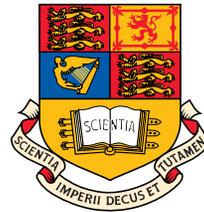# ICASSP Tutorial
iAmp in the Classroom

Danilo Mandic

room 813, ext: 46271

Department of Electrical and Electronic Engineering

Imperial College London, UK

d.mandic@imperial.ac.uk,   URL: www.commsp.ee.ic.ac.uk/∼mandic

Imperial College London

ICASSP 2016 1

Part X: iAmp in the Classroom

Imperial College
London

Coursework based on students' own data

Experiment summary: Students recorded their ECG under varying respiration patterns: (1) unconstrained breathing; (2) controlled breathing at a fast pace (50 breaths/min) and slow pace (15 breaths/min).
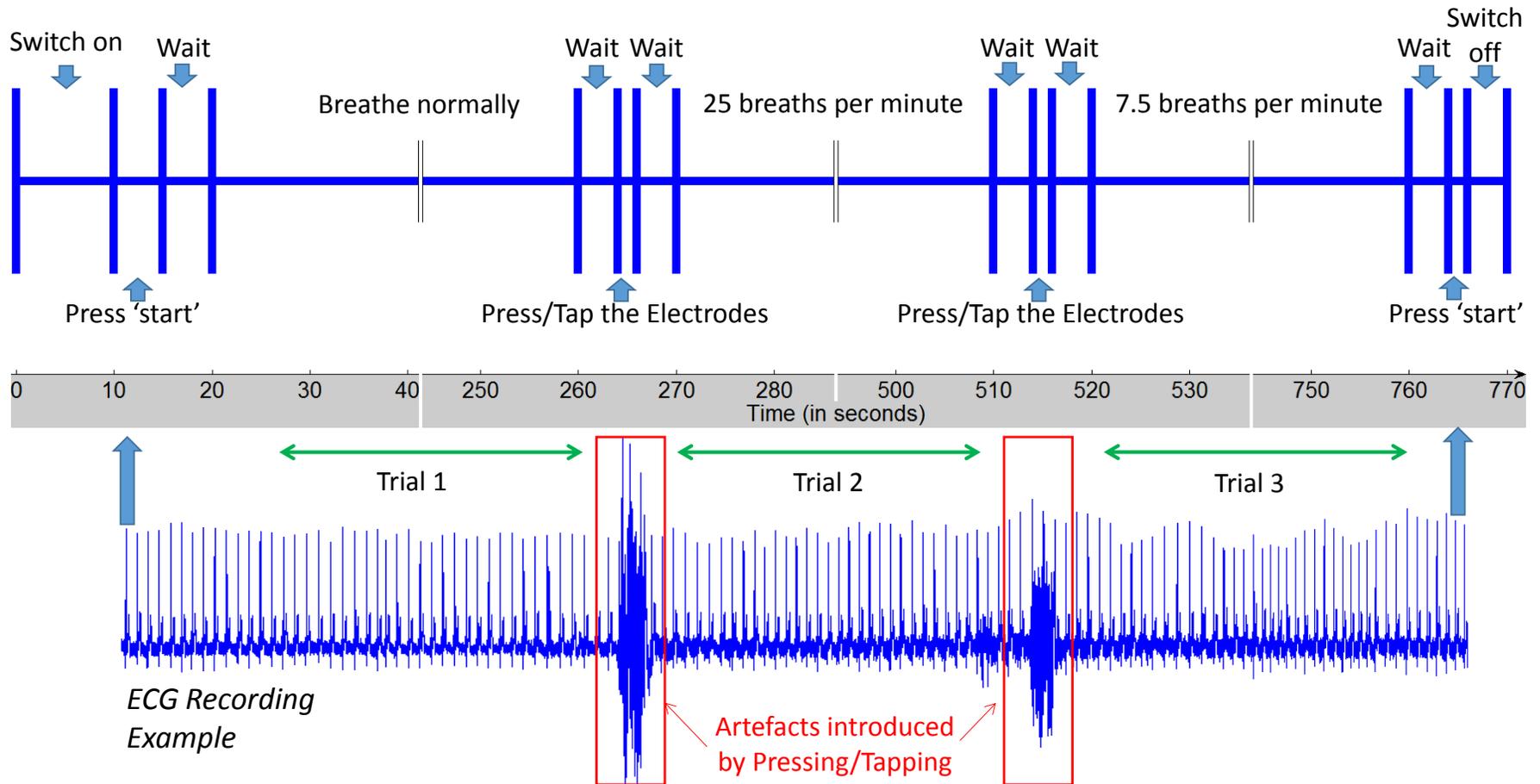
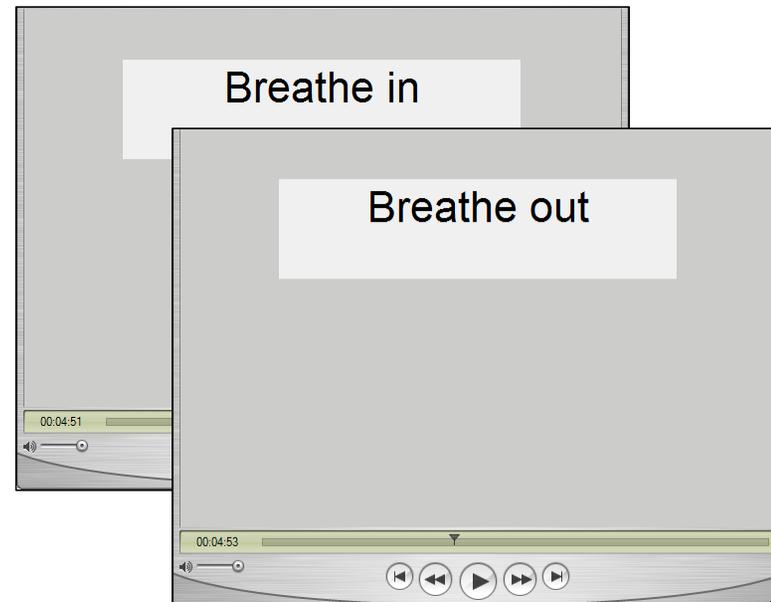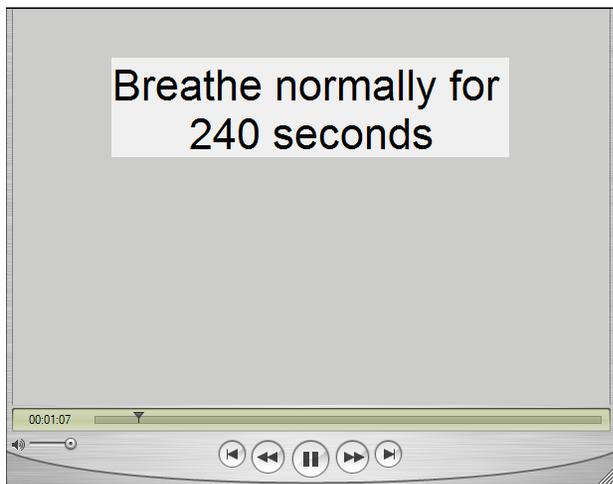Students were provided with easy to follow on-screen instructions.
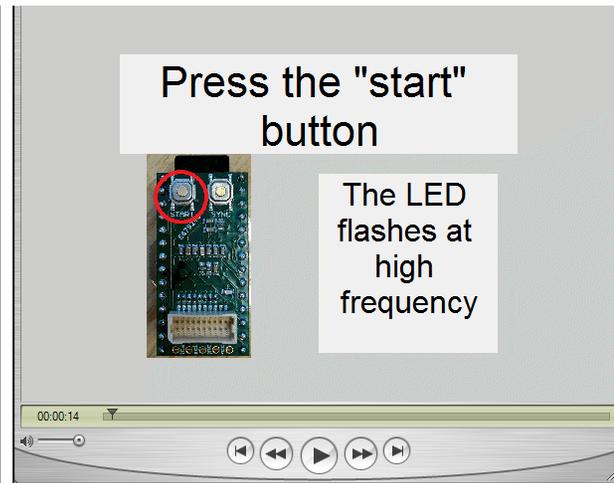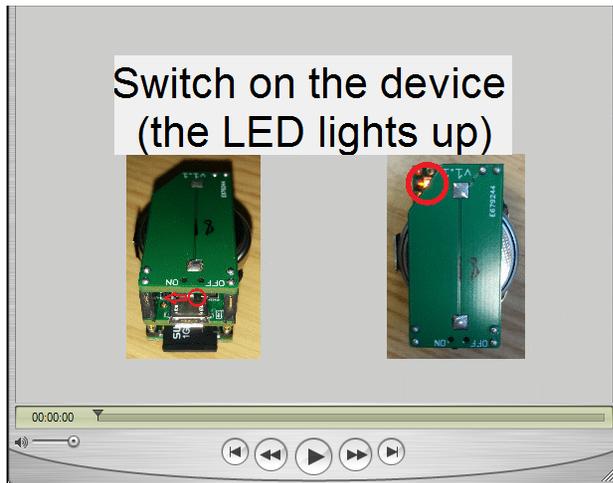

Student placing electrodes on a team-mate.

ECG recording instruction

Instruction Manual

ECG Recording Example

Artefacts introduced by Pressing/Tapping

Keeping the respiratory rhythm: Instructions

Switch on the device (the LED lights up)

00:00:00

Press the "start" button

The LED flashes at high frequency

00:00:14

Breathe normally for 240 seconds

00:01:07

Breathe in

Breathe out

00:04:51

00:04:53

Probability density estimates of heart rate

Coursework question

Adopted from Steven Kay's Statistical Signal Processing questions

$\rightarrow$ **Question:** Using the RRI signal $rr[n]$ from Trial 1 (unconstrained breathing), obtain the heart rate $h[n]$ in beats per minute.

To obtain a smoother estimate of the heart rate, use the following method to average every 10 samples of the heart rate:
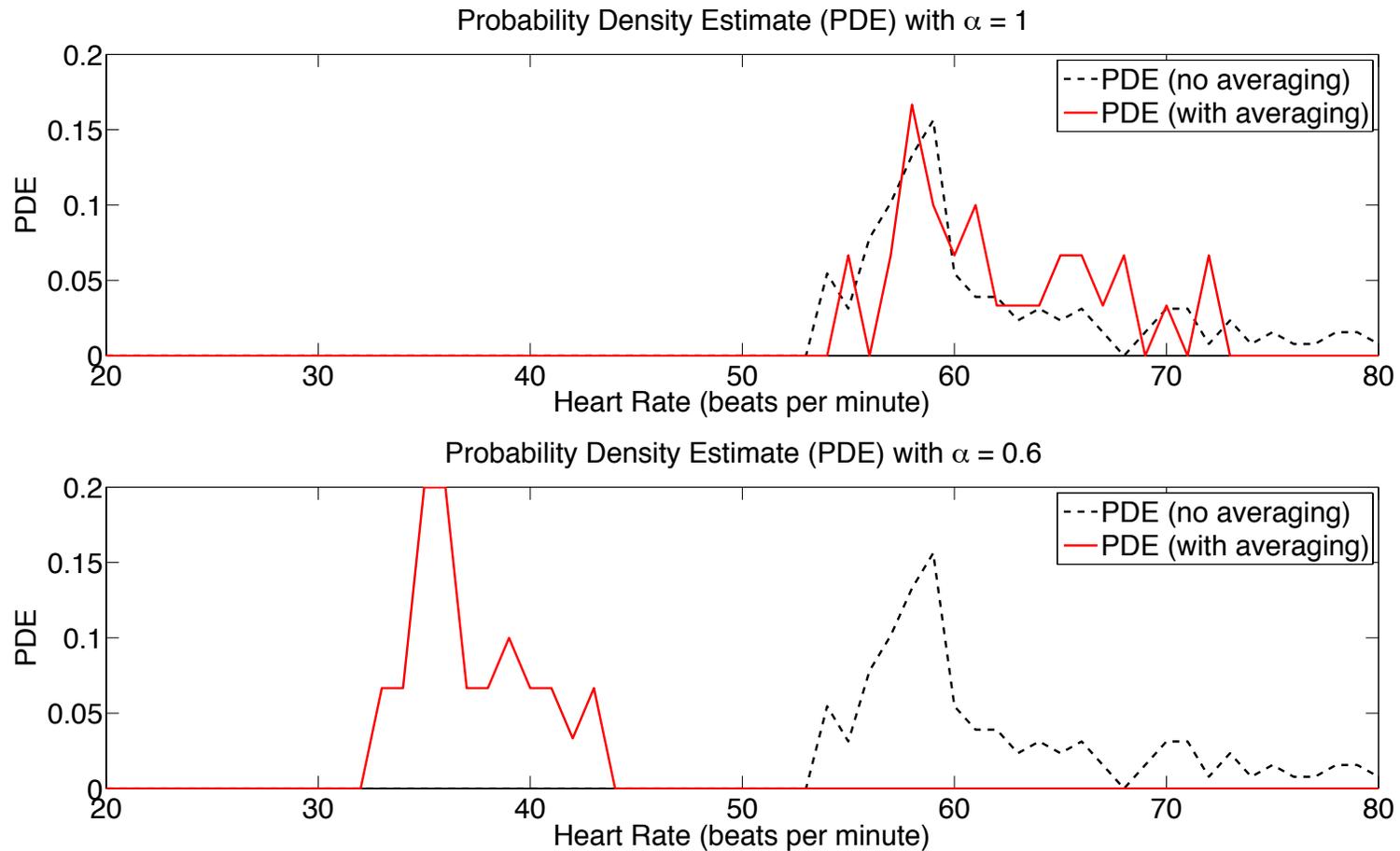
$$\widehat{h}[1] = \frac{1}{10} \sum_{i=1}^{10} \alpha h[i], \quad \widehat{h}[2] = \frac{1}{10} \sum_{i=11}^{20} \alpha h[i], \quad \ldots$$

where α is a scalar.

a) Plot the probability density estimate (PDE) of the original heart rates, $h[n]$, and the averaged heart rates, $\widehat{h}[n]$, for $\alpha = 1$ and $\alpha = 0.6$.

Probability density estimates of heart rate

Excerpt from a student's solution

RSA from the power spectral density

Coursework question

Respiratory sinus arrhythmia (RSA) is the modulation of cardiac function by respiratory effort. This can be readily observed by the speeding up of heart rate during inspiration ("breathing in") and the slowing down of heart rate during expiration ("breathing out").

a) Apply the **standard periodogram** as well as the averaged periodogram with different window lengths (e.g. 100 s, 200 s) to obtain the power spectral density of the RRI data. Plot the PSD of the RRI data obtained from the three trials separately.

b) Explain the difference between the PSD estimates of the RRI data from the three trials? **Identify the the peaks** in the power spectrum corresponding to frequencies of respiration (and their harmonics) for the three experiments.

RSA from power spectral density

Excerpt from a student's solution
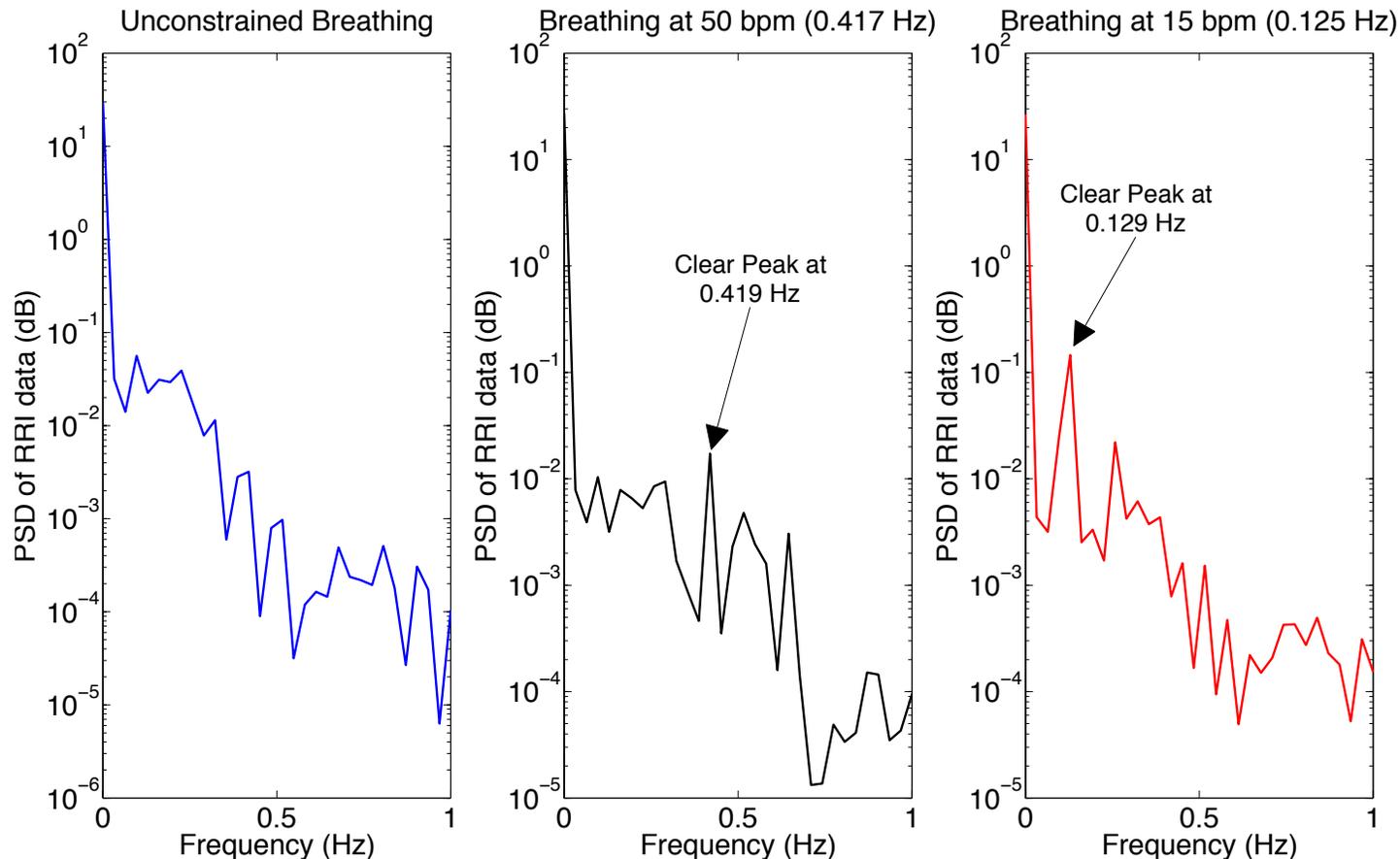
Feedback from student: *Having a coursework which included real world signals like the ECG, voice and sound files made the course so much more tangible and enjoyable.*