Principles of Biological Vision

CS7420 : Programming Assignment 1

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PROBLEM STATEMENT

This programming assignment is the first exercise with Bayesian Networks. You can use any programming language. You need not code belief revision algorithms, but can use any available library, e.g. dlib (available for C++ and Python), or Netica-J (available for Java), for implementing Bayesian Network.

This problem pertains to parameter estimation. In module 04-02, we have seen how Bayesian Reasoning leads to bias in perceptual grouping. Take the case of horizontal versus vertical grouping by proximity, when the cells are equidistant in both directions. Let us denote the unknown probability for perceiving the grouping to be horizontal by θ, when (1- θ) represents the probability of perceiving the grouping as vertical. Assume uniform distribution for θ as prior. Data shows that 17 out of 27 students perceive the organization to be horizontal.

Model the problem with Bayesian Network.

You are required to compute

1. the posterior probability distribution for θ

2. estimated value of θ

APPROACH

1. 100 theta values following Uniform Distribution are taken from formula : np.random.uniform(0,1,100)
2. 17 students perceived the block arrangements as horizontal layout and 10 perceived as vertical layout. So, these appended in a list along with their likelihood values generated randomly i.e Prob(student perceiving horizontal/ theta) and Prob(student perceiving horizontal/ not theta).
3. The prior beliefs for each student is calculated as shown in the edpuzzle 3.06A.

   H = student perceiving horizontal

   T = theta, -T = not theta, -H = Vertical

P(H) = P(H|T)*P(T) + P(H|-T)*P(-T)

P(-H) = P(-H|T)*P(T) + P(-H|-T)*P(-T)

4. Updation of Theta :

   Followed same approach as shown in Edpuzzle

   P(T|H) = P(H|T)*P(T)/P(H)=1

   P(-T|H) = P(H|-T)*P(-T)/P(H)=1

   P(T|-H) = P(-H|T)*P(T)/P(-H)=1

   P(-T|-H) = P(-H|-T)*P(-T)/P(-H)=1

5. After updating the theta's, all the remaining visited student's beliefs are updated using the formula mentioned in point 3, all these updated beliefs are also considered
6. So there are in total 3 functions

   6.1. Compute : Calculating new theta and beliefs

   6.2. Update: Updating beliefs of other students

   6.3. Pdf : Calculating PDF

7. Also, ODDs value is printed to monitor the hypothesis.
8. For every value of theta, estimation of new theta is done.

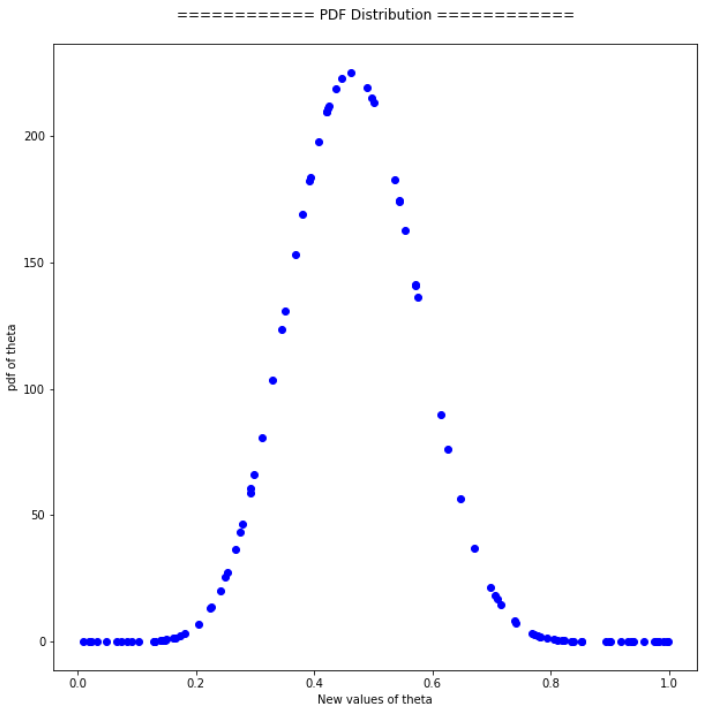
LOGISTICS

1. Programming Language : Python
2. Libraries Used: numpy, matplotlib, random

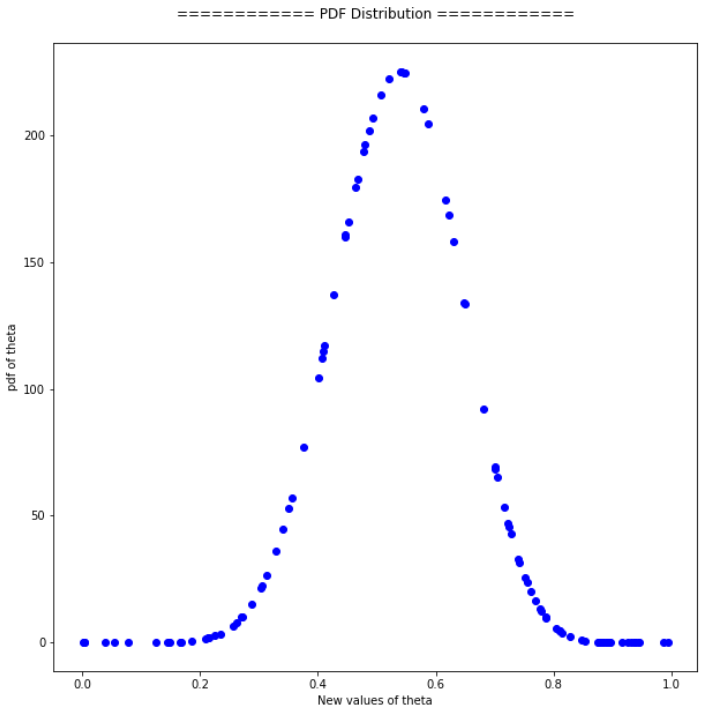
INSTALLATION/PROGRAMMING MANUAL

1. Google Colab/Kaggle (No additional Package is required to be installed)

RESULTS

PARAMETER (Uniform Distribution)	OUTPUT
Posteriori Distribution Mean	63.9493
Posteriori Distribution Standard Deviation	78.9893
PDF Graph	

PARAMETER (Normal Distribution)	OUTPUT
Posteriori Distribution Mean	49.9223

Posteriori Distribution Standard Deviation	70.4396
PDF Graph	

Sample Output(Uniform Distribution):

==========For theta 0.69350338691591==========

Updated Other students beliefs as a result of previous decisions:

Format => belief P(H|theta) P(H|not theta)

['h', 0.7734, 0.4571394576160082]

Theta 42:0.6935

pdf(theta):

44.46844426330692

Expected Theta:

0.3793103448275862

New Theta:

[0.8509571647168295]

Odds : 5.7094805201476

Updated Beliefs:

Prob of horizonal Allignment || Prob of Vertical Allignment

[[0.70697437 0.29302563]

 [0.27210578 0.72789422]

 [0.36290399 0.63709601]

 [0.48768537 0.51231463]

 [0.76842794 0.23157206]

 [0.46358398 0.53641602]

 [0.62368661 0.37631339]

 [0.57553464 0.42446536]

 [0.29137146 0.70862854]

 [0.3959542 0.6040458]

 [0.51361714 0.48638286]

 [0.57713224 0.42286776]

 [0.7948165 0.2051835]

 [0.43425799 0.56574201]

 [0.63225775 0.36774225]

 [0.77375831 0.22624169]

 [0.25187278 0.74812722]

 [0.59982455 0.40017545]

 [0.63608645 0.36391355]

 [0.25079091 0.74920909]

 [0.68608832 0.31391168]

 [0.60666963 0.39333037]

 [0.51592348 0.48407652]

 [0.42219299 0.57780701]

 [0.79099031 0.20900969]

 [0.55272144 0.44727856]