# CSCI 5512: Artificial Intelligence II
# (Spring'11) Prof. Schrater
# Homework 1

(Due Wed, Jan 26, 4pm)

1. Consider the domain of dealing 5-card poker hands from a standard deck of 52 cards under the assumption the dealer is fair.
    a. How many atomic events are there in the joint distribution (i.e. how many 5-card hands are there)?
    b. What is the probability of each atomic event?
    c. What is the probability of being dealt a royal straight flush? Four of a kind?

2. After your yearly checkup, the doctor has good news and bad news. The bad news is that you tested positive for a serious disease and that the test is very accurate: the probability of testing positive when you do have the disease is 0.983, and the probability of testing negative when you don't have the disease is 0.945. The good news is that this is a rare disease, striking only one in ten thousand people in your demographic. Why is the rarity a cause for celebration? What are the chances you have the disease? What if you discover you have a genetic anomaly that changes your demographic to the disease striking one in ten – what are the chances you are diseased?

3. You are given a biased coin whose probability of giving Heads is p. You do not know what p is. How will you use the coin to simulate generation of samples from an biased coin whose probability of giving heads in 1 in 3? (Hint: You may have to toss the biased coin multiple times to get an unbiased 'toss'.)

4. Three prisoners A, B and C are locked in their cells. It is common knowledge that one of them will be executed the next day and the others pardoned. Only the governor knows which one of them will be executed. Prisoner A asks the guard a favor: "Please ask the governor who will be executed and then take a message to one of my friends, B or C to let them know he will be pardoned in the morning." The guard agrees.
    a. The guard comes back later and tells that he gave the pardon message to B – What are A's chances of being executed, given this message (note: use Math to answer, not incoherent verbiage).
    b. If we also know that the guard hates C, and will not give C the pardon message unless it is absolutely necessary – What are A's chances of being executed given a pardon message to B? What are A's chances of being executed if the pardon message were given to C?

5. Suppose you have some kings. The kings are either tyrannical or benevolent in their behavior. Let *B* represent a random variable that represents the events { tyrannical, benevolent } . They also occasionally deposed by a revolution. Let *D* represent the Boolean random variable that deposed is true or false. Here's the joint count of observed events, out of 100 events:

| | | B =Tyrannical | B=Benevolent |
|---|---|---|---|
| Deposed | (D = true) | 24 | 24 |
| Not Deposed | ( D = false) | 26 | 26 |

So, as we can see, a king's behavior doesn't have any influence about how long he reigns. But suppose we divide the kings up into charismatic and un charismatic as follows:

Charismatic/Uncharismatic

| | **Tyrannical** | **Benevolent** |
|---|---|---|
| **Deposed** | 16/8 | 2/22 |
| **Not Deposed** | 24/2 | 8/18 |

a. Use the conditionalized product rule $\mathbf{P}(X,Y \mid e) = \mathbf{P}(X \mid Y,e)\mathbf{P}(Y \mid e)$ to compute the conditional probability of being deposed, given his behavior and charisma $\mathbf{P}(D \mid B,e)$, where *e* is a Boolean random variable representing his charisma.

b. Should the king choose to be benevolent or tyrannical? Does his charisma affect the outcome of his choice? What if the king does not know whether he is charismatic or not?