Politecnico di Milano
Scuola di Ingegneria Industriale e dell'Informazione
Applied Statistics
July 7th, 2023

Problem n.2

You are asked to apply your statistical knowledge to support a Gesture Recognition tool. In file `acceleration.txt` you are provided with a sequence of 70 acceleration measurements of recorded gestures of a human hand movements. The goal is to recognize the specific gestures of "*Swipe*", "*Tap*", and "*Circle*". You are given the following general information:

- *Tap*s typically involve a brief and sudden contact with the phone's screen. The acceleration values are typically short-lived and characterized by a relatively quick increase and decrease in acceleration. The magnitude of acceleration for a *Tap* gesture may be relatively low compared to other gestures. The acceleration values for taps are generally in the range of 1 to 3 m/s^2, distributed according to a Gaussian $N(\mu_T, \sigma_T^2)$;
- *Swipe*s involve a continuous movement of the finger or thumb across the phone's screen. The acceleration values can vary depending on the speed and distance covered during the swipe but, in general, are higher compared to taps due to the continuous motion involved. They typically range from 1 to 10 m/s^2, distributed according to a Gaussian $N(\mu_S, \sigma_S^2)$;
- *Circle*s involve a circular motion or rotation of the finger or thumb on the screen. The acceleration values can vary depending on the circle's radius, the rotation speed, and the applied force. They are generally in the 1 to 5 m/s^2 range, distributed according to a Gaussian $N(\mu_C, \sigma_C^2)$;.

a) Considering a Hidden Markov Model, whose hidden states are the gestures: compute μ_T, μ_S, μ_C, σ_T, σ_S and σ_C, paying attention to correctly assigning the obtained results to each gesture, given the above-listed information.

   Remark: Write `set.seed(3)` before **each** function call.

b) Compute the Transition Matrix;

c) What is the most probable path of hidden states of recorded gestures that generated the sequence of measured accelerations? How do you estimate it?

d) Given the Transition Matrix computed at point b), define a Markov Chain (`markovchain` object) naming the states as done in point a) and provide a graphical representation of the `markovchain`.

   Remark: Recall that rows of a transition matrix should sum to 1. If this doesn't happen from the transition matrix `trans_matr` obtained in b), do scale your probabilities through the command `trans_matr / rowSums(trans_matr)`.

e) Identify:

   1. The long-term probability that the system will be in each state (i.e., the steady states),
   2. The recurrent states and
   3. The transient states.
   4. Are there any absorbing states?

Upload your solution here