InkMaths

ANSWER BOOK

Decision analysis

Decision Mathematics 2 · Year FM

6 questions · 25 marks

NAVY EDITION

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SECTION A · Warm-up

A1 A **square** is a decision node, where you choose. A **circle** is a chance node, where the world chooses, with a probability on each branch. Costs are written on the branch where they are incurred and subtracted there, rather than gathered up at the end, so that every option is compared net of what it costs to take. B1 for the decision node, B1 for the chance node, B1 for the placing of costs. [3]

A2 0.4(250) + 0.6(60) = 100 + 36 = 136. Subtracting the cost of 45 leaves an expected monetary value of **91**. M1 for 0.4(250) + 0.6(60), A1 for 91. Write the 136 in the circle and the 91 beyond the cost, so both numbers are on the tree. [2]

SECTION B · Standard

B1 In-house: 0.5(200) + 0.3(90) + 0.2(20) = 100 + 27 + 4 = 131, less 60 gives **71**.
Licence: 0.7(110) + 0.3(40) = 77 + 12 = 89, less 25 gives **64**.
Do nothing: **0**.
The highest is 71, so **develop** in-house. M1 for an expected value at a chance node, A1 for 71, A1 for 64, A1 for choosing in-house, B1 B1 for the double strokes and the value in the square. Strike through the other two branches at the decision node and write 71 in the square. The two double strokes and the value in the square are worth a mark each, and a bare statement of the decision loses them. [6]

B2 With probability 0.2 the revenue is only 20 against a cost of 60, a **loss** of 40 thousand. Expected monetary value is an average over many repetitions, and this decision is made once. A firm that could not absorb a loss of 40 would rightly take the licence, whose worst outcome is 40 - 25 = 15, a gain. B1 for the loss of 40, B1 for expected monetary value being a long-run average, B1 for the firm being unable to absorb the loss. The calculation is correct and still not the whole answer. [3]

B3 Utility measures how much each outcome is actually worth to the decision maker, rather than its cash value, and for most people it rises less than proportionally with money.
The gamble's expected monetary value is 0.5(200) = **100**, above 80. Its expected utility is 0.5 times the square root of 200, about **7.07**, while the certain 80 has utility the square root of 80, about **8.94**. On utility the **certain** 80 wins, and the two criteria disagree. B1 for what utility is, B1 for the expected monetary value of 100, M1 for the two expected utilities, A1 for the conclusion. [4]

SECTION C · Stretch

C1 After a favourable report, in-house is worth 0.7(200) + 0.2(90) + 0.1(20) = 140 + 18 + 2 = 160, less 60 gives **100**, beating the licence's 64, so choose in-house. [7]
After an unfavourable report, in-house is worth 0.2(200) + 0.4(90) + 0.4(20) = 40 + 36 + 8 = 84, less 60 gives **24**, so choose the **licence** at 64 instead.
The survey's chance node is therefore 0.6(100) + 0.4(64) = 60 + 25.6 = 85.6, less its cost of 10 gives **75.6**.
That beats the 71 available without a survey, so **commission** it. M1 for the favourable branch, A1 for 100 and the in-house choice, M1 for the unfavourable branch, A1 for 24 and the licence choice, M1 for the survey's chance node, A1 for 75.6, A1 for commissioning the survey. The survey is worth 75.6 - 71 = **4.6** thousand, and the whole of that gain comes from the unfavourable branch, where it stops the firm developing in-house.