ISM-E1004 - Business Analytics 2, Lecture, 8.1.2024-19.2.2024

– 1000€ Demand < 2000 Demand < 13000 300€ 300€

≥7000 800€ Demand Demand ≤ 25000 < 7000 0€ 0€ 800€ \geq 35000 ≥ 40000 - 800€ 1000€ Demand Demand < 40000 < 35000 100€ 50€ 100€

Please use the Excel template to formulate your answers. **Answer template for Problem 1**

Show using Bayes' theorem that the correct probability is approximately 0.96. HINT: The binomial distribution can help, but it is not necessary.

result is that we find 4 white balls and one black. Typically people assess that the probability that the selected bag was Bag A is between 0.7 and 0.8.

Let B be the event that Bag B is chosen => P(B) is the probability of choosing Bag B.

Let X be the event that 4 white balls and 1 black ball are drawn.

problem1_Nguyen Xuan Binh_887799.xlsx

Write your answer, using formulas and text, in the field below. We can define the variables as follows: Let A be the event that Bag A is chosen => P(A) is the probability of choosing Bag A.

People tend to change previous probability estimates more slowly than warranted by new data. For instance, consider that you have two bags: Bag A containing 30 white balls and 10 black balls and

Bag B contains 30 black balls and 10 white balls. One of these bags is selected at random and from it five balls are drawn at random, replacing each ball back into the bag after it has been drawn. The

 $P(X|A) = (30/40)^4 * (10/40) = 0.0791015625$ For Bag B, the probability of drawing 4 white and 1 black is

forecasts for three scenarios that capture different possibilities how the demand for robot lawnmovers may develop.

P(X) = 0.0791015625 * 0.5 + 0.0029296875 * 0.5P(X) = 0.041015625

Finally, we can use Bayes' theorem to find P(A|X), the probability that bag A was chosen given that 4 white balls and 1 black ball were drawn:

have given favourable results in 40% of the cases. In some 95% of cases with high demand, market studies have originally given favourable results.

Calculate the EVPI for this decision problem to analyse the value of having perfect information on the demand before making a decision.

buying a market study? What is the probability of non-positive profits if a market study is not bought?

• Bot: Fantastic. What about the certainty equivalent of a 50-50 gamble between 32 M€ and 85 M€?

draw with Excel, using R or Python, or even by hand as long as the graph is as clear as possible. Attach the graph as a PDF file.

Peter has a utility function $U(x) = 0.003 x^2 + x$ and David has utility function $U(x) = 2 \ln(x + 1)$, where x is money in \in .

Now consider three investment opportunities (lotteries) whose monetary values in M€ are described by the following distributions:

a) Report the risk attitudes of Peter and David and justify your answers. Using graphs is helpful.

By how much should the conditional probability P(f | s3) decrease for it to be optimal *not to buy* the market study? (Accuracy of two decimal points is enough.)

Brown Industries is currently considering the decision to enter the market for consumer-grade robotic lawn movers. These devices utilise the most recent advances in AI and can cut the grass

s2: Med demand 50 s3: High demand 120 90 They have also assessed that the probability for low demand is 20%, the probability for medium demand is 45%, and the probability for high demand is 35%. Moreover, they want to also consider a third alternative, that of not entering the market for robotic lawn movers, where the profits for each scenario would be zero.

Before committing to any of the alternative strategies, the team has the possibility to buy a market study that costs €6M. The result of the market study will be either favourable (f) or not favourable (~f).

Historically, similar market studies have provided favourable results in 5% of cases where the demand has been low. Similarly, when demand has eventually turned out to be medium, market studies

Their top management has come up with two alternative strategies: (i) design and manufacture their own model, or (ii) license the technology from another company. The team has prepared profit

Complete Implement a decision tree model of the above decision problem using spreadsheets. Do not hardcode any of the problem parameters (i.e. probabilities, profits) into functions, but write then into cells so they can be changed later. Aim for a clear visual representation that you could use to communicate the model and its results to others. Using the Excel template, answer the following questions. What is the optimal sequence of decisions when maximizing expected profits? What is the corresponding expected profit?

Calculate the EVSI for the market study. Calculate also the efficiency of sample information (=EVSI/EVPI*100%). By how much should the cost of the study increase for the company not to buy it?

Illustrate the CDF for profits for alternatives of buying and not buying a market study (assuming the optimal decision is taken in both cases). What is the probability of non-positive profits when

Flag question **Problem 4**

• Bot: Ok, we are nearly there. Just one more question, which is a tad different this time. Consider an uncertain profit where the probability for 85 M€ is p and the probability for 15 M€ is 1 – p.

a) Estimate the utility function for the profit range [15 M€, 85 M€] so that the least and most preferred profits get utilities 0 and 1, respectively. For your answer, present the function graphically. You can

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Assignment 3 ►

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b) Use the text area below to answer the following question: Is the CEO risk averse in the sense of expected utility theory? Justify your answer briefly. We know the CEO is risk averse if his expected utility is lower than the expected money gains from the profits, because he wants to receive something for certain rather than bearing the risk of

problem4_Nguyen Xuan Binh_887799.pdf

In all four cases, we can see that the CEO wants to receive for certain the profits that is consistently lower than the expected profit, which means the CEO is risk averse as he do not want to gamble

40 **60 70** M€ 10 20 **30 50** 80 90 100 0 0.05 0.12 0.13 0.06 0.15 0.08 0.1 0.12 0.03 0.13 0.03 Prob.

problem5_Nguyen Xuan Binh_887799.xlsx

When one distribution first-degree stochastically dominates another, it means that every risk-averse decision-maker would prefer the dominating distribution, as it either provides a better outcome

Brown Automotive has implemented a large simulation model to support the development of an R&D strategy for the next 5 years. They have also implemented a spreadsheet for visualising the

simulation results (see below link). The simulation model was used to generate a random sample of the total profits that each of the three alternative strategies A, B and C would yield during the

Identify all second-degree stochastic dominances among the alternatives.

Use the visualisation tool to answer the questions below. No file uploads are needed in this problem, justify your answers clearly.

- Strategy A SSD strategy C - Strategy C SSD strategy B

Strategy C has been shown to SSD Strategy B, meaning that it has higher expected utility for risk-averse decision-makers, and also has the highest potential profit among the three strategies. It offers a wider range of outcomes with the possibility of higher profits but with more risk. Since the risk taking behavior of the DM is unknown, I would recommend strategy C to a DM that prefers more profit to less

steadier return, as strategy A SSD both strategies B and C.

Which alternative(s) would you recommend to risk-neutral DM? For a risk-neutral decision-maker (DM), the primary concern is the expected value of the outcomes, rather than their variability or distribution. A risk-neutral DM is indifferent to risk and bases decisions purely on the expected return. In the excel file, I find the expected value from the PDF columns, and E[profit] for each strategies are as follows:

Strategy A: 16.11764706 Strategy B: 12.35294118

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between 10000 and 30000? What is the expected demand (approximately)?

Flag question **Problem 1** You are building a model to identify the optimal order quantity for a product. As an input the model requires the CDF of the demand. A summer trainee interviewed the head of sales, Dr. Jones, to get expert judgement of the uncertain demand (D). Using the trainee's notes (below), estimate and present the graph of the CDF for the demand. What is approximately the probability that demand is Dr. Jones was indifferent between betting on the demand and betting on the wheel of fortune in

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Complete

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Complete

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these six cases: ≥ 13000 500€ ≥ 2000 10€ 10€ 1000€ 500€

≥25000 **700**€ 200€ 200€ 700€

50€

PS. Dr. Jones stated the demand will never exceed 60000. Note that the information given here does not specify a unique CDF, but a group of CDFs each of which is consistent with the subjective probability statements Dr. Jones provided.

Question 1

/ assignm...

Information

Information **Problem 2**

Question 2

Since one of the bags is selected at random, we have P(A) = P(B) = 0.5.Now, we can calculate the probability of drawing 4 white and 1 black from each bag.

For bag A: the probability of drawing 4 white and 1 black is

 $P(X|B) = (30/40) * (10/40)^4 = 0.0029296875$ Now we can calculate P(X), which is the total probability of drawing 4 white balls and 1 black ball by law of total probability: P(X) = P(X|A) * P(A) + P(X|B) * P(B)

P(A|X) = (0.5 * 0.0791015625)/0.041015625 = 0.964285714 (answer)

Information **Problem 3**

Own design Licensing

10

-5

autonomously.

P(A|X) = (P(A) * P(X|A)) / P(X)

Profits (€M) s1: Low demand

Question 3

Assume the company is risk-averse and its risk-preferences are represented by the exponential utility function $1 - \exp(-0.05 x)$ where x is profits in Meur. What is the optimal sequence of decisions when maximizing expected utility? Answer template for Problem 3 problem3_Nguyen Xuan Binh_887799.xlsx

Information The following presents a discussion between a Decision Analysis Chat Bot and a company CEO regarding the use of a profit simulation model. • Bot: Our model predicts that the quarterly profits are between 15 M€ and 85 M€ almost certainly. Consider a gamble with a 50-50 chance between getting 15 M€ or 85 M€ profit. What would be the certainty equivalent in this case? In other words, what profit amount should you get for certain to be indifferent between this certain profit and the above gamble?

• CEO: Oh, about 32 M€.

• CEO: That is easy, it would be 49 M€.

• CEO: I'm gonna go with 21 M€.

• Bot: How about a 50-50 gamble between 15 M€ and 32 M€?

E[profit] for 0.1 - 0.9 gamble between 15 M€ and 85 M€ is 78M€ > 68 M€

Choose the probability p such that you would be indifferent between this uncertain profit and a certain profit of 68 M \in . • CEO: 90%. Question 4

receiving 15 M€ by 0.5 chance. E[profit] for gamble between 15 M€ and 85 M€ is 50 M€ > 32 M€ E[profit] for gamble between 32 M€ and 85 M€ is 58.5 M€ > 49 M€ E[profit] for gamble between 15 M€ and 32 M€ is 23.5 M€ > 21 M€

Information **Problem 5**

b) Compute the expected utilities, certainty equivalents and risk-premia for each investment opportunity for both Peter and David. Make sure that the results you get are in line with their riskattitudes. Provide the exact analytical answers for Lottery 1, simulation answers for Lottery 2, and spreadsheet calculations for Lottery 3. c) Compute the 10% VaR and CVaR risk measures for each investment opportunity.

Question 5

Lottery 1: Uniform between 10 and 100

Lottery 2: Normal with mean 150 and standard deviation 25

for the same level of risk or the same outcome for less risk.

From the CDF figure, we can see that there is only 1 first degree stochastic dominance

Lottery 3: A discrete PDF with distribution as given in the below table

Excel answer template for Problem 5 Information

Problem 6

upcoming 5 years.

- Strategy A FSD strategy B

Question 6 Identify all first-degree stochastic dominances among the alternatives.

For a strategy X to second-degree stochastically dominate strategy Y, the area under the CDF curve of X from minus infinity to any profit level p must be less than or equal to the area under the CDF curve of Y up to that same profit level p. Additionally, FSD also implies SSD, so we have three pairs of second degree stochastic dominance - Strategy A SSD strategy B

Question 7

Question 8 Which alternative(s) would you recommend to a DM that prefers more profit to less?

Question 9 Which alternative(s) would you recommend to risk-averse DM? Strategy A is the best strategy for a risk-averse DM as it shows the highest expected utility without the risk of extreme losses. This strategy is less likely to result in low profit outcomes and has a

Question 10

Strategy C: 14.29411765 Strategy A has highest E[profit], so I would recommend it to a risk-neutral DM.

Previous activity

■ Assignment 1

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