Mind, Brain, and Models 2022/23

CNCR

Multi-Sensory Integration

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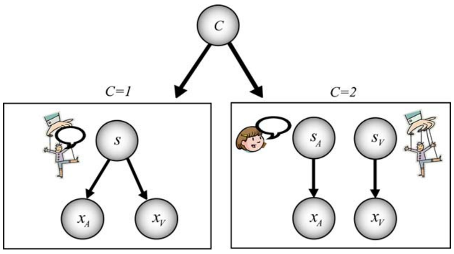
In this lab, you will simulate a situation inducing spatial ventriloquism: the capture of perceived auditory location by a co-occurring visual stimulus. The first part of the coding assignment is equivalent to what was done in lab 2 with grid sampling, but it extends from 1D to 2D. You are asked to submit both the script and a short report with figures. The report will be graded. Please use the templates of lab 1 and lab 2.

Consider only the horizontal position, measured in degrees with 0 corresponding to the front ahead and negative values to the left. After the code heading of lab 1 and 2, define
`angles=-180:1:180;`
The likelihood functions can be obtained using `normpdf`.
(Remember that probability density functions are defined so that their area is 1, but because here the angle step is 1 and constant, it is sufficient to divide the value by the sum.)
The signals are generated by an auditory source at 30 degrees on the left and a visual source at 60 degrees also on the left. Likelihood functions are Gaussians centred at these values. The reliability of the estimates is double with vision (0.05) than with audio information (0.025). Recall that reliability is defined as the inverse of the variance.
1) *Plot the two likelihood functions and the posterior distribution in a graph.*
We make the assumption that the prior is flat, so it does not influence perception. In such a case, the posterior $P(X|r_i)$ is given by the Bayes rule, i.e., by multiplying the likelihoods (and the prior distributions) point by point, followed by normalisation.
2) Estimate the parameters of the posterior distribution and determine whether the value of its mean and reliability corresponds to what you can predict analytically from MLE.
Make the reliability of the auditory estimate equal to the one of the visual estimate and increase the discrepancy between the two sources to a very large value (audio -60 and visual 60).
3) Plot the likelihoods and the posterior and comment on the values obtained.

2D - Breakdown of integration



The second part of the lab involves bivariate distributions. The goal is to model a coupling prior to capture multisensory integration beyond mandatory fusion. We will use grid sampling with:

```
[angles_a,angles_v] = meshgrid(-180:1:180, -180:1:180);
```

4) Generate and display the prior used by Roach et al. (2007).
The following formula uses a Gaussian profile plus a constant w.

```
prior = w+exp( - 1/4 * (angles_a.^2 -
2*angles_a.*angles_v + angles_v.^2) /sigmaPrior^2) ;
```

Set `sigmaPrior=1` and `w=0.0001`.

Normalize the distribution (since step is 1, just divide by the sum of the values) and find a good way to display it. You could use something like:

```
surface(angles_a,angles_v,prior)
shading interp
colormap gray
axis equal tight
```

5) Comment on the report what happens when you change the values of sigma_p and w to the shape of the function.

6) Using the values specified in (1) and (2) of the previous sections, display a bivariate likelihood distribution

Use either the following formula

```
bivariateLikelihood=exp( - 1/2 *((angles_a-
directionAudio).^2/sigmaAudio^2  +(angles_v-
directionVision).^2/sigmaVision^2 )) ;
```

or `mvnpdf` (check the help section).

Calculate the posterior distribution for the two positions of the audio source.
7) Find a good way to display the two posteriors (once for the -60 +60 case, the other for the -30 -60 case). Remember to label the figure.
8) Compare the results with what you obtained in the 1D and the 2D cases and comment. Is the posterior similar to what you would expect? Try to relate the two results to the causal inference model.