Biomedical and Health Informatics: Digital Signal Processing

Due Date: Friday, April 14th at 11:55pm (digitally via T-Square)

1. **[60 pts]** QRS Complex Detection Using the Pan-Tomkins Algorithm

Implement the Pan-Tompkins QRS complex detection algorithm [1] in MATLAB. Various mobile health instruments acquire ECG signals, which must then be analyzed to detect the locations of heart beats. References and guides are available through a web search, and we recommend that you read over the original paper (especially its "Methods" section) to gain some more technical insight into the algorithm's design.

Your algorithm will be written into a MATLAB function named pt_qrs_detect. The inputs and outputs must be exactly as described below:

```
% Usage:
%   qrs = pt_qrs_detect(ecg,fs)
% Inputs:
%   ecg: 1xN (double) - the ECG signal, consisting of N samples
%    fs: 1x1 (double) - the sampling frequency of the signal
% Outputs:
%   qrs: 1xK (double) - the times of the K detected QRS peaks (seconds)
```

As this problem will be graded by an automated algorithm, you **must** follow the function name and order of inputs above to receive full credit. Your algorithm will be scored as follows, with the points divided evenly among multiple test cases:

- **[20 pts]** Identify the correct number of QRS complexes in the sample (within a margin of ±1%)
- **[40 pts]** Identify the times of the QRS complexes accurately (within ±50ms)

To aid in writing and debugging your algorithm, you are being provided with two typical test cases, both of which are located in the file data.mat. Additional test cases will be used for grading. Use the included pt_viz.m test function to visually inspect your algorithm's performance, and ensure accurate detection.

NOTE: Though you are as always free to use online walkthroughs and references in implementing your algorithm, ALL CODE MUST BE YOUR OWN. You may not simply modify and submit publicly available implementations, and we will be scanning for plagiarized code.

[1]   J. Pan and W. J. Tompkins, "A Real-Time QRS Detection Algorithm," *Biomedical Engineering, IEEE Transactions on*, no. 3, pp. 230–236, 1985.

2. **[40 pts]** Propose a design for an mHealth application centered around the management of juvenile diabetes. Discuss the requirements and limitations for such a solution (~200-300 words).