement
```

Timeshif the data

Apply a timeshift:

[81]:
```
timestamp_reader.timeshift()
timestamp_reader.data.head()
```

[81]:
```
                     tag_number             tag
time
```

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```
2017-09-12 21:26:48           1           Shake
2017-09-12 21:27:54           2           Start
2017-09-12 21:28:31           3  BP Measurement
2017-09-12 21:30:02           4  BP Measurement
2017-09-12 21:32:11           5  BP Measurement
```

By providing no parameter to `timeshift` the data is shifted by a random time interval between one month and two years to the past. You can also provide a `pandas.Timedelta` object to shift the data by that timedelta or a `pandas.Timestamp` object to shift the data such that this timestamp is the earliest entry.

Write the data

[82]:
```
tags_write_path = os.path.join(write_dir, 'Tags')

if not os.path.isdir(tags_write_path):
    os.makedirs(tags_write_path)

timestamp_reader.write(os.path.join(tags_write_path, 'tags_write.csv'))
os.listdir(tags_write_path)
```

[82]:
```
['tags_write.csv']
```

2.3 Module reference

2.3.1 devicely.EmpaticaReader

Empatica E4 is a wearable device that offers real-time physiological data acquisition such as blood volume pulse, electrodermal activity (EDA), heart rate, interbeat intervals, 3-axis acceleration and skin temperature.

class devicely.empatica.**EmpaticaReader**(*path*)

Read, timeshift and write data generated by Empatica E4.

start_times

Contain the timestamp of the first measurement for all measured signals (BVP, ACC, etc.).

Type dict

sample_freqs

Contain the sampling frequencies of all measured signals in Hz.

Type dict]

IBI

Contain inter-beat interval data. The column "seconds_since_start" is the time in seconds between the start of measurements and the column "IBI" is the duration in seconds between consecutive beats.

Type pandas.DataFrame

ACC

Contain the data measured with the onboard MEMS type 3-axis accelerometer, indexed by time of measurement.

Type pandas.DataFrame

BVP
Contain blood volume pulse data, indexed by time of measurement.

Type pandas.DataFrame

EDA
Contain data captured from the electrodermal activity sensor, indexed by time of measurement.

Type pandas.DataFrame

HR
Contain heart rate data, indexed by time of measurement.

Type pandas.DataFrame

TEMP
Contain temperature data, indexed by time of measurement.

Type pandas.DataFrame

data
Joined dataframe of the ACC, BVP, EDA, HR and TEMP dataframes (see above). May contain NaN values because sampling frequencies differ across signals.

Type pandas.DataFrame

timeshift(*shift='random'*)
Timeshift all time related columns as well as the starting_times dict.

Parameters **shift** (*None/'random', pd.Timestamp or pd.Timedelta*) – If shift is not specified, shifts the data by a random time interval between one month and two years to the past.

If shift is a timdelta, adds that timedelta to all time-related attributes.

If shift is a timestamp, shifts the data such that the earliest entry has that timestamp. The remaining values will mantain the same time difference to the first entry.

write(*dir_path*)
Write the signal dataframes back to individual csv files formatted the same way as they were read.

Parameters **path** (*str*) – Path of the directory in which the csv files are created.

If the directory exists, the csv files are written using writing mode 'w' ignoring other files in the directory.

If the directory doe not exist, it will be created.

2.3.2 devicely.SpacelabsReader

Spacelabs (SL 90217) is an oscillometric blood pressure (BP) monitor which can be used to automatically track a person's BP in specificed time intervals.

class devicely.spacelabs.**SpacelabsReader**(*path*)
Read, timeshift, deidentify and write data generated by Spacelabs(SL90217).

data
DataFrame with the values that were read from the abp file.

Type DataFrame

subject
Contain the sujbect's id. Can be changed for deidentification.

Type str

valid_measurements
Contain the number of valid measurements in the abp file.

Type str

metadata
The measurements' metadata. Read from the xml at the bottom of the abp file. Can be erased for deidentification.

Type dict

deidentify(*subject_id=None*)
Deidentify the data by removing the original XML metadata and subject id.

Parameters **subject_id** (*str, optional*) – New subject id to be written in the deidentified file, by default None.

timeshift(*shift='random'*)
Timeshift the data by shifting all time related columns.

Parameters **shift** (*None/'random', pd.Timestamp or pd.Timedelta*) – If shift is not specified, shifts the data by a random time interval between one month and two years to the past.

If shift is a timdelta, shifts the data by that timedelta.

If shift is a timestamp, shifts the data such that the earliest entry has that timestamp. The remaining values will mantain the same time difference to the first entry.

write(*path*)
Write the signals and metadata to the writing path in the same format as it was read.

Parameters **path** (*str*) – Path to writing file. Writing mode: 'w'. Use the file extension 'abp' to keep the SpaceLabs standard.

2.3.3 devicely.FarosReader

1-lead ECG monitor FarosTM 180 from Bittium is a one channel ECG monitor with sampling frequency up to 1000 Hz and a 3D acceleration sampling up to 100Hz.

class devicely.faros.**FarosReader**(*path*)
Read, timeshift and write data generated by Bittium Faros devices.

start_time
Start time of all measurements.

Type pandas.Timestamp

sample_freqs
Sampling frequencies of all signals in Hz.

Type dict

units
Units of all signals

Type dict

ECG
ECG signal, indexed by timestamp.

Type pandas.Series

ACC
Three ACC axes, indexed by timestamp.

Type pandas.DataFrame

Marker
Markers, indexed by timestamp.

Type pandas.Series

HRV
HRV signal, indexed by timestamp.

Type pandas.Series

data
Contain all signals (ECG, ACC, Marker, HRV) indexed by timestamp. Since the signals have different sampling frequencies, many values will be NaN.

Type DataFrame

join_dataframes()
Join the individual signal dataframes by timestamp. The resulting dataframe is saved in the attribute reader.data.

timeshift(*shift='random'*)
Timeshift the data by shifting all time related values (i.e. start_time and data.index).

Parameters **shift** (*None/'random', pd.Timestamp or pd.Timedelta*) – If shift is not specified, shifts the data by a random time interval between one month and two years to the past.

If shift is a timdelta, shifts the data by that timedelta.

If shift is a timestamp, shifts the data such that the earliest entry has that timestamp. The remaining values will mantain the same time difference to the first entry.

write(*path*, *file_format='directory'*)
Write the data either to an EDF file or to several files into a new directory. Because of the special structure of EDF files writing to EDF is only possible for readers that have been created from an EDF file and without any changes to the ACC, ECG, Marker, HRV and sample_freqs attributes. Because we want you to be able to modify the signals, you can write the data back to a directory of individual files. Writing to a directory is the preferred method and works in all cases.

Parameters

- **path** (*str*) – Name of the file or directory to write the data to.
- **file_format** (*{'directory', 'edf'}, default 'directory'*) – Format of the written data.

2.3.4 devicely.EverionReader

" Biovotion Everion is a wearable device used for the continuous monitoring of vital signs. Currently, it measures the following vital signs: heart rate, blood pulse wave, heart rate variability, activity, SPO2, blood perfusion, respiration rate, steps, energy expenditure, skin temperature, EDA / galvanic skin response (GSR), barometric pressure and sleep.

class devicely.everion.**EverionReader**(*path*, *signal_tags=[6, 7, 11, 12, 15, 19, 20, 21, 118, 119]*, *sensor_tags=[80, 81, 82, 83, 84, 85, 86]*, *feature_tags=[14]*)
Read, timeshift and write data generated by Biovotion Everion. You can find example data here. Each measurement has a tag which is an information about the type of measurement. By default, only some of the tags are read

for signals, sensors and features. You can find these tags via self.default_signal_tags, self.default_sensor_tags and self.default_feature_tags. You can find out all available tags and what they mean by accessing the attributes EverionReader.SIGNAL_TAGS, EverionReader.SENSOR_TAGS and EverionReader.FEATURE_TAGS.

raw dataframes
These dataframes are accessible via the attributes aggregates, analytics_events, attributes_dailys, everion_events, features, sensors and signals. Each dataframe corresponds to a file in the reading path.

Type dataframes

data
Joined version of the raw dataframes (aggregates, analytics_events, attributes_dailys, everion_events, features, sensors and signals).

Type DataFrame

SIGNAL_TAGS
Signal tag numbers and their meaning.

Type dict

SENSOR_TAGS
Sensor tag numbers and their meaning.

Type dict

FEATURE_TAGS
Feature tag numbers and their meaning.

Type dict

default_signal_tags
Subset of tags that are read by default for signals.

Type list

default_sensor_tags
Subset of tags that are read by default for sensors.

Type list

default_feature_tags
Subset of tags that are read by default for features.

Type list

timeshift(*shift='random'*)
Timeshift the data by shifting all time related columns in the joined dataframe (data) and raw dataframes (aggregates, analytics_events, attributes_dailys, everion_events, features, sensors, signals).

Parameters **shift** (*None/'random', pd.Timestamp or pd.Timedelta*) – If shift is not specified, shifts the data by a random time interval between one month and two years to the past.

If shift is a timdelta, shifts the data by that timedelta.

If shift is a timestamp, shifts the data such that the earliest entry has that timestamp. The remaining values will mantain the same time difference to the first entry.

write(*path*)
Write the raw dataframes back to individual files in the same format as they were read. Thus, the resulting directory can be read again using an EverionReader.

Parameters **path** (*str*) – Path to the writing directory.

2.3.5 devicely.ShimmerReader

Shimmer Consensys GSR is a device that is used to collect sensor data in real time and it contains sensors such as GSR / EDA, photoplethysmography (PPG), 3-axis accelerometer, 3-axis gyroscope, 3-axis magnetometer & integrated altimeter.

class devicely.shimmer_plus.**ShimmerPlusReader**(*path*)

Read, timeshift and write data generated by Shimmer Consensys GSR.

data

DataFrame with the read signals. The column 'Shimmer_40AC_Timestamp_Unix_CAL' contains the timestamps of measurement.

Type DataFrame

units

A unit for each column in the dataframe.

Type pandas.Series

timeshift(*shift='random'*)

Timeshift the data by shifting all time related columns.

Parameters **shift** (*None/'random', pd.Timestamp or pd.Timedelta*) – If shift is not specified, shifts the data by a random time interval between one month and two years to the past.

If shift is a timdelta, shifts the data by that timedelta.

If shift is a timestamp, shifts the data such that the earliest entry has that timestamp. The remaining values will mantain the same time difference to the first entry.

write(*path*)

Write the DataFrame and units to the writing path in the same format as it was read.

Parameters **path** (*str*) – Path to writing csv file. Writing mode: 'w'.

2.3.6 devicely.MuseReader

Module to process Muse data from the mind monitor application

class devicely.muse.**MuseReader**(*path*)

Parses, timeshifts and writes data generated by the Muse S headband using the Mind Monitor application.

data

dataframe of the read data

Type DataFrame

timeshift(*shift='random'*)

Shifts the index column 'TimeStamp'.

Parameters **shift** (*None/'random', pd.Timestamp or pd.Timedelta*) – If shift is not specified, shifts the data by a random time interval between one month and two years to the past.

If shift is a timdelta, shifts the data by that timedelta.

If shift is a timestamp, shifts the data such that the earliest entry is at that timestamp and the remaining values keep the same time distance to the first entry.

write(*path*)

Writes the dataframe back into a csv file.

Parameters **path** (*str*) – path to the write file.

2.3.7 devicely.TimeStampReader

TimeStamp for Android allows you to record the timestamp of an event at the time it occurs. It also allows you to create specific tags such as "Running" or "Walking" and timestamp those specific activities.

class devicely.time_stamp.**TimeStampReader**(*path*)
Read, timeshift and write data generated by the Android app TimeStamp

data
DataFrame with datetime index and 'tag' column.

Type DataFrame

timeshift(*shift='random'*)
Timeshift the data by shifting the index.

Parameters **shift** (*None/'random', pd.Timestamp or pd.Timedelta*) – If shift is not specified, shifts the 'time' column by a random time interval between one month and two years to the past.

If shift is a timdelta, shift the index by that timedelta.

If shift is a timestamp, shifts the data such that the earliest entry has that timestamp. The remaining values will mantain the same time difference to the first entry.

write(*path*)
Write the DataFrame stored in 'data' to 'path' in the same format as it was read.

Parameters **path** (*str*) – Path to writing csv. Writing mode: 'w'

2.4 How to contribute

Whether you would like to add a new sensor, fix a bug or help with packaging, we would love for you to contribute. To make a contribution, please fork our repository and open a pull request when you are done with your changes.

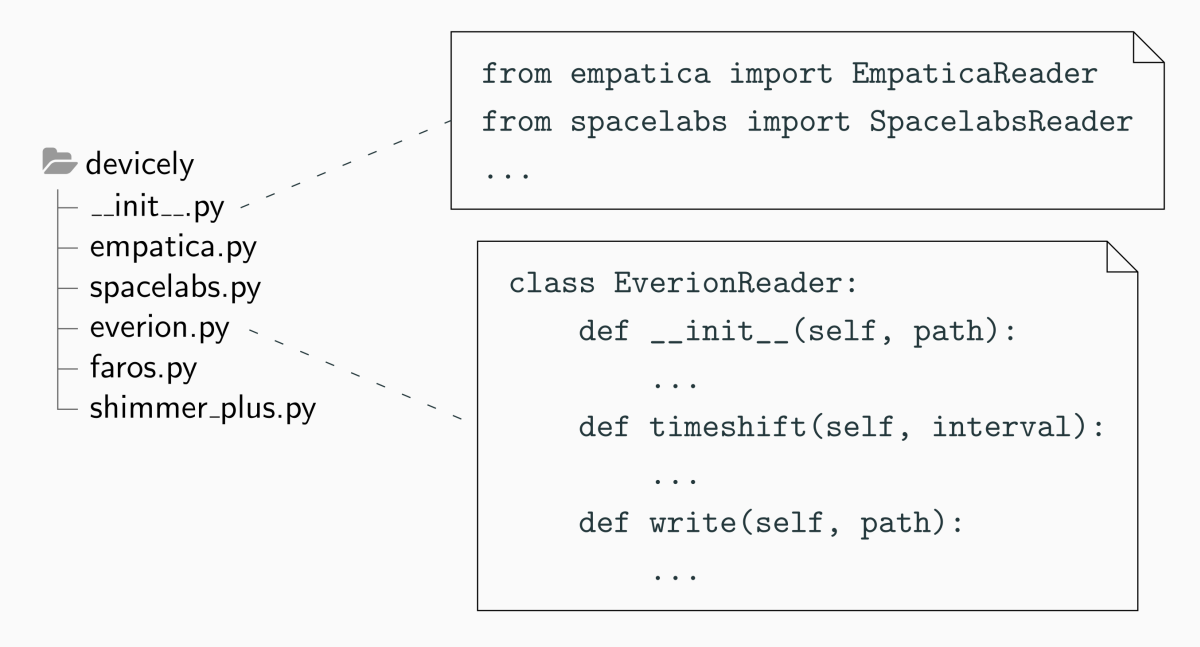
2.4.1 Getting started with development

If you wonder why we do not have a `setup.py`, `setup.cfg` or `requirements.txt`, it is because we use poetry for packaging, building and dependency management. To get a development environment, clone the repository and exeute `poetry install`. This will create a virtual environment for the project and install all runtime- and development dependencies. Now you can run the tests with `poetry run pytest`, work on the example jupyter notebook with `poetry run jupyter notebook` or enter the virtual environment with `poetry shell`.

2.4.2 Add a sensor class

One reason why you might want to contribute to devicely is to add a new sensor class to the package. Please follow these steps if that is the case:

Your sensor class needs to have its own module in the devicely package:



Please create a class member for each signal that your sensor records. To provide an example, if your sensor contains heart rate and acceleration data, use uppercase attribute names like `reader.ACC` and `reader.HR`. These attributes should be dataframes, indexed by time of measurement. For metadata, you can use basic data structures such as dictionaries. Apart from the individual signal dataframes, your sensor should have an attribute `reader.data` which is a joined dataframe of all individual signal dataframes.

The `timeshift` method should accept three types of parameters: nothing, a `pandas.Timestamp` or a `pandas.Timedelta`. With no parameter, all time-related data attributes are shifted between one month and two years to the past. With a `pandas.Timedelta`, all attributes are shifted by adding the timedelta to them. With a `pandas.Timestamp`, all attributes are shifted such that the provided timestamp is the earliest data entry and all other data entries keep the same distance to it.

Timeshifting is not the only way to anonymize data. If your sensor uses other metadata such as a patient id, please add a method `deidentify` to clear such metadata. You can look at `devicely.SpacelabsReader.deidentify` for an example.

With the `reader.write` method, users can write the identified data to be persistent, ideally in the same original sensor format. Keeping the original format is not strictly necessary, just make sure that your reader class can be instantiated with the written data.

2.4.3 Write unit tests

Unit tests ensure that our sensor classes work the way we expect them to, which is why we aim for a high test coverage. The existing test cases are a good example to see how your test case should be structured. In general, have one test case for your sensor and one directory with data for testing. Write test methods for the most important use cases of your sensor, e.g. reading, timeshifting and writing. Please make sure that your test cases run fairly quickly as this helps us run tests locally and keep the GitHub Actions jobs fast. It helps to use small sensor files for testing, e.g. only 30 seconds long.

2.4.4 Write documentation

At devicely, we live by the motto **Docs or it didn't happen**.

Therefore, all sensor classes need to be documented well. Most importantly, you need to add the following docstrings to your class:

1. a docstring on top of the class definition containing information about the sensor and what the most important class attributes are
2. a docstring for each method that users are meant to call specifying the syntax, parameters and return values

Apart from docstrings, all you need to do is add example code to the notebook with examples. Not only is this notebook meant to be run by users themselves, but it is also rendered in our *Start guide for the devicely package* documentation section.

The docstrings and the notebook are basically all you have to do to document your sensor class. Feel free to look at the existing sensors as a guide!

2.4.5 Provide example data

If you want people to try out your reader class, you need to provide example data. For this purpose we maintain this example repository with examples and data, to which you can create a PR to supply example data for your sensor.

2.4.6 License and Copyright

Currently **devicely** is licensed under the MIT license and all copyright is attributed to the Digital Health Center (Hasso Plattner Institute).

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