

## 1 Chapter 1: Uncertainty and Inference

**Problem 1.10** *The images below show a hollow face mask, rotated progressively from a side view (left) to reveal the hollow back of the mask (right): The right image looks like a normal, convex face, when in reality it is the hollow (concave) side of the mask. This is called the hollow-face illusion or the hollow-mask illusion. Provide a Bayesian explanation for this illusion.*

A Bayesian explanation of the hollow-mask illusion is that perception is a process of Bayesian inference where it is modeled as a process of combining prior knowledge with likelihood.

We have the prior experience that faces are convex since nearly everything we see in daily life follow this structure. Thus, even when our sensory input suggest the opposite, our brain strongly tend to perceive the hollow-mask to be convex as well.

For likelihood, the visual system is also gathering sensory evidences from the mask, such as depth cues, shading, and different perspective (however those cues can be ambiguous).

$$P(Hypo | Obs) = \frac{P(Obs | Hypo)P(Hypo)}{P(Obs)}$$

$P(Hypo)$  = Prior probability (strong belief in convex faces);

$P(Obs | Hypo)$  = Likelihood of observing the thing given the belief.

Now, since  $P(Hypo) = \text{convex} > P(Hypo) = \text{concave}$ , even  $P(Obs | Hypo)$  is tending towards concavity, our posterior probability is still more clinging towards convexity.