

DECISION ANALYSIS

Decision Trees, Part 1

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Generally speaking, modeling in resource management is for the purpose of informing a decisions, and as important as getting the model working is making sure that the decision context in which it's used is properly organized and thought through. So we're going to now spend some time talking about decision analysis. Decision analysis is just an organized structured way of reaching a decision. Models feed into that decision analysis.

Now, as you are getting people towards decision analysis, if I go back to this diagram. Suppose you've started in a conflicted situation but the people who deal with conflict resolution, the facilitators, are getting people to move towards decision analysis. Then somewhere over here in the middle models can become important. And the reason they can become important is because they might provide a common language or common way of looking at the problem for people to communicate with. Not only that, they might begin to show people the kinds of trade-offs that might be worth considering. And once you've got to that point, you are ready - once people recognize there are going to be trade-offs - you are ready to move into a more structured, formal decision analysis process.

To get a feel for how decision analysis works, we're going to imagine a scenario, and I want you to suspend your moral judgment throughout the scenario. For a start, I'm going to turn you into a gambler, and secondly, I'm going to introduce some dishonest characters.

I want you to imagine the local state fair and imagine that a big company - let's go with Microsoft - has an exhibit at the fair, and if you look at this diagram, it represents the exhibit. There's a fence around two booths. The one booth is red. The other booth is blue. There's a gate into the enclosure and there's a person at the gate, and if you line up to go into the enclosure, the person at the gate says, "Welcome to our exhibit. Here are a hundred betting coupons. Do you want to bet at the red booth or the blue booth?"

Now, what happens in each booth is that somebody is flipping a coin, which we hope was tested by the Bureau of standards. If the coin comes up heads in the red booth, you win \$10. If it

comes up tails, you lose a dollar. The odds in the blue booth are different. If it comes up heads, you win \$100, and if it comes up tails, you have to pay \$20.

Now, as I said, when you line up to go in, the person at the gate says, here are a hundred betting tickets, do you want to go red or blue? You can't mix them. You either have to place 100 bets at the red booth or 100 bets at the blue booth. The tickets are free. You're only going to be allowed into the enclosure once during the state fair. They're probably going to put a transponder under your arm or something like that to make sure you don't go in again. You don't have to settle your betting ball until the end of the 100 bets. So if that stage you owe money, you can pay - and they take credit cards.

So the decision you have to make is: Are you going to ask for red tickets for the red booth or blue tickets for the blue booth? Think about that for a second.

Well, if you look at those numbers, you might say, gee, I think I can win more at the blue booth, but if you look at the ratio of 100 to 20, that is 5 to 1, whereas in the red booth, the ratio is 10 to 1. So maybe it more sense to bet at red. Well, it turns out that people in business school, not surprisingly, have come up with a method of analysis that applies to this kind of problem, and that method of analysis is called **decision trees with expected values**. And I'm going to show you how we develop a decision tree for this particular problem.

There's a whole notation that goes with that. A little square like that means make a decision. In this instance, our decision is either to go to the red booth or to the blue booth. So it's red versus blue. We then trace what happens if you go to the booth. If you go to the red booth, the first thing that happens is somebody flips a coin. A circle in decision trees means a chance event. In this case, there are two outcomes to the chance event. You can either come up heads or tails. If you come up heads, there's a payout. And remember, the payout at the red booth for heads was plus \$10. If it comes up tails, the payout is a negative \$1.

At the blue booth, the same sort of story happens. If you went to blue, you would also spin a coin. It would also come up heads or tails. But the payoffs would be different. Heads is plus 100. Tails is negative 20.

The other information we need on the diagram is: What are the probabilities associated with each outcome at a chance event? And if it's a fair coin, it's going to be .5 in each case.

That's your decision tree. What you do with that decision tree is you calculate an expected value for each option. And the way you calculate the expected value is you calculate the probability of getting to each end point. Now, in this diagram it's very simple. The probability of getting to that end point is .5. The probability of that is .5. There's no fancy probability calculation. But in practice, you might run into a situation where perhaps if you win at the red booth a pickpocket is going to take the money out of your pocket. And there might be a certain probability of that, in which case you would have probabilities following upon probabilities, and you'd have to multiply the probabilities to get to the end point.

So, these diagrams can be more complicated, but in this case you calculate the expected value for red by just taking the probability of getting to that end point and multiplying it by the payoff. And then adding in the probability of getting to that end point and multiplying it by its payoff. And if you do the arithmetic there, you see that your expected value is \$4.50. If you do the same story here - you are going to get .5 times 100, plus .5 times negative 20, and the expected value there \$40. What that tells you is every time you bet at red, on average you expect to win \$4.50. Every time you bet a blue, on average you expect to win \$40.

Now, of course, when you bet once you could never win \$40. You either win 100 or lose 20. But if you bet a hundred times, you would expect to walk away with \$4,000 if the laws of averages work for you at the blue booth, whereas you would only walk away with \$450 if the laws of average work for you at the red booth

So the decision tree analysis makes a very convincing case for going to the blue booth.

Suppose you go back and look at the odds, and you say to yourself, Well, I can see I have a greater chance of winning at the blue booth, but I'm really averse to losing money. So I would rather go red because I'm less likely to come out a loser. So the question then is: Is there anything else you can do to try and convince yourself that 100 bets is sufficient for you to be able to trust the laws of averages and go and bet blue?

So what I would like you to do is imagine that you're sitting at home the night before you go to the state fair. You've got your computer in front of you, and you say, is there anything I could do on a spreadsheet that would help me feel comfortable with going to bet at the blue booth rather than the red booth?

Think about that for a moment, and we'll then look at a spreadsheet and see what you might have come up with.

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