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Decision Theory
(5072)

Final Exam

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GROUP A

Each of the following questions has four possible answers, of which only one is correct. If you solve a problem correctly, you will receive one point; if you do not answer a problem you will receive zero points; and if you answer a problem incorrectly, you will lose one half point. It is therefore better to not answer a question at all, than to answer the question incorrectly; better still is to answer the question correctly. Be careful in marking your answers — if more than one answer to a problem is marked, the problem will be valued as incorrect.

The exam consists of this title page and ten further pages with problems; please count the pages. Behind the pages with problems there are five empty pages for your calculations. These pages may not be separated from the other pages.

Admitted Aids: Non-programmable calculator, dictionary.

- Which of the following preference statements cannot be characterized graphically by indifference curves:

  - ☐ Given two employees, I always prefer the one who works longer. If two employees work the same number of hours per day, I prefer the one who begins earlier in the morning.
  - ☐ I can get no satisfaction from vermouth alone or gin alone, but I love drinking Martini (which is a 1:3 mix of vermouth and gin)
  - ☐ I don't care if she writes in British or American English as long as we can get her articles for our newspaper.
  - ☐ I like drinking beer when eating pretzels, but after 12 beers I begin feeling sick.

- An Audio-Video-Retailer sells 900 television sets per year (at a constant rate). It costs 10€ to store a set for a year. When the retailer is out of stock he can reorder new television sets from the manufacturer. This involves a fixed cost of 45€ plus 15€ for each set. How many times per year should the store reorder in order to minimize total costs?

  - ☐ 5 times.
  - ☐ 9 times.
  - ☐ 10 times.
  - ☐ 15 times.

- To carry out an order for one of its products a company has access to three alternative production processes. The following table shows the quantities (in kg) of natural resources used in each process, the required machine time (in hrs.), and the respective expected profits:

Production Process	Resource Usage (in kg)	Machine Time (in hrs.)	Expected Profit (in 1000 €)
a_1	40	80	15
a_2	40	60	10
a_3	60	40	15

The company wishes to pursue three objectives:

1. Maximize profit, measured in units of 1000€.
2. Economize on the use of resources, where the benefit is measured in kilograms of resources left after the order has been completed, with an initial quantity of 100 kg.
3. Economize on machine time, where the benefit is measured by the difference between the maximum feasible machine time of 80 hrs. and the time required to complete the order.

Suppose profit maximization is eight times as important for the company as resource usage or machine time. Which preference ordering for the three alternatives does this imply?

- ☐ $a_1 \sim a_2 \succ a_3$.
- ☐ $a_2 \succ a_3 \succ a_1$.
- ☐ $a_3 \succ a_1 \succ a_2$.
- ☐ $a_1 \sim a_3 \succ a_2$.

- A chemical company is expanding its operations and a disused woolen mill is to be converted into a processing plant. Four companies have submitted designs for the equipment which will be installed in the mill, and a choice has to be made between them. The manager of the chemical company has identified three attributes which he considers to be important in the discussion: 'cost,' 'environmental impact,' and 'reliability.' He has assessed how well each design performs on each attribute by allocating values on a scale from 0 (worst) to 100 (best). These values are shown below, together with the costs which will be incurred if a design is chosen:

Design	Cost ($)	Env. Impact	Reliability
A	60 000	0	50
B	90 000	20	100
C	110 000	70	0
D	170 000	100	90

Which design should be chosen if the manager is willing to trade the benefit of environmental impact with that of reliability on a 1:1 basis, assuming that this is cost neutral, and if he is willing to pay $500 for each extra point of reliability?

- ☐ Design A.
- ☐ Design B.
- ☐ Design C.
- ☐ Design D.

- Eva is looking for an appartment near her new university. She is pursuing two objectives: "a low rent" and "living close to campus." Possible alternatives range from 200 to 600 €, and the distances range from 0 to 7 km. Her value function for rent is linear, and her value function for distance v_{dis} is a strictly monotonously decreasing continuous function with the following values

dist. (km)	0	2	4	7
v_{dis}	100	50	25	0

Eva thinks that an appartment 4km from campus with a rent of 300 Euros is just as attractive as an appartment 2km from campus costing 500 Euros. Using this information, determine the weight, ω_d, of the attribute distance, assuming an additive value function.

- ☐ $\omega_d = 1/3$
- ☐ $\omega_d = 1/2$
- ☐ $\omega_d = 2/3$
- ☐ $\omega_d = 3/4$

- Rose has taken a Summer job in a flower market and has been given the task of placing price tags on garden flowers. In particular, she must identify three different kinds of flowers and assign the price tag for **A**sters to one, **B**egonias to another, and **C**hrysanthemums to the third. Unfortunately, Rose cannot tell the difference between these flowers and therefore assigns the three price tags at random. Determine the possible values and corresponding probabilities for the random variable X defined to be the number of correct identifications.

- ☐ $P(X = 0) = 1/2$, $P(X = 1) = 1/3$, $P(X = 2) = 0$, $P(X = 3) = 1/6$
- ☐ $P(X = 0) = 1/3$, $P(X = 1) = 1/2$, $P(X = 2) = 0$, $P(X = 3) = 1/6$
- ☐ $P(X = 0) = 1/3$, $P(X = 1) = 1/3$, $P(X = 2) = 0$, $P(X = 3) = 1/3$
- ☐ $P(X = 0) = 1/4$, $P(X = 1) = 1/4$, $P(X = 2) = 1/4$, $P(X = 3) = 1/4$

- The owner of a small business is unhappy with the service she has been receiving from her bank and has decided to move her account to a rival bank. Her decision on which bank to choose will be based not only on the estimated annual bank *charges* which each bank will levy, but also on the following benefit attributes, for which she has also assessed the swing weights (bold numbers in parentheses):

  - the *proximity* of the local branch **(20)**,
  - whether the local branch has a small business *adviser* **(50)**,
  - the maximum automatic *loan* allowed **(100)**,
  - whether a *telephone* banking facility is offered **(80)**.

  The alternative banks are listed below, together with their estimated annual costs and the scores the business owner has allocated for each of the benefit attributes.

Bank	*Charges*	*Proximity*	*Adviser*	*Loan*	*Telephone*
Central	3000	0	100	40	0
Direct	5000	100	100	80	0
Marks	2000	70	0	100	100
Northern	1000	30	0	0	100
Royal	4000	90	100	20	0

  Contrasting annual Charges with the overall benefits of each bank, which are the efficient choices?

  - ☐ Northern and Marks.
  - ☐ Northern and Direct.
  - ☐ Northern and Royal.
  - ☐ Direct and Royal.

- Suppose a decision maker's preferences are characterized by the von-Neumann-Morgenstern utility function $u(w) = \sqrt{w}$. Which maximum price would this person be willing to pay for a lottery offering a prize of 10 000€ with a 10% chance (and 0€ otherwise)?

  - ☐ 10€
  - ☐ 50€
  - ☐ 100€
  - ☐ 1000€

- Producer A values a lottery yielding \$10 000 with a probability of 20% and \$1 000 with a probability of 80% the same as a sure payment of \$3 000. Producer B, on the other hand, is indifferent between a sure payment of \$7 000 and a lottery giving \$10 000 with a probability of 70% and \$1 000 with a probability of 30%. Concerning the risk attitudes of the two producers, one can say that

  ☐ Producer A is risk-neutral and producer B risk-averse.

  ☐ Producer A is risk-seeking and producer B risk-neutral.

  ☐ Producer A is risk-seeking and producer B risk-averse.

  ☐ Producer A is risk-averse and producer B risk-seeking.

- A factoring bank is offering its services: "As soon as your merchandise leaves the company your claims will become liquid assets. For every purchased claim we will cover 100% of the default risk." The factoring bank charges 10% of the claim for its services.

  Producer Schulz judges from his experience that, with a claim on 1 mill. €, there is an 85% chance that the bill will be settled by his customers without any problems. The chance of a complete loss is estimated to be 5%. However, there is also a 10% chance that payments will be delayed or may require additional transactions, thus reducing the value of the claim to 800 000 €. Suppose Schulz makes his decisions in accordance with the von-Neumann-Morgenstern utility function

  $$u(x) = \ln(100000 + x),$$

  where x is the risky return payment, if the services of the the factoring bank are not used. How should Schulz then decide concerning the sale of his claim to the factoring bank?

  ☐ He should sell the claim, because the price is higher than the certainty equivalent of the risky return payment of his customer.

  ☐ He should not sell the claim, because the price is lower than the certainty equivalent of the risky return payment of his customer.

  ☐ He should not sell the claim, because the expected value is higher than the certainty equivalent of the risky return payment of his customer.

  ☐ It does not matter how Schulz decides, because he is indifferent between selling and keeping the claim.

- Consider four alternatives, a_1, a_2, a_3, a_4, and their consequences, x, for which the following probability distribution is given:

	0.5	0.3	0.2
a_1	6	10	3
a_2	4	9	8
a_3	8	6	4
a_4	12	3	1

Which alternative should be chosen, if the decision maker's preferences are characterized by the following von-Neumann-Morgenstern utility function:

$$u(x) = 6x + 127\,?$$

☐ a_1

☐ a_2

☐ a_3

☐ a_4

- Incentix wants to make the annual income of their Chief Executive Officer (CEO) dependent on the company's annual profit. The formula for the new payment scheme is

$$I = 200000 + p\,(\pi - \hat{\pi})\,,$$

where I denotes the CEO's income, π denotes the company's actual profit, and $\hat{\pi}$ denotes Incentix' target profit, which is currently $\hat{\pi} = 1000000$. $p \in [0, 1]$ is a negotiable percentage rate. Suppose that Incentix' actual profit is a random variable with the following probability distribution:

Profit π	950 000	1 000 000	1 050 000
Probability	0,25	0,5	0,25

Which percentage rate p is optimal for the CEO, if his preferences over income are characterized by the von-Neumann-Morgenstern utility function $u(I) = \ln(I)$?

☐ $p = 0$.

☐ $p = 0,5$.

☐ $p = 1$.

☐ The CEO is indifferent between any values of $p \in [0, 1]$.

- For the upcoming season a travel agent has the possibility of booking 0, 1000, 2000, or 3000 nights in a hotel in Antalya, Turkey. If she sells these nights through her package holidays she can achieve a revenue of 10€ per night. For every night that she is not able to sell she must bear a unit cost of 10€.

  The travel agent does not know the behavior of the tourist market for the next season, but suppose that the demanded number of nights in Antalya can take only the values 0, 1000, 2000, or 3000.

  In order to make a decision the travel agent is only interested in total revenue, where her utility is measured in units of 1000€. How many nights in Antalya should she purchase, if she makes her decision according to the Hurwicz rule, with an optimism parameter of 2/3?

  ☐ 0

  ☐ 1000

  ☐ 2000

  ☐ 3000

- Uncle Euclid, an ancient Athenian entrepreneur, is anxious to start a new business. Four possibilities are available to him, and the success of each enterprise depends on the volatile tastes of the consumers of Athens. In analyzing his decision problem, Euclid has classified the market conditions into three possible states, $\theta_1, \theta_2, \theta_3$, and he assesses his profit (in monetary units) for each of the four enterprises, a_1, a_2, a_3, a_4, as:

	θ_1	θ_2	θ_3
a_1	5	0	13
a_2	6	7	7
a_3	3	4	9
a_4	8	2	6

To help him determine the future state of the market, Euclid may, at a price, consult the Delphi Oracle, who will tell him for certain which of the states will prevail. Calculate the maximum that Euclid would be prepared to pay the Oracle for this information if he makes his decision according to the minimal-regret rule.

☐ 4

☐ 5

☐ 6

☐ 7

- Sensonic Systems has developed a new biosensory alarm system and is now confronted with the decision whether or not to market the new product -- relevant for their decision is only the expected profit. There is the possibility of conducting a market test in order to support Sensonic's decision, but the decision can also be made without the test. The market test would cost 100 000€, and there is the possibility of a positive or a negative result. There is a 60% chance that the result will be positive.

  The cost of marketing the biosensory alarm system is 150 000€. The total revenue of the new product is 500 000€, but only if marketing activities successfully meet the expectations of the desired target group. Otherwise, revenue is expected to be only 250 000€. The chance of reaching the target group is 50% without the market test. With a market test, the chance of successful marketing rises to 75%, if the test is positive, and it drops to 10%, if the test is negative.

  If Sensonic Systems decides not to market the product, there are no further costs or revenues. What is Sensonic's optimal policy in this decision problem?

  - ☐ The biosensory alarm system should be marketed without the market test.
  - ☐ The market test should not be conducted, because under no circumstances should the biosensory alarm system be marketed.
  - ☐ The market test should be conducted, and if the test result is positive, the alarm system should be introduced.
  - ☐ The market test should be conducted, and if the test result is negative, the alarm system should not be introduced.

- A police patrol judges from the suspicious behavior of a driver during a control that there is a 10% chance that the driver's blood has an alcohol content of more than 0.5 promille. This, however, can only be revealed precisely by a costly blood test. To assist them police patrols are equipped with a mobile breath test. For subjects with more than 0.5 promille, the test shows a positive result in 90% of the cases. However, even subjects with less than 0.5 promille test positive in 5% of the cases.

  If a driver is convicted with more than 0.5 promille, then he must pay the community a fine of 250€. This, however, requires a precise blood test, which costs 60€, and these costs have to be covered by the community. The mobile breath test offered to police patrols costs the community only 10€, but since this is not sufficient for conviction, it must be backed by the blood test in order to fine a drunken driver.

  Given the police patrol's prior beliefs concerning the driver, what should they do, if their goal is to maximize the expected budget surplus of the community?

  - ☐ Have the driver take the breath test, and only if the breath test is positive, have the driver take the blood test.
  - ☐ Have the driver take both the breath test and the blood test.
  - ☐ Have the driver take only the blood test.
  - ☐ Let the driver go without any test.

CALCULATIONS

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