Vital lab worksheet #03

Electrocardiogram and Heart Sounds

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Analysis:

Exercise 1: ECG in a resting volunteer

Record the average amplitude in Table 1.

Count the number of QRS complexes between the Marker and the Waveform Cursor. Multiply this number by four to calculate resting heart rate in beats per minute (bpm).

Amin : 17 * 4 = 68

Mahdi : 18 * 4 = 72

For each interval, calculate the heart rate using the equation below, and record these results in Table 2 of the Data Notebook.

$$\text{Heart rate (beats / minute)} = \frac{60}{\text{time interval (seconds)}}$$

Calculate the average duration for each waveform from four separate ECG cycles and record these results in Table 1 or a table like it.

Exercise 2: ECG for a range of volunteers

Compare the duration and amplitude of the P waves, QRS complexes and T waves between those in the group and with other members of the class. Record these results in Table 3 of the Data Notebook. It may help to note down the sex and apparent fitness levels of the volunteers.

Exercise 3: ECG and heart sounds

1. Select a region of data with two or three cardiac cycles, by clicking and dragging in the Time axis area (this will select both of the displayed channels).
2. Select Zoom Window from the Window menu. The Zoom window appears with the Event and ECG signals overlaid.
3. Note the correlation between Event and ECG signals.

Note any differences from the expected timing of the Event signal.

Table 1. Results table for the data analysis from Exercise 1.

Amin

Component	Amplitude (millivolts)	Mean	Duration (seconds)	Mean
P wave	0.056	0.061	0.068	0.073
QRS complex	0.24	0.2375	0.11	0.126
T wave	0.079	0.0825	0.038	0.039

Mahdi

Component	Amplitude (millivolts)	Mean	Duration (seconds)	Mean
P wave	0.063	0.068	0.070	0.069
QRS complex	0.25	0.254	0.121	0.119
T wave	0.076	0.078	0.042	0.046

Table 2. Results table for the heart rate calculation in Exercise 1.

Amin

Pair	Time Interval (seconds)	Heart Rate (beats per minute)
1	0.98	61.22
2	0.82	73.17
3	0.90	66.66

Mahdi

Pair	Time Interval (seconds)	Heart Rate (beats per minute)
1	0.89	67.41
2	0.86	69.76
3	0.845	71

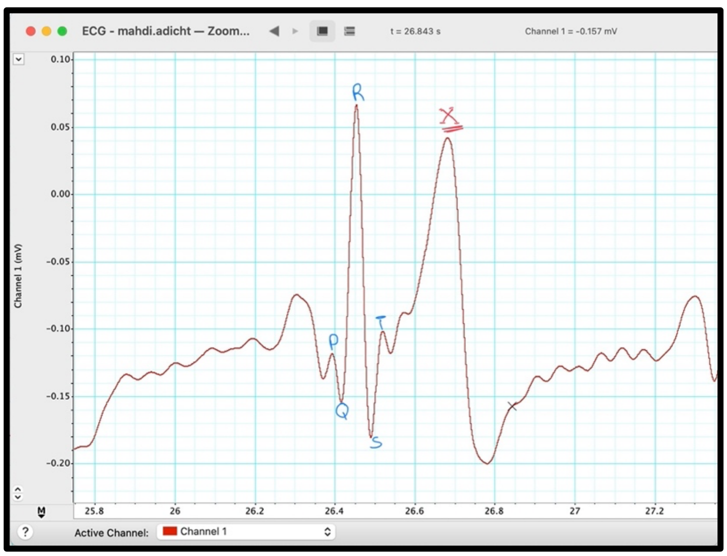
Table 3. Group data results for Exercise 2.

Person's name	Mean P amplidude (mV)	Mean P duration (sec)	Mean QRS amplitude (mV)	Mean QRS duration (sec)	Mean T amplitude (mV)	Mean T duration (sec)
Mahdi	**0.068**	**0.069**	**0.254**	**0.119**	**0.078**	**0.046**
Amin	**0.061**	**0.073**	**0.2375**	**0.126**	**0.0825**	**0.039**

Results:

Exercise 1: ECG in a resting volunteer

Attach a copy of the Zoom window of resting ECG. Indicate on the figure the P-wave, QRS complex, and the T wave.



As shown in figure the P-wave, QRS complex, and the T wave are marked with a blue pen and the additional X wave is marked with a red pen, this wave wasn't meant to be recorded and occurred due to a malfunction of the ECG device during recording.

Fill in the results from Table 1 in the space below.

Amin

Component	Mean Amplitude (millivolts)	Mean Duration (seconds)
P wave	**0.061**	**0.073**
QRS complex	**0.2375**	**0.126**
T wave	**0.0825**	**0.039**

Mahdi

Component	Mean Amplitude (millivolts)	Mean Duration (seconds)
P wave	**0.068**	**0.069**
QRS complex	**0.254**	**0.119**
T wave	**0.078**	**0.046**

Show the calculation for heart rate in the space below:

$$\text{Heart rate (beats / minute)} = \frac{60}{\text{time interval (seconds)}}$$

These calculations are for table 2 :

Amin : pair 1 : $\frac{60}{0.98} = 61.22$

pair 2 : $\frac{60}{0.82} = 73.17$

pair 3 : $\frac{60}{0.90} = 66.66$

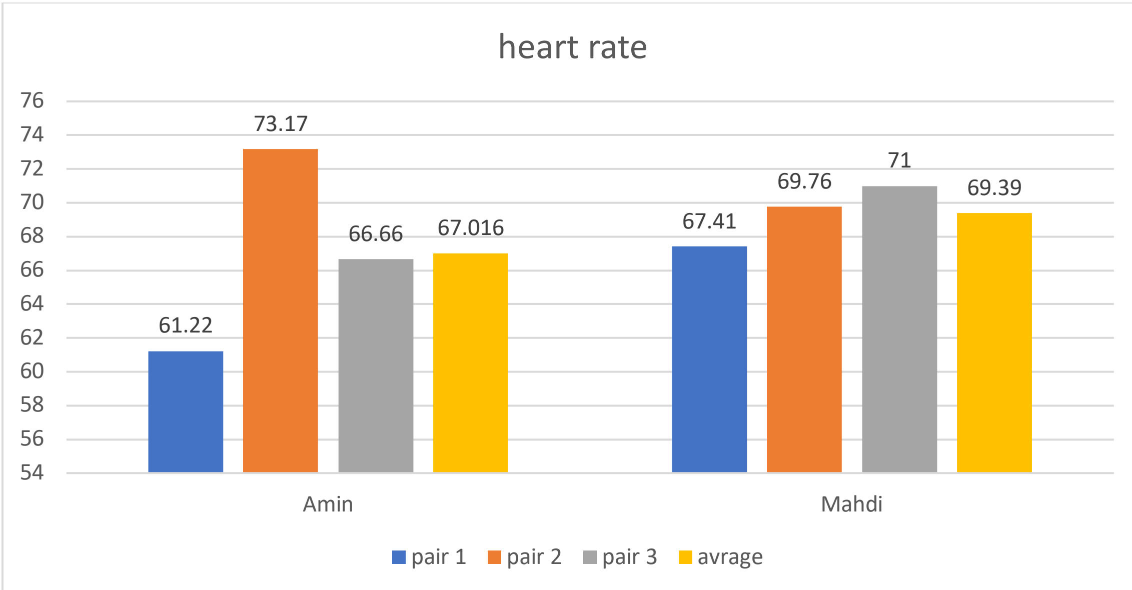
Mahdi : pair 1 : $\frac{60}{0.89} = 67.41$

pair 2 : $\frac{60}{0.86} = 69.76$

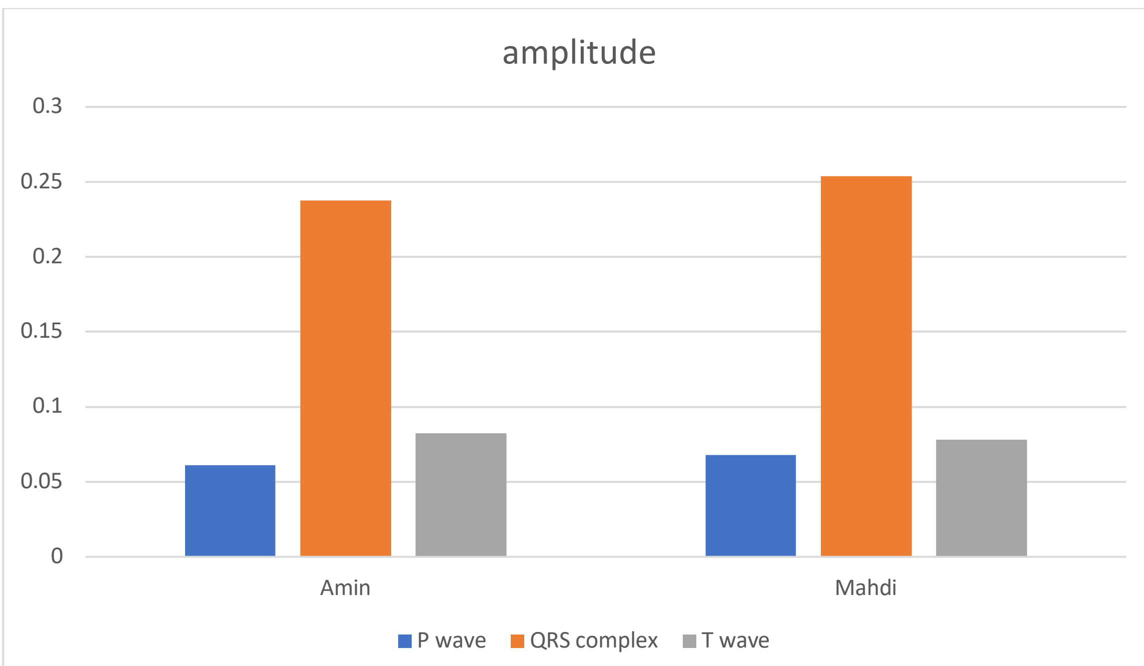
pair 3 : $\frac{60}{0.845} = 71$

Exercise 2: ECG for a range of volunteers

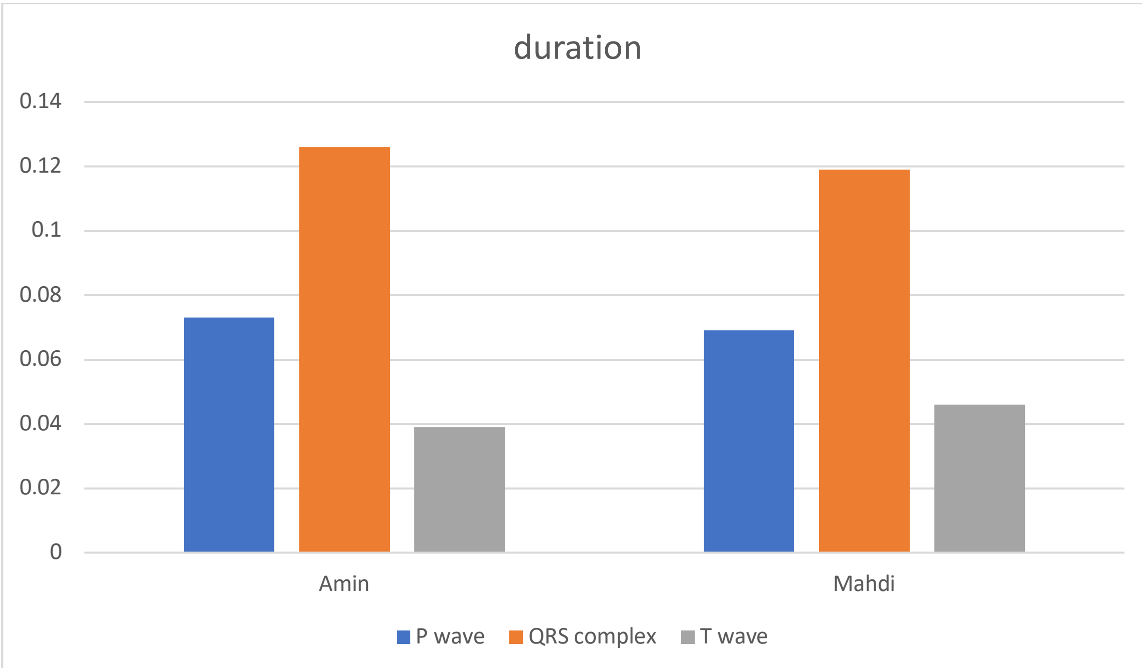
Draw a column graph in the space below showing the average heart rate for the entire class:



Draw a column graph showing the average amplitudes of the P wave, QRS complex, and T wave for the class.

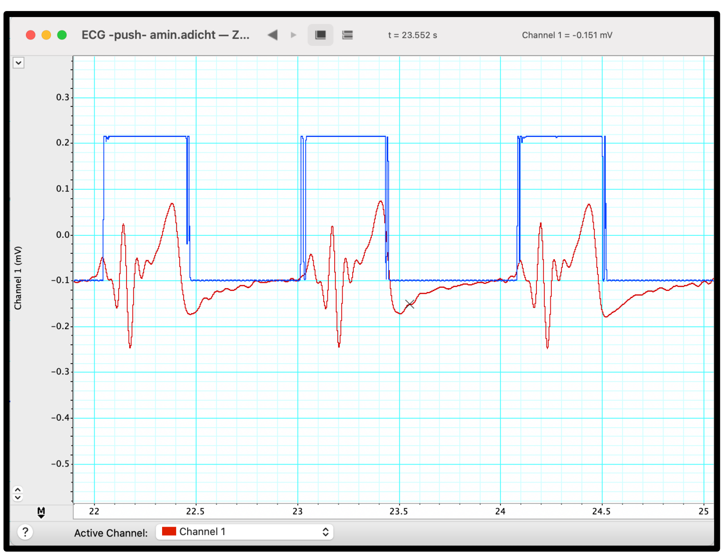


Draw a column graph showing the average duration of the P wave, QRS complex, and T wave for the class.



Exercise 3: ECG and heart sounds

Attach a copy of the Zoom window in the space below showing the ECG and heart sounds trace. Indicate on the figure where the "lub" and "dup" sounds were heard.



Conclusions:

1. Describe the events that are occurring in the heart during the following times:

a. P wave: During the P wave the atria are depolarizing, which triggers atrial contraction. This prepares the heart for ventricular contraction and subsequent blood ejection.

b. QRS complex: During the QRS complex the ventricles are depolarizing, leading to ventricular contraction. This results in the ejection of blood from the ventricles into the pulmonary artery and aorta.

c. T wave: During the T wave the ventricles are repolarizing, which allows them to relax and prepare for the next cardiac cycle. This phase signifies the beginning of ventricular diastole, the relaxation phase of the cardiac cycle.

2. Did the amplitudes of the ECG waves vary greatly between individuals in your class?

No, there was a slight difference in the amplitudes of the ECG waves.

3. Did the duration of the ECG wave vary greatly between individuals in your class?

No, there was some differences but it wasn't major.

4. Did heart rate vary between members of your class? Did sex appear to relate to heart rate?

Yes, it was different for each person but for the next part of the question because there were only male volunteers we can't tell if there is a major difference or not but as shown in the internet generally, at rest, women tend to have slightly higher heart rates than men. This difference is mainly attributed to physiological factors such as body size, hormonal influences, and differences in heart size and function

5. Explain why the QRS complex appears before the "lub" sound.

The QRS complex appears before the "lub" sound of the heart because the QRS complex represents the depolarization of the ventricles, which triggers ventricular contraction. The "lub" sound, also known as the first heart sound, occurs at the beginning of systole when the atrioventricular (AV) valves close due to ventricular pressure exceeding atrial pressure. So, the electrical activity represented by the QRS complex precedes the mechanical event of ventricular contraction and the associated closure of the AV valves, which produces the "lub" sound.

6. Explain why the "dup" sound occurs after the T wave.

The "dub" sound of the heart, also known as the second heart sound, occurs after the T wave because it corresponds to the closure of the semilunar valves (aortic and pulmonary valves). During the T wave, the ventricles are repolarizing and beginning to relax, leading to ventricular diastole. As the ventricles relax, their pressure decreases, causing the blood in the aorta and pulmonary artery to briefly flow back toward the heart. This reversal of blood flow closes the semilunar valves, producing the "dub" sound.

7. Explain why there may be errors in the timing of your heart sounds.

Errors in the timing of heart sounds can occur due to various factors:

1. **Physiological Variability:** Heart sounds can vary slightly between individuals due to differences in heart rate, cardiac output, and anatomy.
2. **Positioning:** Body position can affect the timing and intensity of heart sounds.
3. **External Factors:** Background noise, equipment malfunction, or poor recording quality can introduce errors in the interpretation of heart sounds.
4. **Interpretation:** Interpreting heart sounds is subjective and requires skill and experience. Different clinicians may interpret sounds slightly differently.

Extra:

In the ECG signal, we recorded a different amplitude in R signal and the differences look like a sinus signal, we searched the web looking for answer to this and concluded them as shown in below:

If you're observing variations in the amplitude of the R wave in an electrocardiogram (ECG) signal that resemble a sinusoidal pattern, there are several potential factors to consider and analyze:

1. Respiratory Sinus Arrhythmia (RSA): RSA is a normal variation in heart rate that occurs with breathing. During inhalation, heart rate typically increases, while during exhalation, heart rate decreases. This variation in heart rate can sometimes manifest as subtle changes in the amplitude of the R wave, resulting in a sinusoidal pattern superimposed on the ECG signal.

2. Vagal Tone: The activity of the vagus nerve, which is part of the parasympathetic nervous system, can influence heart rate variability and lead to sinusoidal-like fluctuations in the amplitude of the R wave. Higher vagal tone tends to increase heart rate variability, while lower vagal tone can result in more regular heart rate patterns.

3. Artifact: Check for any potential sources of artifact in the ECG signal, such as patient movement, electrode placement issues, or electrical interference. Artifacts can distort the ECG waveform and create false patterns in the signal.

4. Arrhythmias: Certain arrhythmias, such as sinus arrhythmia or atrial fibrillation, can cause irregularities in the R wave amplitude. However, these irregularities may not necessarily manifest as a sinusoidal pattern and would likely be accompanied by other characteristic changes in the ECG signal.

To analyze the sinusoidal-like pattern in the R wave amplitude:

• Ensure proper signal acquisition and electrode placement to minimize artifacts.

• Evaluate the timing of the variations relative to the respiratory cycle. If the pattern correlates with breathing, it may be indicative of RSA.

- Consider the overall clinical context, including the patient's medical history and symptoms, to assess the significance of the observed pattern.

- Consult with a medical professional or cardiologist for further interpretation and evaluation, especially if there are concerns about potential cardiac abnormalities.