SIGNAL & DATA ANALYTICS IN IoMT
Tech-in-Med Summer Camp
PREMANANDA INDIC, PH.D.
DEPARTMENT OF ELECTRICAL ENGINEERING

MATLAB Access for Everyone at

University of Texas at Tyler

MATLAB

Workspace

Text Editor

Command window
OUTLINE

1. Different physiological signals
2. Features of the signals associated with health
3. Differentiating signals and data
4. Development of algorithms
5. Processing of signals
6. Data analytics
7. Converting algorithms into software code
8. Embedding the code in the sensors.
EXAMPLE 1

Identify the type of physiological signal?

Example 2

➢ Identify the type and characteristics of the signals?
EXAMPLE 3

➢ More Physiological Signals

- Respiratory Muscles
  - Nasal Airway Pressure
  - Abdomen
    - Max Air Pressure (0.501 atm)
  - Chest Wall
    - ABC (0.599 atm)
- Blood-Oxygen Saturation
- Heart Rate
TYPES OF BIOMEDICAL DATA

➢ PHYSIOLOGICAL OR BEHAVIOURAL SIGNALS

➢ IMAGES

➢ GENOMES
TYPES OF BIOMEDICAL DATA

➢ PHYSIOLOGICAL OR BEHAVIOURAL SIGNALS

➢ IMAGES

➢ GENOMES
SYSTEM vs. SIGNALS

- DETERMINISTIC vs. STOCHASTIC
- STATIONARY vs. NONSTATIONARY
- TIME INVARIANT vs. TIME VARYING
- LINEAR vs. NONLINEAR

System

Input ➔ System ➔ Output = Signal
Exercise 1

The input – output relationship of a system can be represented by an equation of a straight line as

\[ output = m \times input + C \]

where \( m \) is the slope and \( C \) is the intercept. Is the given system linear?
Exercise 2

Plot in MATLAB the input – output relationship of a system can be represented by an equation of a straight line as

\[ \text{output} = m \times \text{input} + C \]

where \( m \) is the slope and \( C \) is the intercept, with \( m = 0.5 \) and \( C = 10 \). Consider input from a random number generator. Is the given system deterministic or stochastic?
REGULAR vs. NORMAL

➢ Which of the given signal is regular?

➢ Which of the given signal is normal?

(A) [Heart Rate graph]

(B) [Heart Rate graph]
REGULAR vs. NORMAL

➢ Which of the given signal is regular?

➢ Which of the given signal is normal?

(A) [Graph of EEG]

(B) [Graph of EEG]
REGULAR vs. NORMAL

➢ Which of the given signal is regular?

➢ Which of the given signal is normal?

(A) [Image of signal]

(B) [Image of signal]

Respiration
HYPOTHESIS

Scientific hypothesis, an idea that proposes a tentative explanation about a phenomenon or a narrow set of phenomena observed in the natural world. The two primary features of a scientific hypothesis are falsifiability and testability.

Source: https://www.britannica.com/science/scientific-hypothesis
Exercise 3: Hypothesis Testing

Given the preterm infant database (Preterm_Infants.xlsx), generate some hypothesis and test the hypothesis by writing codes in MATLAB.
Discretization of Signals

Identify the features of the given signal $y(t) = Asin(2\pi ft)$, and explain how you will discretize the signal?
Exercise 4: Discretization of Signals

Generate the discrete version of \( y(t) = A \sin(2\pi f t) \), with \( A = 1 \) \( f = 60 \text{Hz} \) and use different sampling frequencies starting from \( f_s = 10 \text{Hz} \) with an increment of 10Hz. At what sampling frequency you can detect the frequency of the original analog signal of 60 Hz.
Exercise 5: Discretization of Signals

Generate the discrete version of \( y(t) = A_1 \sin(2\pi f_1 t) + A_2 \sin(2\pi f_2 t) \), with \( A_1 = 1 \) and \( A_2 = 0.5 \), \( f_1 = 7 \)Hz and \( f_2 = 22 \)Hz. Choose an appropriate sampling frequency.
Exercise 6: Is the given signal stationary?

Check whether the given signal in testEEG.txt is stationary?