MS-E2134 - Decision making and problem solving

Assignment 2 **Due: 10:15 am 21.10.2021**

General instructions:

- *Justify for answers to each part by, e.g., presenting appropriate calculations.*
- *Hand-written report is OK as long as it is readable.*
- *Please attach a cover page (available on the "Assignments" subpage in MyCourses) to your report.*
- *Submit the report as a pdf-file on "Assignments" subpage in MyCourses.*
- *For problems #1, #2, #4, and #5, please submit also your Excel- and Matlab-files on the "Assignments" subpage (**Note: you must also present your related answers in the report, according to the instruction of a given task!**)*
- *You may discuss the problems with your fellow students, but everyone must submit their individual solutions. **Copying is strictly forbidden.***
- *The total score of the assignment is scaled linearly to exam points, 7 points being the maximum. For reports submitted after the deadline, one exam point is reduced from the scaled score for each starting 12 h period after the deadline.*

#1 Simulation (6 pts)

Dr. Cuckoo is thinking about leaving a steady job with 30k€/year net salary to pursue his own business. With regard to this business venture, he estimates that in the first year, the net earnings are normally distributed with a mean of 40k€ and a standard deviation of 10k€. Moreover, with regard to the following years, he estimates that his yearly net earnings from the business venture are normally distributed so that each year's mean is equal to the previous year's net earnings, and the standard deviation each year is 10k€. Dr. Cuckoo's yearly expenses, which he wants to be covered by his earnings, are uniformly distributed between 20k€ and 25k€.

a) Using Excel, simulate 200 replications of Dr. Cuckoo's net cash flows (net earnings minus expenses) from both the steady job and the business venture over the next five years, assuming that the net salary from the steady job does not change. Include to your report a screenshot of your Excel file showing 10 replication rounds throughout the five-year simulation period.
b) Compute and report the average net cash flows for each year for both the steady job and the business venture. Which option looks better?
c) Based on you simulations, what is the probability for each year that Dr. Cuckoo cannot cover his expenses by the earnings from the business venture? What are these probabilities, if Dr. Cuckoo stays in his steady job? You don't need to take into account possible savings made on previous years; just compare the earnings and expenses of a given year to each other.

#2 Decision trees (12 pts)

You have been seriously injured at a company's premises and have sued them for 8M€. The company refuses to pay this much, but has offered you 2M€ instead. You can either accept this offer or present a counteroffer of 5M€. You have estimated the probability of the company accepting you counteroffer to be 40%. If the company declines your counteroffer, the case goes to court. If you win in court, you get 8M€.

If you lose, you don't get anything and need to pay legal fees for the amount of 1M€. You have estimated your probability to win in court to be 50%. Your objective is to maximize the expected monetary value.

a) Build a decision tree for your legal problem and include a figure of it to your report. Should you accept the company's offer or not?
b) Calculate the expected value of perfect information (EVPI) for the problem.

Before you decide whether to accept the initial 2M€ offer or to present the 5M€ counteroffer, you may consult an insider in the justice system about whether you would win the case if it went to court. The services of this insider cost 0.5M€. She can tell you by 100% accuracy if you are going to win, but even if you are actually going to lose, she has a 20% chance of falsely predicting that you would win.

c) Build an extended decision tree using Excel. Do not hardcode any of the problem parameters (probabilities, profits, costs) into functions but instead write them into cells so that you can changes their values later. Aim toward visual clarity. Include a figure of the decision tree to your report.
d) What is the optimal sequence of decisions to be made?
e) Calculate the expected value of sample information (EVSI) for the insider's services. Calculate also the efficiency of sample information (=EVSI/EVPI*100%). By how much should the cost of the insider's services decrease for you to be willing to pay for it?
f) What is the maximum fee you would be willing to pay to an insider with perfectly accurate information about the court's future decision (i.e., 100% of correctly predicting whether you are going to win or lose)?

#3 Elicitation of utility functions (5 pts)

You have been hired as a decision analyst to help a company make an investment decision. The COO, Dr. Stoveo, wants to limit risks of low profits (or even losses) and has told you to incorporate his risk aversion into your decision model. You have the following conversation with Dr. Stoveo.

You: Dr. Stoveo, based on my analyses, your profits for the next quarter are almost certainly between -2M€ and 10M€, regardless of which investment opportunity you decide to pursue. To help you with the decision, I would still need to ask a few questions about your risk preferences…

Dr. Stoveo: Ok, but I am super busy and only have time to answer four questions. Shoot!

You: Ok! First, consider a profit distribution in which there is a 50-50 chance between a profit of -2M€ or 10M€. What would be the amount of profit that you would need to get for sure to be indifferent between this certain profit and the aforementioned uncertain profit?

Dr. Stoveo: I really hate losing money… I'd say about 1.5M€.

You: Good. What about for a 50-50 gamble between 1.5M€ and 10M€?

Dr. Stoveo: Let's go with 4M€.

You: Thank you. How about a 50-50 gamble between -2M€ and 1.5M€?

Dr. Stoveo: Have I told you that I really, *really* hate losing money? I could never accept a sure loss, so I'm going to say 100k€. Are we almost done here?

You: Yes, just one more question: Consider an uncertain profit such that the probability of 10M€ is *p* and that of 4M€ is 1-*p*. What should the value of *p* be for you to be indifferent with this uncertain profit and a certain profit of 6M€?

Dr. Stoveo: Let's say 40%. Now, go analyze!

Plot the utility function for the range [-2M€, 10M€] such that the least and most preferred profits correspond to utilities 0 and 1, respectively, and linear interpolation is used between the elicited points. Is Dr. Stoveo actually risk averse as defined in Expected Utility Theory?

#4 Expected utility, risk-attitude, and risk measures (10 pts)

Consider two investors:

1. Rick Averell, whose preferences are represented by utility function $u(x) = \sqrt{x}$, and
2. Ricki Seeck, whose preferences are represented by utility function $u(x) = x^3$,

where *x* is the monetary value in M€.

a) What are the investors' risk attitudes, given that x > 0?

Now, consider three investment opportunities, whose monetary values in M€ are realizations from the following distributions:

i. UNI(50,100)
ii. LogN(3,1^2)
iii. A discrete distribution with PMF

Probability	0.05	0.05	0.1	0.2	0.3	0.15	0.1	0.05
M€	5	10	50	80	100	130	170	200

b) Compute the expected utilities, certainty equivalents, and risk-premia for each investment opportunity for both investors. Check that the results are in line with the investors' risk attitudes.
c) Compute the 10% VaR and CVaR risk measures for each investment opportunity.

For (i), provide analytic solutions. For (ii), provide estimated results by simulating 5,000 replications in Matlab. (The built-in function "random" of Matlab is useful here.) For (iii), provide results that are computed in Matlab without any simulations and are precise to two decimal places.

#5 Stochastic dominance (5 pts)

Consider the three investment opportunities in problem #4. Plot the CDFs for all three opportunities in the same figure using Matlab.

a) Identify all first-degree stochastic dominances among the alternatives.
b) Identify all second-degree stochastic dominances among the alternatives.
c) Which alternative(s) would you recommend to a risk averse DM that prefers more to less?

d) Which alternative(s) would you recommend to a risk-neutral DM that prefers more to less?