Problem Set 4—Decision Analysis

MSIS 504—Professor Hillier

Individual Submission due Friday, July 18, 11:59pm

Team Submission due Saturday, July 19, 11:59pm

Instructions

1. Solve each problem in separate tabs in a single Excel file. Label the tabs by problem number (i.e., 1a, 1b, and 2). Submit your individual solution to Canvas no later than the due date and time shown above.
2. Meet with your study team. Compare and discuss your various solutions. Create a single submission. One member of your team should submit it to Canvas no later than the due date and time shown above.

1. Who Wants to be a Millionaire

You are a contestant on *Who Wants to be a Millionaire*. You have already answered the $250,000 question and now must decide if you would like to answer the $500,000 question. You can choose to walk away at this point with $250,000 in winnings, or you may decide to answer the $500,000 question. If you answer the $500,000 question correctly, you can then choose to walk away with $500,000 in winnings or go on and try to answer the $1,000,000 question. If you answer the $1,000,000 question correctly the game is over, and you win $1,000,000. If you answer either the $500,000 or the $1,000,000 question incorrectly, the game is over immediately, and you take home "only" $32,000.

A feature of the game *Who Wants to be a Millionaire* is that you have three *lifelines*—namely *50-50*, *ask the audience*, and *phone a friend*. At this point (after answering the $250,000 question), you have already used two of them, but you have the *phone a friend* lifeline remaining. With this option, you may phone a friend to get their advice on the correct answer to a question before answering it. You may use this option only once (i.e., you can use it on either the $500,000 question or the $1,000,000 question, but not both). Since your friends are all smarter than you are, *phone a friend* improves your odds for answering a question correctly. Without *phone a friend*, if you choose to answer the $500,000 question you have a 65% chance of answering correctly, and if you choose to answer the $1,000,000 question you have a 50% chance of answering correctly (the questions get progressively harder). With *phone a friend*, you have an 75% chance of answering the $500,000 question correctly, and a 60% chance of answering the $1,000,000 question correctly.

a. Use TreePlan to construct and solve a decision tree to decide what to do. State (in words below the tree) what is the best course of action, assuming your goal is to maximize your *expected* winnings.

b. Copy the worksheet from part a (hold down control (PC) or option (Mac) and drag the tab for 1a to create a copy of that tab, and then relabel the new tab 1b. Using the exponential utility function to account for *your* level of risk aversion, re-solve the decision tree. Include on the spreadsheet a brief description of *how* you determined the RT value that was appropriate for you to use for the exponential utility function (i.e., describe the process and specific gamble that you considered)*. Does the best course of action change?

* **There is a "bug" associated with the exponential utility function and RT value with TreePlan:** Having an RT value that is *way* lower than the payoffs in the tree (over 1000 times lower) can lead to numerical issues (with #NUM displayed for some of the results). Some of the payoffs in the question at hand are up to $1 million. If you use an RT value of less than $1 thousand or so, the payoffs are all *so much* larger than the RT value that it leads to the exponential function it uses to calculate utility to have issues calculating properly. **So, even if your true RT value is less than $1 thousand, you will need to use a value of at least $1 thousand in order to get results from your model.**

2. UW Toys and the Professor Hillier Action Figure

UW Toys has developed a new product—the Professor Hillier Action Figure (PHAF). They are now deciding how to market the doll.

One option is to immediately ramp up production and launch an ad campaign throughout the state of Washington. This option would cost $70,000. Based on past experience, new action figures either take off and do well, or fail miserably. Hence, they predict one of two possible outcomes— total sales of 16,000 units or total sales of only 2000 units. The net profit per unit sold is $8.

Another option is to first test market the product in Yakima before deciding whether to sell statewide. The test market would require less capital for the production run, and a much smaller ad campaign. Again, they predict one of two possible outcomes for Yakima. The product will either do well (sell 800 units) or do poorly (sell 200 units). The cost for this option is estimated to be $2000. The net profit per unit sold is $8 for the test market as well. Once the test market is complete, University Toys would then use these results to help decide whether to market the toy statewide.

University Toys has test marketed similar toys in the Yakima market 40 times in the past, with the results shown in the table below. Since University Toys thinks PHAF is similar to these other toys, they plan to estimate the probabilities of the various outcomes based on these historical results. For example, ignoring the test-market results, 22 out of 40 of the previous toys sold well statewide, so without a test market they estimate a 55% probability for PHAF to sell well statewide. If a test market is done, these same data should be used to estimate the probabilities of the various outcomes.

	Sells Well Statewide	Sells Poorly Statewide
Tests Well in Yakima	14	6
Tests Poorly in Yakima	8	12

There is a complication with the Yakima test market option, however. A rival toy manufacturer is rumored to be considering the development of a Dean Hodge Action Figure (DHAF). After doing the test market in Yakima, if University Toys decides to go ahead and ramp up production and market throughout the state, the cost of doing so would still be $70,000. However, the sales prospects depend upon whether DHAF has been introduced into the market or not. If DHAF has *not* entered the market, then the sales prospects will be the same as before (i.e., 16,000 units if PHAF does well, or 2000 units if PHAF does poorly, on top of any units sold in the test market). However, if DHAF *has* entered the market, the increased competition will diminish sales of PHAF. In particular, they expect to sell 8000 if PHAF does well, and 1000 units if it does poorly, on top of any units sold in the test market. Note that the probability of PHAF doing well or doing poorly is not affected by DHAF, just the final sales totals of each possibility. If a test market is done, there is a 20% chance that DHAF will enter during the test market (before it completes). On the other hand, if UW Toys markets PHAF immediately, they are guaranteed to beat DHAF to market, thus making DHAF a non-factor.

a. Use TreePlan to develop a decision tree to help UW Toys decide the best course of action and the expected payoff. In words below the tree, state the best course of action assuming your goal is to maximize the expected payoff.

b. Now suppose UW Toys is uncertain of the probability that DHAF will enter the market before the end of the test market in Yakima would be completed (if it were done). How does the expected payoff vary as the probability that the DHAF would enter the market changes? On the same worksheet used for part *a*, generate a data table that shows how the expected payoff and the initial decision changes as the probability that DHAF enters varies from 0% to 100% (at 10% increments). At what probability does the decision change?