top_count_validation

November 23, 2023

1 Validating ToP 1min vs actual Actigraph counts

We use a sample raw acceleration measurement dataset from a GT3X+ Actigraph for which counts at various epochs, including 1 minute epoch, have been produced thanks to the official Actilife Software, ver 5.10.0

[ ]:
```
import os
import pandas as pd
import seaborn as sns
import numpy as np
from sklearn.linear_model import LinearRegression
import top

root_datafolder = 'i:
 ↪\\Benoit\\WORKSPACE\\INTERACT_data_pipeline\\data\\count_test_data'
```

1.1 Loading Raw GT3X+ data

Header:

```
------------ Data File Created By ActiGraph GT3X+ ActiLife v5.10.0 Firmware v2.4.0 date format
Serial Number: NEO1D24110312
Start Time 16:00:00
Start Date 2018-03-19
Epoch Period (hh:mm:ss) 00:00:00
Download Time 10:44:47
Download Date 2018-03-28
Current Memory Address: 0
Current Battery Voltage: 4.15     Mode = 12
--------------------------------------------------
```

[ ]:
```
# Load raw GT3X file
gt3x_fname = os.path.join(root_datafolder, 'Actigraph0\\NEO1D24110312␣
 ↪(2018-03-28)RAW.csv')
gt3x = pd.read_csv(gt3x_fname,
                   skiprows=10) # skip header
gt3x.index = pd.date_range(name='utcdate', start='2018-03-19 16:00:00',␣
 ↪periods=len(gt3x.index), freq=f'{1/50:f}S')
```

```
print(gt3x)
```

```
                        Axis1  Axis2  Axis3
utcdate
2018-03-19 16:00:00.000  1.009  0.091 -0.003
2018-03-19 16:00:00.020  1.012  0.091 -0.009
2018-03-19 16:00:00.040  1.012  0.091 -0.003
2018-03-19 16:00:00.060  1.012  0.091 -0.009
2018-03-19 16:00:00.080  1.012  0.091 -0.003
…                        …      …      …
2018-03-28 10:44:57.420  0.000  0.000  0.000
2018-03-28 10:44:57.440  0.000  0.000  0.000
2018-03-28 10:44:57.460  0.000  0.000  0.000
2018-03-28 10:44:57.480  0.000  0.000  0.000
2018-03-28 10:44:57.500  0.000  0.000  0.000

[37934876 rows x 3 columns]
```

[ ]:
```
gt3x.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 37934876 entries, 2018-03-19 16:00:00 to 2018-03-28
10:44:57.500000
Freq: 20L
Data columns (total 3 columns):
 #   Column  Dtype
---  ------  -----
 0   Axis1   float64
 1   Axis2   float64
 2   Axis3   float64
dtypes: float64(3)
memory usage: 1.1 GB
```

1.2 Load Axtigraph 1min counts

This is our gold standard

[ ]:
```
agcnt = pd.read_csv(os.path.join(root_datafolder, r'Actigraph0\NEO1D24110312␣
↪(2018-03-28)60secDataTable.csv'), skiprows=1)
agcnt['utcdate'] = pd.to_datetime(agcnt['Date'] + ' ' + agcnt[' Time']) #␣
↪Notice space before Time column name...
print(agcnt)
```

```
            Date      Time   Axis1  Axis2  Axis3  Steps  Lux  Inclinometer  \
0     2018-03-19  16:00:00       0      0      0      0    0             1
1     2018-03-19  16:01:00       0      0      5      0    0             1
2     2018-03-19  16:02:00       0      0      0      0    0             1
3     2018-03-19  16:03:00       0      0      0      0    0             1
4     2018-03-19  16:04:00      10      5     26      0    0             1
```

```
…           …       …     …    …    …    …  …            …
12639  2018-03-28  10:39:00       0      0      0      0  161            0
12640  2018-03-28  10:40:00       0      0      0      0  153            0
12641  2018-03-28  10:41:00       0      0      0      0  174            0
12642  2018-03-28  10:42:00    1362   1581   1774     11   78            1
12643  2018-03-28  10:43:00     811   1709    697     12  108            1

       Vector Magnitude             utcdate
0                  0.00 2018-03-19 16:00:00
1                  5.00 2018-03-19 16:01:00
2                  0.00 2018-03-19 16:02:00
3                  0.00 2018-03-19 16:03:00
4                 28.30 2018-03-19 16:04:00
…                 …                    …
12639              0.00 2018-03-28 10:39:00
12640              0.00 2018-03-28 10:40:00
12641              0.00 2018-03-28 10:41:00
12642           2738.92 2018-03-28 10:42:00
12643           2015.99 2018-03-28 10:43:00

[12644 rows x 10 columns]
```

1.3 Compute ToPs using INTERACT procedures

1.3.1 1 sec ToP

[ ]:
```
# Reformat GT3X df and generate dummy GPS file
gt3x = gt3x.rename(columns={'Axis1': 'x', 'Axis2': 'y', 'Axis3': 'z'}).
 ↪reset_index()
gps = pd.DataFrame({'lat': 0, 'lon': 0, 'alt': 0},
                   index=pd.date_range(name='utcdate', start='2018-03-19 16:00:
 ↪00', periods=100, freq=f'1S')).reset_index()


# Compute 1sec ToP
top1s = top._top_1sec('iid', 'sd', gps, gt3x)
print(top1s)
```

```
                     interact_id sd_id  count_x  count_y  count_z  count_vm  \
utcdate
2018-03-19 16:00:00         iid    sd       30        0        0      30.0
2018-03-19 16:00:01         iid    sd        0        0        0       0.0
2018-03-19 16:00:02         iid    sd        0        0        0       0.0
2018-03-19 16:00:03         iid    sd        0        0        0       0.0
2018-03-19 16:00:04         iid    sd        0        0        0       0.0
…                           …   …       …       …      …       …
2018-03-28 10:44:53         iid    sd        0        0        0       0.0
2018-03-28 10:44:54         iid    sd        0        0        0       0.0
```

```
2018-03-28 10:44:55         iid    sd        0        0        0       0.0
2018-03-28 10:44:56         iid    sd        0        0        0       0.0
2018-03-28 10:44:57         iid    sd        0        0        0       0.0

                     lat  lon  alt
utcdate
2018-03-19 16:00:00  0.0  0.0  0.0
2018-03-19 16:00:01  0.0  0.0  0.0
2018-03-19 16:00:02  0.0  0.0  0.0
2018-03-19 16:00:03  0.0  0.0  0.0
2018-03-19 16:00:04  0.0  0.0  0.0
…                    …    …    …
2018-03-28 10:44:53  NaN  NaN  NaN
2018-03-28 10:44:54  NaN  NaN  NaN
2018-03-28 10:44:55  NaN  NaN  NaN
2018-03-28 10:44:56  NaN  NaN  NaN
2018-03-28 10:44:57  NaN  NaN  NaN

[758698 rows x 9 columns]
```

[ ]:
```
print(top1s[['count_x', 'count_y', 'count_z', 'count_vm']].describe())
```

```
            count_x        count_y        count_z       count_vm
count  758698.000000  758698.000000  758698.000000  758698.000000
mean        2.099473       1.994653       2.431674       4.457543
std        11.256183       8.727783       9.976883      17.229156
min         0.000000       0.000000       0.000000       0.000000
25%         0.000000       0.000000       0.000000       0.000000
50%         0.000000       0.000000       0.000000       0.000000
75%         0.000000       0.000000       0.000000       0.000000
max       371.000000     376.000000     368.000000     474.017932
```

1.3.2 1 min ToP

[ ]:
```
# Compute 1min ToP
top1m = top._top_1min(top1s)
print(top1m)
```

```
                    interact_id sd_id  count_x  count_y  count_z     count_vm  \
utcdate
2018-03-19 16:00:00         iid    sd       30        0        0    30.000000
2018-03-19 16:01:00         iid    sd        0        0        4     4.000000
2018-03-19 16:02:00         iid    sd        0        0        0     0.000000
2018-03-19 16:03:00         iid    sd        0        0        0     0.000000
2018-03-19 16:04:00         iid    sd       11        0       24    26.400758
…                           …    …        …        …        …           …
2018-03-28 10:40:00         iid    sd        0        0        0     0.000000
2018-03-28 10:41:00         iid    sd        0        0        0     0.000000
2018-03-28 10:42:00         iid    sd     1338     1608     1784  2749.284270
```

```
2018-03-28 10:43:00         iid    sd      783     1764      683  2047.260120
2018-03-28 10:44:00         iid    sd        0        0        0     0.000000

                     lat  lon  alt  wearing
utcdate
2018-03-19 16:00:00  NaN  NaN  NaN        0
2018-03-19 16:01:00  NaN  NaN  NaN        0
2018-03-19 16:02:00  NaN  NaN  NaN        0
2018-03-19 16:03:00  NaN  NaN  NaN        0
2018-03-19 16:04:00  NaN  NaN  NaN        1
…                    …    …    …        …
2018-03-28 10:40:00  NaN  NaN  NaN        1
2018-03-28 10:41:00  NaN  NaN  NaN        1
2018-03-28 10:42:00  NaN  NaN  NaN        1
2018-03-28 10:43:00  NaN  NaN  NaN        0
2018-03-28 10:44:00  NaN  NaN  NaN        0

[12645 rows x 10 columns]
```

[ ]:
```
print(top1m[['count_x', 'count_y', 'count_z', 'count_vm']].describe())
```

```
            count_x       count_y       count_z      count_vm
count  12645.000000  12645.000000  12645.000000  12645.000000
mean     125.968051    119.678845    145.900040    247.399177
std      584.877732    350.792357    413.853639    791.632964
min        0.000000      0.000000      0.000000      0.000000
25%        0.000000      0.000000      0.000000      0.000000
50%        0.000000      0.000000      0.000000      0.000000
75%        0.000000      4.000000      9.000000     18.000000
max     6717.000000   3385.000000   3787.000000   7436.134345
```

1.4 Comparing ToP 1min with Actigraph counts

[ ]:
```
cmp_cnt = top1m[['count_x', 'count_y', 'count_z', 'count_vm']].join(agcnt.
 ↪set_index('utcdate'), how='inner')
cmp_cnt = cmp_cnt.drop(columns=['Date', ' Time', 'Steps', 'Lux',␣
 ↪'Inclinometer'])
print(cmp_cnt)
```

```
                     count_x  count_y  count_z     count_vm   Axis1  Axis2  \
utcdate
2018-03-19 16:00:00       30        0        0    30.000000       0      0
2018-03-19 16:01:00        0        0        4     4.000000       0      0
2018-03-19 16:02:00        0        0        0     0.000000       0      0
2018-03-19 16:03:00        0        0        0     0.000000       0      0
2018-03-19 16:04:00       11        0       24    26.400758      10      5
…                        …        …        …           …      …      …
2018-03-28 10:39:00        0        0        0     0.000000       0      0
```

```
2018-03-28 10:40:00        0        0        0     0.000000       0      0
2018-03-28 10:41:00        0        0        0     0.000000       0      0
2018-03-28 10:42:00     1338     1608     1784  2749.284270    1362   1581
2018-03-28 10:43:00      783     1764      683  2047.260120     811   1709

                     Axis3  Vector Magnitude
utcdate
2018-03-19 16:00:00      0              0.00
2018-03-19 16:01:00      5              5.00
2018-03-19 16:02:00      0              0.00
2018-03-19 16:03:00      0              0.00
2018-03-19 16:04:00     26             28.30
…                       …                 …
2018-03-28 10:39:00      0              0.00
2018-03-28 10:40:00      0              0.00
2018-03-28 10:41:00      0              0.00
2018-03-28 10:42:00   1774           2738.92
2018-03-28 10:43:00    697           2015.99

[12644 rows x 8 columns]
```

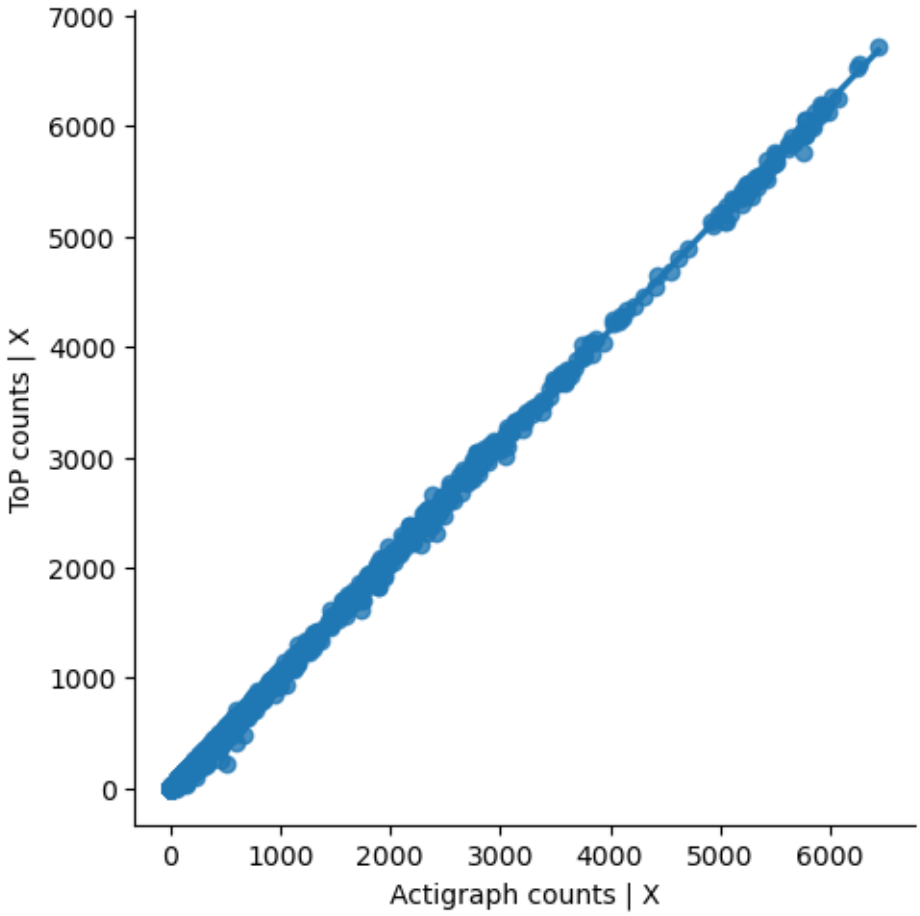
1.4.1 X axis

[ ]:
```
# Plot Axis 1
g = sns.lmplot(data=cmp_cnt,
               x=' Axis1', y='count_x')
g = g.set_axis_labels('Actigraph counts | X','ToP counts | X')

# Compute regresion
x = cmp_cnt[' Axis1'].array.reshape((-1, 1))
y = cmp_cnt['count_x']
model = LinearRegression().fit(x, y)
print(f'Model: ToP = {model.coef_[0]:.3f} x Ag count + {model.intercept_:.3f}')
print(f'R\u00B2: {model.score(x, y):.3f}')
```

```
c:\Users\benoit\miniconda3\envs\py311_jupyter\Lib\site-
packages\seaborn\axisgrid.py:118: UserWarning: The figure layout has changed to
tight
  self._figure.tight_layout(*args, **kwargs)
```

```
Model: ToP = 1.039 x Ag count + -0.703
R²: 0.999
```



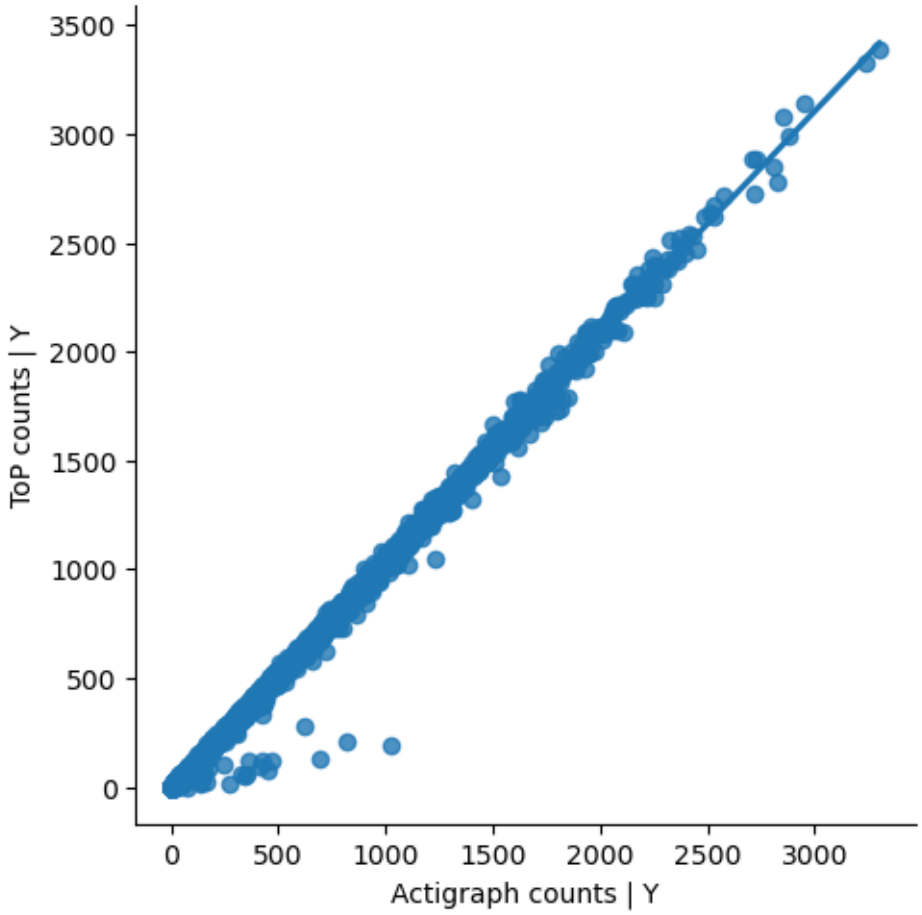
1.4.2 Y axis

[ ]:
```
# Plot Axis 1
g = sns.lmplot(data=cmp_cnt,
               x='Axis2', y='count_y')
g = g.set_axis_labels('Actigraph counts | Y','ToP counts | Y')

# Compute regresion
x = cmp_cnt['Axis2'].array.reshape((-1, 1))
y = cmp_cnt['count_y']
model = LinearRegression().fit(x, y)
print(f'Model: ToP = {model.coef_[0]:.3f} x Ag count + {model.intercept_:.3f}')
print(f'R\u00B2: {model.score(x, y):.3f}')
```

```
c:\Users\benoit\miniconda3\envs\py311_jupyter\Lib\site-
packages\seaborn\axisgrid.py:118: UserWarning: The figure layout has changed to
tight
  self._figure.tight_layout(*args, **kwargs)
```

```
Model: ToP = 1.035 x Ag count + -0.862
R²: 0.997
```



1.4.3 Z axis

[ ]:
```
# Plot Axis 1
g = sns.lmplot(data=cmp_cnt,
               x='Axis3', y='count_z')
g = g.set_axis_labels('Actigraph counts | Z','ToP counts | Z')

# Compute regresion
x = cmp_cnt['Axis3'].array.reshape((-1, 1))
y = cmp_cnt['count_z']
model = LinearRegression().fit(x, y)
print(f'Model: ToP = {model.coef_[0]:.3f} x Ag count + {model.intercept_:.3f}')
print(f'R\u00B2: {model.score(x, y):.3f}')
```

```
c:\Users\benoit\miniconda3\envs\py311_jupyter\Lib\site-
packages\seaborn\axisgrid.py:118: UserWarning: The figure layout has changed to
```

```
tight
  self._figure.tight_layout(*args, **kwargs)
```

```
Model: ToP = 1.041 x Ag count + -1.260
R²: 0.998
```