IE 48B Time Series Analytics
Homework 1, due November 5th, 2021

Instructions: Please solve the following exercises using R (http://www.r-project.org/) or Python (https://www.python.org/). You are expected to use GitHub Classroom and present your work as an html file (i.e. web page) on your progress journals. There are alternative ways to generate an html page for you work:

- A Jupyter Notebook including your codes and comments. This works for R and Python, to enable using R scripts in notebooks, please check:
  - https://docs.anaconda.com/anaconda/navigator/tutorials/r-lang/
  - https://medium.com/@kyleake/how-to-install-r-in-jupyter-with-irkernel-in-3-steps-917519326e41

  Things are little easier if you install Anaconda (https://www.anaconda.com/). Please export your work to an html file. Please provide your *. ipynb file in your repository and a link to this file in your html report will help us a lot.

- A Markdown html document. This can be created using RMarkdown for R and Python Markdown for Python

Note that html pages are just to describe how you approach to the exercises in the homework. They should include your codes. You are also required to provide your R/Python codes separately in the repository so that anybody can run it with minimal change in the code. This can be presented as the script file itself or your notebook file (the one with *.ipynb file extension).

The last and the most important thing to mention is that academic integrity is expected! Do not share your code (except the one in your progress journals). You are always free to discuss about tasks but your work must be implemented by yourself. As a fundamental principle for any educational institution, academic integrity is highly valued and seriously regarded at Boğaziçi University.

Task: Gesture Recognition

The conference paper by Liu et al. (2009) starts with the following statement: “Gestures have recently become attractive for spontaneous interaction with consumer electronics and mobile devices in the context of pervasive computing”. The aim is to provide efficient personalized gesture recognition on wide range of devices.

To achieve this, Liu et al. (2009) uses a single three-axis accelerometer to collect data from eight users to characterize eight gesture patterns. The library, uWaveGestureLibrary, consists over 4000 instances each of which has the accelerometer readings in three dimensions (i.e. x, y and z). Eight gestures are illustrated in Figure 1.

The dataset is provided in the following link:
https://drive.google.com/drive/u/1/folders/13553neknux7U8why55KM1WrjgkA9IJKm

Note that there are separate files for each axis and each row corresponds to one gesture in the files. First column has the class information. The information between second and last column is the time

ordered observations in the corresponding axis (provided in the file name as X, Y or Z). Moreover, the data is split into training and test sets. For now, you are expected to work with only the training series. Hence, following files are to be used:

- uWaveGestureLibrary_X_TRAIN,
- uWaveGestureLibrary_Y_TRAIN,
- uWaveGestureLibrary_Z_TRAIN

1) Read the data and visualize one instance (all axes) from each class and try to relate the shape (time series) you see with the gestures shown in Figure 1 (this is just for fun, sometimes it is good to start with data visualization to understand what is going on). A 3D scatter plot would be interesting. Note that this is an acceleration information. You can transform this information to a velocity vector by computing the cumulative sum of acceleration over time.

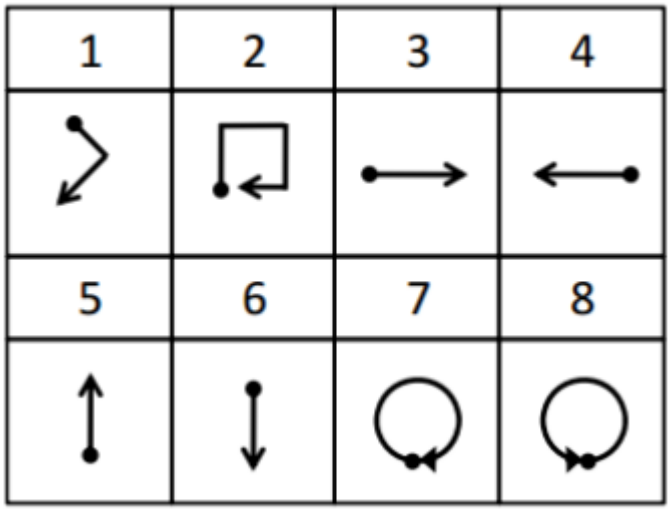

Figure 1: Gesture vocabulary considered by Liu et al. (2009). The dot denotes the start and the arrow the end

2) Propose two alternative time series representations. In other words, you are expected to summarize the data with few numbers. You can make use of the representations discussed in the class. Alternatively, based on your observations or research, you can propose alternative representations. Evaluate your proposed representation visually (as covered in the examples in the class). Due to this restriction, you may want to end up with simple representations (i.e. 1D or 2D) that are easier to visualize based on the class information. Compare your representations and justify your choice of introduced feature representation.

Reference

J. Liu, Z. Wang, L. Zhong, J. Wickramasuriya, and V. Vasudevan. uWave: Accelerometer-based personalized gesture recognition and its applications. Pervasive Computing and Communications, IEEE International Conference on, 0:1-9, 2009.
(link: http://www.ruf.rice.edu/~mobile/publications/liu09percom.pdf)