Results of MBA survey about challenges in using decision trees in managerial practice

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1 Introduction

We conducted a survey among executives in two different MBA classes in order to understand how what challenges are managers facing when using decision trees as a decision making support tool. The results show that both understanding the structure of the problem and assigning specific probabilities to the states of the world in decision trees are problematic, while assigning specific payoffs after the states of the world have been defined is not.

More specifically, the results of our survey show that managers typically: (i) have at least some idea regarding probabilities of states (i.e., do not necessarily treat states as equally likely); (ii) are not sure, however, about the specific values of probabilities; (iii) this ambiguity is not of statistical nature (i.e., cannot be expressed as an estimation error distribution, e.g., by using a Dirichlet distribution); (iv) the range of ambiguity is quite large (typically around 10–20 percentage points, pp).

Even though managers are ambiguous about specific probabilities, they still want to base their decision on the expected value maximization, but according to the survey results, they also pay attention to the outcome in a single, most likely state of the world. Managers also consider the maxi-min and maxi-max approach to be interesting, but clearly less so. Finally they strongly point to the need for sensitivity analysis (SA) showing the impact of ambiguity on decision alternatives.

2 Survey results

Our experience with teaching decision analysis to executives in various MBA programs showed that managers find it difficult in real life to assign probabilities to uncertain events and consider it valuable to learn the impact specific assignment has on the results. In order to confirm and quantify these observations we ran a web-based survey among the participants of two executive MBA programs run at the Warsaw School of Economics (one jointly with the University of Quebec at Montreal). All the respondents were managers with substantial business experience. We ran the survey as part of the course on statistics and decision analysis. The survey was anonymous and voluntary. This target group was selected so as to make sure that we collected opinions about actual business-related experience in managerial decision making and that the respondents are comfortable with the terminology used in the survey.

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The exact questions were selected to measure what poses difficulty for managers when making decisions under uncertainty, how they wish to approach the decision making process, and what kind of additional information they would like to see to understand the robustness of their decision. We conducted a preliminary survey (among another MBA class) to verify the specific subquestions. In this survey the respondents were, e.g., asked to choose from pairs of lotteries and explain their choice. In particular, the survey results reveal that managers often looked at the most likely outcome of a lottery, which is not a typical approach presented in the existing literature, and thus motivated us to pursue this issue in the actual survey.

We summarize the questions and answers in Table 1. The actual survey can be accessed at http://bogumilkaminski.pl/pub/mbasurvey.htm. We received 60 completed surveys, but two respondents answered negatively to the first question about having previous experience with problems under uncertainty, and so they were not asked subsequent questions. Thus, we effectively had 58 completed surveys. In the remaining questions (Q2–Q5) we used a rating scale with 1 denoting lowest intensity (*never* in Q2 & Q3; *not interesting* in Q4 & Q5), and 5 denoting greatest intensity (*often* in Q2 & Q3; *very interesting/crucial* in Q4 & Q5). As our goal was to select what seems subjectively the most important to decision makers, we decided to use this subjective scale (instead of, e.g., asking for a percentage of decision problems in which a given issue listed in Q2 was encountered).

Table 1 presents the four questions with sub-questions, the average score (slightly misrepresenting the ordinal nature of the scale), and the percentage of respondents selecting 4 or 5. We compare the distribution of answers in pairs of subquestions using the non-parametric Wilcoxon signed-rank test (to account for the ordinality of the scale).

We consider the following findings important. Managers do not know the exact probabilities they should ascribe to the states of the world, and this ambiguity is most typically not of a statistical nature: scores were high in Q2c, statistically significant against all the remaining subquestions ($p^* \leq 0.01$). To complete the picture, managers rarely know the probabilities exactly: scores were lowest in Q2e, statistically significant against all the remaining subquestions ($p^* \leq 0.005$). The remaining subquestions (other than Q2c and Q2e) were answered with a similar degree of conviction. Observe that managers often do not know how to structuralize the decision problem, which motivates using a formal modeling approach (i.e., decision trees).

The above is further confirmed by Q3. Managers are rarely at a complete loss regarding how to treat possible states of the world (low scores in Q3a). They are most often able to either at least rank the states or ascribe coarsely approximate probabilities (within a range of 10–20 pp): Q3b and Q3c do not differ in a statistically significant way ($p^* = 0.177$) and ranked significantly higher than other subquestions ($p^* \leq 0.0001$). Also, the managers know the probabilities up to just 5–10 pp precision (Q3d) more frequently than up to 1–5 pp precision (i.e., Q3e, $p^* \leq 0.0001$) or precisely (i.e., Q3f, $p^* = 0.0085$).

The above results suggests the following assertions. Firstly, when modeling decision problems under uncertainty it makes sense to work on some probabilities assigned to states of the world rather than assume all the states are equally probable *à la* Laplace. This initial probability assignment is either needed to reflect the decision maker's knowledge (however coarse, i.e., with a precision of 10–20 pp) or it can be used to dictate the ranking of the states (cf. Q3b). Using the cardinal approach (probabilities assigned) to represent ordinal knowledge (ranking of the states) may be perceived as an over-interpretation of available information, and so the tools presented in the present manuscript are more suitable for the situations referred to in Q2c.

Secondly, these probabilities will be only assigned by decision makers with an ambiguity that is not immediately subject to any commonly used, formal analysis, e.g., randomizing the probabilities from a Dirichlet distribution in a Monte Carlo simulation. Thus some other methods of perturbing these probabilities should be introduced and used in SA.

Question 4 shows that managers find two criteria to be the most useful for making choices:

Question	Mean	≥ 4
Q2: How often do you encounter the following types of uncertainty?		
a) I cannot determine the structure of the problem	3.33	43.1%
b) I cannot assign probabilities to the states of the world at all	3.09	34.5%
c) The probabilities are given with error of non-statistical type	3.79	70.7%
d) The probabilities are given with error of statistical type	3.31	48.3%
e) I know the probabilities, but don't know what will happen	2.47	20.7%
f) The state of the world still does not imply payoffs	3.05	36.2%
Q3: What is the usual degree of uncertainty when assigning probabilities?		
a) I cannot determine at all (which state is less/more probable)	2.38	12.1%
b) I can rank the states of the world, but not assign probabilities	3.55	56.9%
c) I can assign probabilities with the error of around 10–20%	3.31	51.7%
d) I can assign probabilities with the error of around 5–10%	2.59	25.9%
e) I can assign probabilities with the error of around 1–5%	1.93	10.3%
f) I know the probabilities	2.12	13.8%
Q4: What decision making rule is worth using under uncertainty? Selecting the alternative that gives the largest payoff ...		
a) as expected value	3.53	58.6%
b) in the worst case	3.07	43.1%
c) in the best case	3.14	39.7%
d) on average between the worst and the best case	2.79	24.1%
e) on average between the worst and the expected case	2.88	27.6%
f) on average between the best and the expected case	2.91	29.3%
g) in the single, most likely case	3.64	62.1%
Q5: Assume your choice is driven by the expected payoff with probabilities assigned. How important a support would be additional information on ...		
a) largest perturbation of probabilities not changing the choice	4.09	84.5%
b) optimal choice under unfavorable perturbation of probabilities	3.93	70.7%
c) optimal choice under favorable perturbation of probabilities	3.81	65.5%
d) is current decision still optimal for the worst-case scenario	3.76	63.8%
e) is current decision still optimal for the best-case scenario	3.53	55.2%
f) is current decision still optimal for the equal-probabilities scenario	3.03	39.7%

Table 1: Survey questions and results.

the expected value (Q4a) and, surprisingly for us, the payoff in the single most likely case (Q4g). Q4g was assigned higher ranks than all the subquestions Q4b–Q4f ($p^* \leq 0.01$), and Q4a almost so ($p^* = 0.0565$ vs Q4c, $p^* \leq 0.01$ vs remaining cases). Luckily that goes hand in hand with their opinion that in most cases they are able to assign some probabilities or at least rank the states (and so determine the most likely one) expressed in earlier questions. The desire to focus on a single most likely event is driven by the fact that many business decisions amount to a single shot ones and so managers are thinking in terms of most likely outcomes. Under yet another interpretation evaluating a single, most likely outcome may be seen as complementary to analyzing the expected value, which is based on all the outcomes, and the managers may want to have a more complete picture. The respondents also considered that basing their choice on the worst or the best case (Q4b and Q4c) is slightly interesting, yet the differences versus remaining approaches (Q4d–Q4f) were not statistically significant.

Moving from originally assigned probabilities towards focusing on the most likely case is, mathematically, the opposite of moving towards assuming that all probabilities are equal (Laplace approach): the former decreases the entropy of the probability distribution, and the latter increases it. As shown by Q4, managers are interested in the most-likely case approach and simultaneously showed a lack of interest in the Laplace approach in Q5 (Q5f ranked lower than the remaining ones, $p^* \leq 0.005$). Q5 also points to the following. Firstly, SA seems to be crucial for managers: many questions were assigned high scores, e.g., four subquestions (Q5a–Q5d) were given maximal scores by more than a quarter of respondents, while no other subquestion collected more than 20% of maximal scores). Secondly, verifying the stability of the currently optimal decision was found to be the most interesting (albeit not statistically significant across all the comparisons: $p^* = 0.162$ vs Q5b, $p^* \leq 0.05$ vs Q5c–Q5f). Respondents want to assign some probabilities (even with ambiguity) in the SA and verify how the available alternatives behave under various assignments. Thirdly, the respondents like both types of SA: a threshold SA (by how much can we change parameters for the current decision to be optimal, e.g., Q5a) and a scenario SA (what is optimal under some perturbation of parameters, e.g., Q5b). Notice that a preference for Q5a (however slight and not significant versus Q5b) favors the threshold SA over the SA that possibly provides a list of optimal decisions for various sizes of perturbations.