ENEL 563 Biomedical Signal Analysis

Project on Morphological Analysis and Pattern Classification of ECG Signals

1 Objectives

- Filter and remove artifacts in ECG signals
- Detect, segment, and extract discriminative features from QRS complexes in ECG signals for the characterization of normal beats and premature ventricular contractions (PVCs).
- Classify ECG beats (waveforms) into two groups: normal and PVC.

2 Specific Tasks

1. Get an ECG signal with PVCs. You may use the data file ecgpvcs.mat and the program pvcs.m from

   `http://www2.enel.ucalgary.ca/People/Ranga/enel563/SIGNAL_DATA_FILES/`

   Use only the first signal (ecg1) in the file ecgpvcs.mat. The sampling rate is 200 Hz.

2. Implement two filtering methods (see Chapter 3 of the textbook) to remove high-frequency and low-frequency artifacts in the signal.

3. Implement the Pan–Tompkins method to detect QRS complexes in the ECG signal; see Chapter 4.

4. Implement methods to derive at least two features to characterize each segmented ECG beat, such as the preceding RR interval, the QRST area, and the correlation coefficient with the template of a normal beat; see Chapter 5.

5. Implement a method to classify each beat as a normal or a PVC using one of the methods described in Chapter 9. Use features from about 30% of the signal as the training or reference set for the classifier and the remaining features to test the classifier. Check the results of your classification procedure, and compute the accuracy of classification, including measures of true-positive, false-positive, true-negative, and false-negative fractions. Note also the number of beats not detected and false detections of beats (if any) by your program. Prepare a summary of your results in a table.

See figures in the textbook for examples on how to illustrate signals before and after filtering, how to label plots with the results of detection or segmentation, how to show plots of features belonging to different types of signals, and how to evaluate the results of classification.

Use graphs to explain your results as necessary. Always label the axes of your graphs and show the proper units. If the units of a variable are not calibrated or are unknown, label the corresponding axis as "arbitrary units" or "AU".