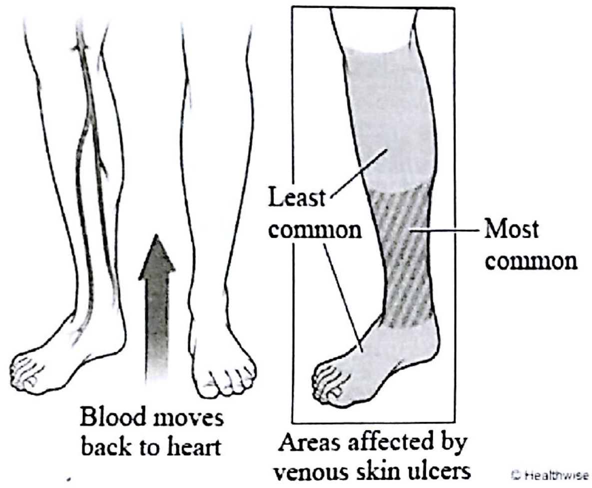
Course "Intelligent Systems"

PROJECT

A.Y. 2015/2016

The project requires the analysis of a set of medical data. The application context is dermatology and, in particular, the compression therapy by means of bandages in the treatment of venous ulcers of the leg.



In dermatology, venous ulcers are very frequent lesions of the skin of the legs, due to compromised functioning of the blood circulation. To repair these ulcers, the blood circulation must be enhanced by exploiting the calf muscle pump which allows the blood to be moved back to the heart. The basic way to re-establish the blood circulation is the compression therapy.

In the compression therapy, the doctor applies a compression bandage on the leg of the patient providing a given pressure on the ulcer area. The pressure applied by the bandage allows to repair the ulcer, typically, in a few months.

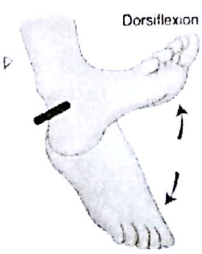
The pressure applied by the bandage, and thus the efficiency of the therapy, depends on several factors:

- the type of bandage (depending, e.g., on the elasticity);
- the correct application of the bandage: an appropriate pressure should be applied in several parts of the leg according to the position of the ulcer, and the pressure should remain constant as much as possible between bandage applications;
- the activities performed by the patient during the therapy (e.g., walking, standing, etc.).

Data description: The data refer to 10 volunteers. A compression bandage was applied to their calf. Three sensors were applied in three different positions to measure sub-bandage pressure. Each volunteer wears the bandage for 12 minutes. During this time, the volunteer performs different activities or maintains different positions. Each activity/position is performed/maintained for about 3 minutes. The sensors measure the pressure with a sampling time of about 82 ms. The positions/activities taken into account are the following:

FACCIO SELEZIONE DELLE FEATURES CHE HO SCELTO PER ESPRIMERE IL SEGNALE

- supine position
- dorsiflexion standing
- walking
- stairs climbing



10 VOLONTARI

∀ VOLONTARIO 4 MISURAZIONI

∀ MISURAZIONE 3 SENSORI & TEMPO

∀ SENSORE ≃2000 VALORI

andamento simile tra sensori: normalizzo! (e per le attività)

metto insieme i segnali della stessa attività

4 classi (1 per ogni attività). Le features sono 2000 (i campioni)

mi servono 2000 per dire cammino/seduto? No, seleziono le features (es. 5 con segnatolfo) (es. la media)

Oppure uso sotto campioni (30 sec) posso usare anche indici statistici (varianza, etc) oppure fft.

The data are organized as follows. One folder for each volunteer is provided. In each folder there are 4 files, one for each position/activity performed. Each file contains the measurements of the three sensors (in the first three columns), and the corresponding sampling time (in the last column). Please, note that the sensor measurements are electrical resistances and are measured in Ohms.

Objective: The objective of the project is twofold (DOPPIO): on the one hand, you have to identify the position/activity of the volunteer by analyzing the pressure values of the bandage, i.e., to distinguish among supine position, dorsiflexion standing, walking and stairs climbing; on the other hand, you have to find out the least temporal interval that is necessary and sufficient to recognize the position/activity.

Project development: You have to solve the problem by developing a neural system, a Mamdani-type fuzzy inference system and a Sugeno-type fuzzy inference system. The input to each of these systems will be a sensor signal.

You have to use the *Neural Network Toolbox* and the *Fuzzy Logic Toolbox* of Matlab.

You can consider the sensor signals in the temporal domain or in the frequency domain, or both. Further, you can also consider the data coming from the three sensors as independent data sets to be appropriately integrated.

Of course, each signal has to be appropriately represented in terms of a reduced set of features. To this aim, you have to perform feature selection.

Descrivere scelte e metodi!

NEURAL SYSTEM: MAMDANI-TYPE / SUGENO-TYPE } FUZZY INFERENCE SYSTEM

NEURAL NETWORK nntool
FUZZY LOGIC fuzzy
nnstart

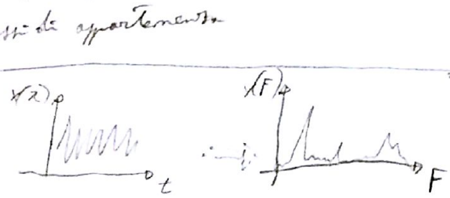
xlsread (un file)

sugFIS = mam2sug(mamFIS)

per ogni gruppo prendo il valore min e max (l'intervallo lo uso come regola nel toolbox)
definisco delle classi di appartenenza

Regole del tipo: If (Sens1 is low) & (Sens2 is medium) then (supine)

fft(x)
dati



prova tutti $f_1 f_2 f_3 f_4$ ... finché il max n° di features è raggiunto [max]
$[f_1, ?$

f_1 ... f_{10} N: 10 → n: 5

(Y)
altra parte del progetto feature selection N → n, n << N
input output

[..., history] = sequentialfs(@fun, x, t, 'cv', 'none', 'opt', options, 'nfeatures', max)
options: statset('display', 'iter')

... = fun(x, t)