

Biological Vision Assignment 1: Bayesian Network

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Report

The Link to the code: [Colab Link 1](#) OR [Colab Link 2](#)

1. Approach to the problem:

The problem needs to be framed as evidential or abductive reasoning using Bayesian Network. Here, we have an unknown probability for perceiving the grouping to be horizontal by θ , when $(1-\theta)$ represents the probability of perceiving the grouping as vertical. We are given the data that 27 trails have been conducted and in 17 students among them reported the perceiving of grouping to be horizontal.

I have taken a fixed value 0.5 as the conditional probability ($P(h|\theta)$) since the prior is chosen as uniform. This tells us 50% students are assumed to perceive horizontal alignment initially before we do any experiment. Now we need to instantiate each evidence as horizontal or vertical and calculate the posterior probability $P(\theta|h)$ in 27 iterations. Ten Priors are chosen as 0.05, 0.15, 0.25 from 0 to 1.

After the 27 trails for a specific prior value is conducted, the mean of the 27 trail results are calculated. This will give us the estimated value of θ .

2 . The programming language and libraries used

I have used python with the following libraries:

```
import numpy as np
import random
from matplotlib import pyplot as plt
from statistics import mean
```

I have not used any external library for calculating Bayesian inference.

Results:

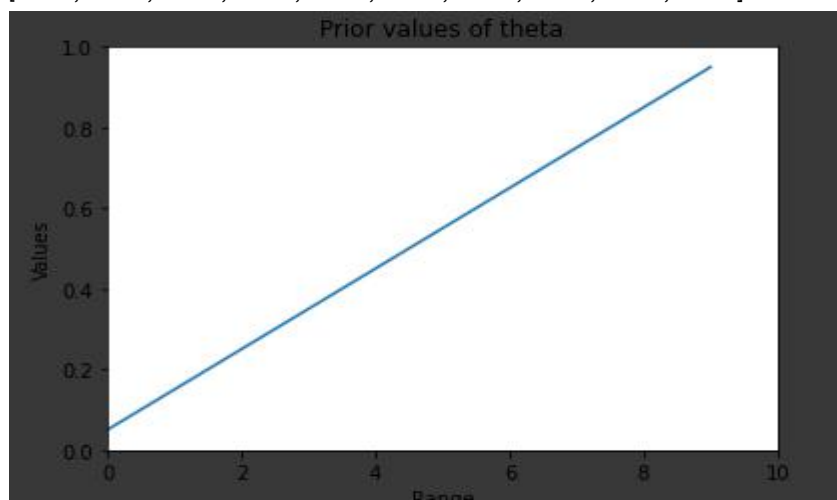
1. Created 10 intervals between 0-1 with step 0.1

[0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]

2. Prior values are taken as centre of these intervals. So we get 10 assumed priors.

Where 0.05 is weak prior and 0.95 is strong prior for perceiving horizontal.

[0.05, 0.15, 0.25, 0.35, 0.45, 0.55, 0.65, 0.75, 0.85, 0.95]



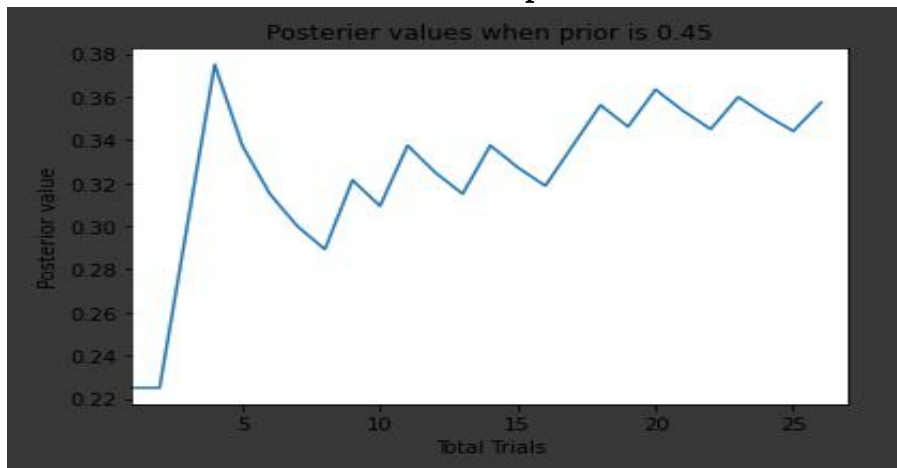
3. Now 27 trails have been chosen se below . Perception of Horizontal and Vertical is chosen as 1 and 0 respectively.

[1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 1, 0]

4. Now we have iterated 27 times for each of the above priors.

5. We have some the results of each trail after the students are reporting either horizontal or vertical. The graph of the change in posterior value after each trail is shown below.

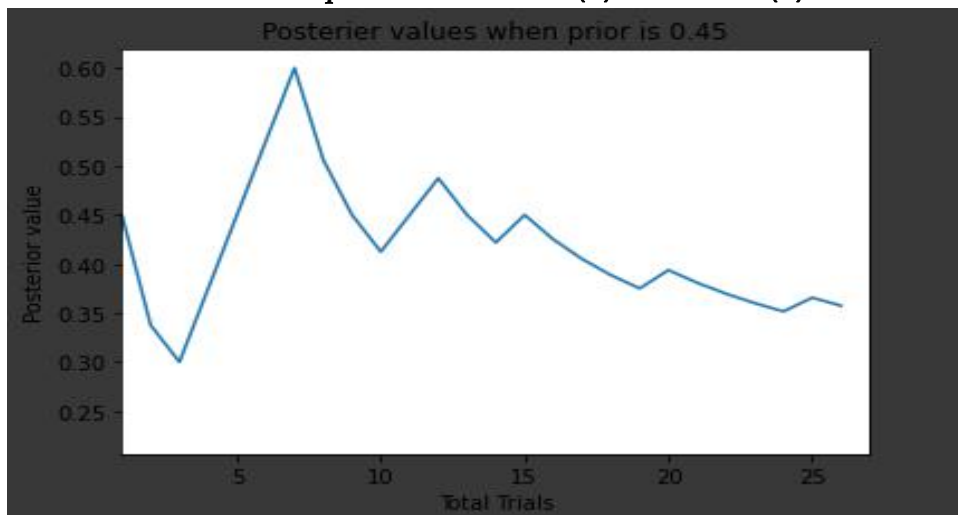
Posterior value when prior is 0.45



We get a sudden jump initially as the students are reporting horizontal perception initially but as more students are reporting vertical, the graph seems to go for a convergence. This was expected for this experiment.

6. Depending on the different sequence of students perceiving horizontal/ vertical, the graph is changing. But the final converging value seems to be same as expected.

Same Prior = 0.45 but different sequence of horizontal(1) and vertical(0) trail results



7. Finally we calculated the expected value of posterior and the results are as follows and I have shown the prior value and the estimated value of theta for comparison.

```
Prior theta: 0.05 and estimated theta : 0.036
Prior theta: 0.15 and estimated theta : 0.107
Prior theta: 0.25 and estimated theta : 0.179
Prior theta: 0.35 and estimated theta : 0.251
Prior theta: 0.45 and estimated theta : 0.322
Prior theta: 0.55 and estimated theta : 0.394
Prior theta: 0.65 and estimated theta : 0.465
Prior theta: 0.75 and estimated theta : 0.537
Prior theta: 0.85 and estimated theta : 0.609
Prior theta: 0.95 and estimated theta : 0.68
```

a) What are the nodes in the network? What variables do they represent?

There are 3 **main nodes** -

1. Prior $P(\Theta)$,
2. Student reporting horizontal $P(h|\Theta)$
3. Posterior $P(\Theta|h)$ - instantiated 27 nodes for each students which are independent to each other but causally connected to $P(h|\Theta)$.

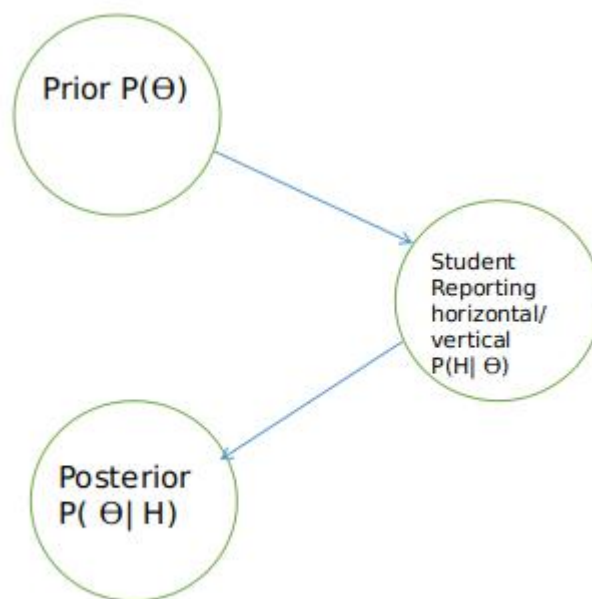
b) What are the different states of the variables?

Let $h = \{H, V\}$

1. Student reporting horizontal or vertical $[P(h=H|\Theta) \text{ or } P(h=V|\Theta)]$
2. Posterior $P(\Theta|h=\text{Horizontal})$ or $P(\Theta|h=\text{Vertical})$

c) What is the connectivity in the network?

The connectivity has been shown here.



d) Which pairs of nodes are conditionally independent?

The 27 trials nodes, which are instantiated at a time, are independent to each other.

e) What are the network parameters, i.e. prior/conditional probabilities for the network nodes?

The network parameters are prior Θ and condition probability $P(h|\Theta)$.