Assignment 2. Heart rate detection

Hardware 1 - Orientation to Health Technology

The aim

The aim of this assignment is to get familiar with a peak detection algorithm and the heart rate variability measurements.

Use of AI tools

You are allowed to use AI tools in this assignment. If you use any AI tools, like large language models such as ChatGPT or Copilot, in formatting or editing your document, you must mention them. For example: “Microsoft M365 Copilot (based on GPT-4) was used to write comments to the code snippets”.

Instructions

In this task, you use Python and some additional libraries that are commonly used for numerical and scientific computing to analyze a photoplethysmography signal (PPG), which reflects the variations in blood circulation. Your goal is to find the peaks in the signal, which correspond to heart beats, and calculate heart rate variability parameters from the peak intervals.

Notice that you **cannot use this code in the project,** as MicroPython does not have these libraries. You can still get some ideas on *how the peak detection algorithm works* and then adapt these ideas in your project.

To complete this task, you will need the following Python libraries:

- **numpy**: for performing numerical computations
- **matplotlib**: for plotting the signal
- **pandas**: for reading the data file
- **scipy**: for peak finding

It is recommended to use either PyCharm, Visual Studio Code, or Anaconda Distribution which contains all required additional libraries. You can install the missing libraries with the following command (write in Command Prompt in Windows or in Terminal in Linux/Mac):

```
python –m pip install numpy matplotlib pandas scipy
```

or by removing the comment and executing the following line in the Notebook:

```
# Run if needed
# !pip install numpy pandas matplotlib scipy
```

In the given assignment Notebook (HT_A2_your_name.ipynb), there is a code snippet that uses your student ID to select one of the given data files. When you open the Notebook, first enter your name and your student ID. The name is given as string and thus includes the quotation marks around it. The student ID is an integer, so give it as a number, for example:

```
name = "your name"
id = 1234567
```

Read in the given data file to your notebook using pandas read_csv -function. Remember, also open and read the associated text file (bidmc_XX_Fix.txt). It contains information of the patient's age and sex.

The example code also shows how to plot the first 180 seconds of the PPG-signal. Use that code to check that you can read and plot the given data file.

Task

Write a Python code that

- analyses the given signal (based on your student ID) and find the peaks
- plots the detected peaks, and
- prints out the HRV analysis parameters (mean PPI, mean HR, and SDNN or RMSSD).

Finally, interpret the analysis results:

1. Was the mean heart rate (in BPM) low or high?
2. Was the mean PPI (in milliseconds) low or high?
3. How much variation was there in the PPI values (standard deviation and/or root-mean-square value of successive intervals)?
4. Was the variation low or high?
5. Compare these values to the given normal values (see the lecture notes) and interpret the recovery and/or stress level of the patient.

Submission

When you have completed the coding tasks, save your Notebook (or Python scripts). Return either

- a Notebook (ipynb-file) or
- if you have used normal python coding (py-files), write a Word document where you document your code, the results (outputs of your code), and your interpretation of the results.

Return as attachment (one file): Notebook (ipynb), Word (docx), PDF, or HTML file.

Evaluation

The assignment is evaluated using the following criteria:

- The assignment is returned on time.
  Yes (1 p), A week late (0 p), Two weeks late (-1 p), Three or more weeks late (-2 p)
- The returned answers meet the given requirements.
  Yes (1 p), No (0 p)
- The content of the returned document is
  Excellent (3 p), Good (2 p), Satisfactory (1 p), Weak (0 p)