

Lecture Notes Statistic for Astronomy

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1 Statistics basics

1.1 Cox's rules

The first rule states that the probability of something happening, let's call the event X , plus that of X not happening is one:

$$P(X) + P(\bar{X}) = 1 \quad (1)$$

The second rule (the product rule) states that the probability of events X and Y happening is given by:

$$P(X, Y) = P(X|Y) \cdot P(Y) \quad (2)$$

Where $P(X|Y)$ is the probability of X given Y happening.

1.2 Bayes' theorem

Bayes' theorem gives us the probability of the hypothesis H being true given the data D .

$$P(H|D) = \frac{P(D|H) \cdot P(H)}{P(D)} \quad (3)$$

Where $P(H|D)$ is called the posterior, $P(D|H)$ the likelihood, $P(H)$ the prior, and $P(D)$ the evidence.

1.3 Marginalization

Suppose you have a range of hypotheses $\{H_i\}$, where $i = 0, 1, 2, 3, \dots$. Then

$$\sum_{i=0}^{N-1} P(H_i) = 1 \quad (4)$$

Then suppose we have some nuisance parameter X , then

$$\sum P(H_i, X) = \sum P(H_i|X) \cdot P(X) \tag{5}$$

$$= P(X) \sum P(H_i|X) \tag{6}$$

$$= P(X) \tag{7}$$

Which could also be written as

$$P(X) = \int_{-\infty}^{\infty} P(X, Y) dY \tag{8}$$