Workshop #2: Making plans under uncertainty.

Instructions: Your organization has been asked to compile a comprehensive report and accompanying recommendation to the University about the possibility of closing campus to motor vehicles. The University has expressed to you that it recognizes that a large sum of money is earned each year through sales of parking passes and parking garage tickets, but that it must balance management of medical emergencies, student safety, campus beauty, and other environmental factors with this extra income. In this workshop, you will think through this problem and ultimately provide a 1-slide recommendation to the University at the end of the session.

Part 0: What is the problem? Define what you think is the set of potential solutions. Begin to think about the consequences and tradeoffs of each potential solution, but don't do anything with this yet.

Part 1: Suppose that there is no uncertainty in this decision. The University is simply making a (complex) cost benefit analysis based on the state of campus right now. Create a decision matrix that lists the two potential decisions (or "alternatives") and at least 5 of the most relevant objectives (or decision criteria) that you should consider when making this decision. Sketch the decision matrix like we have done in class, and be able to justify your assumptions. At the end of this step, you should have a value for the benefit of each of the two decisions. There is no need to make this complex unless you want to. The most important part to me is that you specify what is important.

Part 2: Now introduce uncertainty. Part 1 gives you the relevant information for the portion of the decision tree that I have referred to in class as "the outcome if the path is realized". However, this only considers what would happen if everything stayed the same. There are many reasons to believe that this is not the case. But for simplicity, let's imagine that the State of Ohio is considering implementing a tax on non-electric vehicles that would both reduce the environmental impact of driving and reduce the number of drivers entirely. The probability of this proposal actually being voted into effect is α (meaning that the probability that the proposal will not take effect is 1-α). Create a second decision matrix that depicts this counterfactual reality where this policy does take effect. Use the same 5 (or more) objectives, but reimagine the benefits now as if Ohio State must make this decision to close campus to motor vehicles conditional on the fact that non-electric vehicles are taxed. Draw the decision tree that your team faces now where the probabilities are α and 1- α, and the outcomes for each branch are defined by the decision matrices that you created in Part 1 and Part 2.

Part 3: You've now set up the problem, but you need to determine α. This is really why OSU hired you to begin with. You have no idea how likely α is to occur, so you naively think that the policy has a 50% likelihood of occurring. But you're smarter than that. You go out and you scour the internet to try to get a better sense of this proposal's likelihood of success. Your first Google search yields an article from the National Inquirer that reports that secretly recorded conversations of Ohio politicians suggests that this is very likely to pass. Any amount of challenge that is portrayed in the media, reports the National Inquirer, is merely for show.

Since you had no idea what to believe before you read this article from National Inquirer, some information might be better than no information, but you are inherently skeptical of this new information since the source is not very trustworthy. Indeed, while you expect that the National Inquirer will correctly report that an event actually occurred 20% of the time, your experience is that 80% of the time, the National Inquirer reports something happening when it really did not happen.

Let's walk through an example using Bayes Theorem to update our expectations with this new information.

Here are a few helpful definitions:

Bayes Theorem: $P(A|B) = \dfrac{P(B|A) * P(A)}{P(B)}$

P(A): This is your initial (or technical name is) "prior" belief in the event occurring. Or rather, your initial belief that the policy will pass.

$P(\neg A)$: This is your prior belief in the probability that event A truly does <u>not</u> occur, or rather $1 - P(A)$.

P(A|B): This is what you're really after. You want to know how likely A is *given that* National Inquirer reports that the policy is going to pass. You can think of this as being your updated prior/initial belief given some new information.

P(B|A): This is the probability that you would receive new information from the National Inquirer about the policy passing *given that* the policy actually did pass. You can think about this as being, how likely is the outlet to report the truth if it actually occurred. Hopefully high for reputable news sites, right? Maybe less so for non-reputable sites.

P(B|$\neg A$) This is the probability that National Inquirer would report that the policy will pass when it actually will fail. Think of this as the fake news component of your belief calculation.

P(B): This is simple on its face, but requires a bit more technical detail, which is why I only put this in a workshop and not on a quiz or homework. I want you to have exposure to it, but you could study take multiple courses on this topic before you really have mastered it. Anyway… this is your prior belief that the National Inquirer would report the policy passing at all.

$$P(B) = P(B|A) * P(A) + P(B|\neg A) * P(\neg A)$$

You can see in this definition of P(B) that we have all the pieces of it. We know what is our prior belief in the probability of A occurring. We know what is our prior belief in the probability of A not occurring. We also know our belief in how likely the National Inquirer is to report information that is actually true. Finally, we know our belief in how likely National Inquirer is to report information as true when it is actually not true. So we can plug all of these pieces into the equation to get the probability of B, i.e. P(B).

Try your best to use the above information in this scenario, and all the definitions that I provided to calculate your updated belief P(A|B) with this gossip news report. What conclusion do you draw? Remember that P(A) is what you initially believed and P(A|B) is what you initially believed given this report from a site that is usually wrong. Is there any meaningful intuition that can be gleaned from this?

Part 4: Now we're going to explore how this changes if you receive good information. Now instead of reading National Inquirer (pretend you never saw this article), you click on an article from the BBC which says that the policy is likely to pass. The BBC almost always reports a policy passing when it does pass (let's say 95% of the time), and it rarely reports a policy passing when it does NOT pass (let's say 3% of the time). Follow Part 3 and update your belief of event A occurring, P(A), given this BBC report. That is, find P(A|B). To reiterate, assume in this question that the only information about National Inquirer that applies to this example is that your prior belief in A, P(A), is 50%.

Part 5: Put together 1 ppt slide. No formality or elegance needed for formatting. If we have time to present to the class what you found in each of the above parts, we will do this. Otherwise, I just want to see what assumptions you made, and how comfortable you feel with the material. Grading will only be done with completion, but it will give me an idea of the extent to which I need to teach the information better or (hopefully) if you're getting the majority of it!