1.7 Discussion: Prisoner’s Choice and Medical Testing Problems

Each of the problems you have worked on in this module use Bayes theorem but in different ways.

**Directions:** Explain your approach to each of the problems in the exercises by answering the following prompts and questions:

**How is the prisoner’s choice problem similar to and different from the Monty Hall problem, and how do these differences and similarities affect the solution?**

Both problems have 1 of three options that could be considered success, i.e. the prisoner goes free in the Prisoner’s Choice problem, or the contestant gets a real prize in the Monty Hall problem. However, Prisoner’s Choice does not allow the prisoner to change their outcome after the additional information is given, whereas in Monty Hall the additional information is of utility (similar to the flower picked being over 6 feet tall in the lecture session).

**Suppose in the prisoner’s choice problem that the jailer tells us that prisoner B will be set free. Does that change the probability that prisoner C will be set free?**

No, this does not change the probability for the prisoner because the additional information is not of use to them Their probability is fixed.

**In the medical testing problem, compare the probability that the patient has ebola using frequentist and Bayesian probabilities.**

In the frequentist example, there is a 1/10000 chance the patient has ebola. The false positive and false negative information is of some comparative, except the small false positive rate (2.3%) may give the frequentist a false sense of confidence that a positive test indicates ebola.

A Bayesian approach allows underlying information about both the properties of the test and the frequency of ebola in a population to be used; giving a much more reasonable picture of the patient’s true probability of ebola. I am interested in how an epidemiologist updates their frequency to calculate p(Disease=true | Test=true) during a local or widespread outbreak of disease.

# 1.11 Discussion: Distributions and Expectations of Univariate Random Variables

Management of uncertainty in machine learning requires good facility in the use of probability distributions. The discussion provides some initial practice in inference using probability distributions.

**Directions:**The random variables problem you worked on in the previous exercise requires an understanding of probability distributions. Explain your approach to each problem.

**Problem One:**

Problem 1 made it clear that there were 2 possible outcomes: processor fail, processor doesn’t fail. The problem also described that a subset (> 50%) of the cores needed to fail for the processor to fail. In the quad example either 3, or 4 cores need to malfunction, and in the duo processor, both cores need to fail. Because we new this was a binomial distribution (multiple trials with two outcomes) I used the binomial probability mass function.

**Problem Two:**

Problem 2 identified the Poisson distribution with a known lambda, i.e. expected value. This made the selection of the probability mass function, and formula very simple to calculate with

**Problem Three:**

Problem 3 identified a Gaussian distribution for a continuous variable with known mean and std, which again, made the problem easy to solve using the cumulative distribution function on a normal distribution.

**Problem Four:**

Again, a common theme that having a known distribution for a random variable allows easy calculation of the expected value, and probability for a particular value/ or data. In this problem, knowing that the 2 random variables were from Poisson distributions with known lambdas made calculation of the expected value of the sum of the distributions easy to calculate.

# 1.15 Discussion: Distributions and Expectations of Random Variables

**Directions:** Each of the problems in the exercises requires an understanding of expectations and variances. Explain your approach to each problem.