

README for MATLAB function to classify sedentary behaviour with ActiGraph data (runBehaviourPredictionActiGraph)

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MATLAB

This function was created with MATLAB v9.6 (2019a), and needs access to the following toolboxes: Signal Processing Toolbox, Statistics and Machine Learning Toolbox, Financial Toolbox. If you do not have access to MATLAB and these toolboxes, contact roman.kuster@alumni.ethz.ch

Preparation

Download the MATLAB and Excel files to your local hard disk (e.g. create the folder C:\User\me\documents\myMATLABskripts\ActiGraphSedentaryBehaviourPrediction). Make sure all required files are stored in the same folder. The required files are (in alphabetical order):

- addCountsPerMinuteAG.m (function to summarize counts per second to minutes)
- getFeaturesAndPredictAG.m (function to predict sitting)
- limitDataToProtocolAG.m (function to limit recording, requires optional input argument)
- loadCPSfileAG.m (function to load counts per second .csv files)
- loadRAWfileAG.m (function to load raw data .csv files)
- PosturePredictionAlgorithm.mat (trained algorithm to predict posture)
- Protocol_Template.xlsx (Excel file to specify recording time for each subject)
- runBehaviourPredictionActiGraph.m (main function calling all other functions)

Locate and organise the folder of your ActiGraph data to be used. The prediction requires the counts-per-second and the raw data csv files, stored for all subjects in one main folder. Ensure the counts-per-second files end on *1sec.csv and the raw data files end on *RAW.csv (where the * represents a placeholder and must not be included in the filename)

It is highly recommended to make a local copy of the folder on your hard disk. Similarly organise your data as described below for the folder myStudy located in C:\User\me\documents

Main Folder:

- C:\User\me\documents\myStudy

Files for each subject in main folder (two files per subject):

- C:\User\me\documents\myStudy\AG0001 (2016-11-22)1sec.csv
- C:\User\me\documents\myStudy\AG0001 (2016-11-22)RAW.csv
- C:\User\me\documents\myStudy\AG0002 (2016-10-12)1sec.csv
- C:\User\me\documents\myStudy\AG0002 (2016-10-12)RAW.csv
- C:\User\me\documents\myStudy\AG0004 (2016-12-3)1sec.csv
- C:\User\me\documents\myStudy\AG0004 (2016-12-3)RAW.csv
- ...

If you want to limit the behaviour prediction to a start and stop time for each subject (see optional input arguments how to do so), move the Protocol_Template.xlsx to the main folder (C:\User\me\documents\myStudy), and add the information for each subject. Skip this step if you do not want to limit the behaviour prediction to a start and stop time. In the Protocol_Template.xlsx:

- SubjectID must be equal to the filename of the subject until the first space, e.g. AG0001, AG0002, AG0003
- StartDay contains the start day in format dd.mm.yyyy
- StartTime contains the time on the start day at which the sensor was attached in format HH:MM:SS
- StopDay contains the stop day in format dd.mm.yyyy
- StopTime contains the time on the stop day at which the sensor was removed in format HH:MM:SS

Make sure that there is only one .xlsx document in your main folder containing the case-sensitive keyword *Protocol*, and that this file is not open when executing the function. The SubjectID must be equal to the filename of the subject until the first space, else the protocol data is ignored, and the entire recording is used. Use as many columns as necessary for each subject (e.g. start and stop for each day). If using the protocol, make sure that all wear-time is indicated in the protocol, the time not covered by the protocol is ignored. If no StartDay is available, the StartTime is ignored. If no StartTime is available, the recording is assumed to have started at 00:00 on the specified StartDay. If no StopDay is available, the StopTime is ignored. If no StopTime is available, the recording is assumed to have ended at 24:00 on the specified StopDay. Do not enter any additional information in the Protocol_Template.xlsx file.

Sedentary Behaviour Prediction

Open MATLAB and set its current directory to the folder the function files are stored (e.g. C:\User\me\documents\myMATLABskripts\ActiGraphSedentaryBehaviourPrediction). Below are three alternatives on how to set the current directory of MATLAB:

- a) Type the following command in the Command Window (with the location of your folder):
`cd('C:\User\me\documents\myMATLABskripts\ActiGraphSedentaryBehaviourPrediction')`
- b) Go to MATLABs Current Folder Window, and navigate to the folder manually
- c) Copy-paste the folder direction
C:\User\me\documents\myMATLABskripts\activpalSedentaryBehaviourPrediction into the folder
information of MATLAB (right below the main menu spreadsheets).

Execute the function by typing `runBehaviourPredictionActiGraph` in your MATLAB Command Window. An explorer window pops up where you have to select the folder in which your data is stored. Select the main folder containing all the subject files (e.g. C:\User\me\documents\myStudy). The function first checks the input files (*1sec.csv and *RAW.csv), and will then run through all the subjects. Each step is documented in the Command Window. The processing should take, depending on your computer and the recording duration, around 3 to 10 minutes per subject.

The output data of the function is stored in a .csv file, with the name of the subject and 1minSedentaryBehaviour appended (e.g. AG0001 (2016-11-22)1minSedentaryBehaviour.csv). The output file is in a similar format as the input files, with the numeric start time in column 1, a time string in column 2, the predicted posture in column 3, the y-axis counts-per-minute in column 4, and the behaviour code in column 5. The posture code uses 0 for sitting, 1 for standing, and 2 for stepping. The behaviour code uses

- 0 for sedentary behaviour
- 1 for active sitting
- 2 for inactive standing
- 3 for active standing
- 4 for stepping

A code of 99 (posture and behaviour) and y-axis counts-per-minute of -99 indicates excluded time due to the protocol data. An additional output file named "Summarised Behaviour Prediction_date-and-time.xls" containing the data of all subjects processed in one run through the function is also stored in the main folder (the one you selected in the beginning, e.g. C:\User\me\documents\myStudy). The time the file was created is appended to prevent overwriting previous rounds. You find the data of each subject in an own spreadsheet.

Specify optional input arguments if 1) you want to use time information to limit the behaviour prediction (protocol); 2) you want to exclude subjects already having the output file; 3) you want to suppress the generation of a summary file for all subjects; 4) you want to exclude non-valid time in the output file; 5) your input file has a different axis order than x, y, z; 6) you want to use other cut-points than 75 counts-per-minute to separate inactive and active sitting and/or 150 counts-per-minute to separate inactive and active standing. By default, all optional input arguments are deactivated.

1) Limit the behaviour prediction to start and stop time for each subject as stored in the Protocol_Template.xlsx file.

To run the function with this optional input, copy the following command in the Command Window:

```
runBehaviourPredictionActiGraph('UseProtocolFileToLimitTime','Yes')
```

The command window will tell you whether the recording could be limited with the protocol data or not.

2) To process only the subjects not yet having an output file, copy the following command in the Command Window:

```
runBehaviourPredictionActiGraph('ExcludeSubjectsHavingOutputCSV','Yes')
```

Note that each time you run the function a new summary file will be created in the main folder containing only the processed subject data. Make sure that you do not specify this input argument if you change the information in the protocol.

3) To suppress the generation of the summary file, copy the following command in the Command Window:

```
runBehaviourPredictionActiGraph('SuppressSummaryFile','Yes')
```

4) To exclude non-valid time in the output file, copy the following command in the Command Window:

```
runBehaviourPredictionActiGraph('ExcludeNonValidTimeInOutput','Yes')
```

This command erases all minutes not covered in the Protocol (no effect if protocol is not used)

5) To specify a different axis order than x, y, z (e.g. y, x, z) of your input files, copy the following command in the Command Window: `runBehaviourPredictionActiGraph('AxisOrder', {'y','x','z'})`

6) To use other cut-points than 75 counts-per-minute to separate inactive and active sitting (e.g. 100) and/or than 150 counts-per-minute to separate inactive and active standing (e.g. 200), copy the following command in the Command Window:

```
runBehaviourPredictionActiGraph('CutPoints', [100, 200])
```

Note that the separation of inactive and active standing is not validated.

You can combine the optional input arguments in whatever combination, e.g. by copy the following command in the Command Window:

```
runBehaviourPredictionActiGraph('UseProtocolFileToLimitTime','Yes','ExcludeSubjectsHavingOutputCSV','Yes','SuppressSummaryFile','Yes','CutPoints',[75, 175])
```

to limit processing to protocol data, process only the subjects not having an output file, suppress the generation of a summary file, and use a cut-point of 175 counts-per-minute to separate inactive and active standing.

Troubleshooting

The function was tested on various ActiGraph data sets recorded with different sensor and firmware versions. As it is very unlikely that all errors and bugs were fixed, we ask you to report any errors that occurred to roman.kuster@alumni.ethz.ch. Contact us if you need any assistance, as well as for questions and suggestions to improve.