DECISION ANALYSIS

# Simple Multi-Attribute Ranking Technique

# SMART

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recorded: 2005

The problem we looked at about betting at the booths [decision trees] was simple in the sense that it only had one objective - you were out to make as much money as possible. It was perhaps a little bit more complicated because of the fact that it was stochastic in nature. Chance was an important element in the analysis. It helps, in fact, to characterize problems in terms of whether they are stochastic or deterministic, and whether they have a single objective or more than one objective.

If we look at this diagram, at the bottom we have deterministic problems or stochastic problems. And then we have multiple objective or single objective problems. So far in the booths we have been talking in this area of stochastic single-objective problems. We can, in fact, write into this diagram some of the techniques we used. For example, we used ‘simulation’, when we were talking about booths. And we also used ‘decision trees’.

Most problems in resource management are multi-objective and very often they are multi-objective stochastic. But what we are going to talk about now is a problem that is multi-objective deterministic. Because I want to stress the difference between a single objective and a multiple objective.

So, let's think about a problem that might be multiple objective and perhaps controversial. Let's try and keep it light. How about choosing a car for your teenage son or daughter? Let's think about the sense in which it's multiple objective. First of all, who are the stakeholders? Well, obviously your son or daughter, yourself and your spouse. Maybe the grandparents are helping to pay for it. Maybe your son or daughter has a good friend who has an opinion. You could imagine a group of people with differing objectives getting around a table trying to come up with a decision as to which car to buy.

What we are going to do is go through a number of steps of a very organized decision process, using this as an example. The first thing one needs to do in making an organized decision is to spell out the [1] **broad objectives**.  And the broad objectives usually up sending rather like motherhood and apple pie.  For example, if one came up with a general agreement around the table of what the broad objectives are, they would probably be:  A cheap, reliable, safe, fuel-efficient, cool car.  In other words, the best of all possible worlds.  Because the broad objectives are so broad, and because they usually are sort of motherhood and apple pie, one then has to break them down into [2] **measurable goals**.  So the next item on our list is measurable, and the emphasis here is on the word 'measurable'.

Let's think about what the measurable goals might be for a problem like this.  If one had people sitting around a table discussing the goals that they wanted to meet.  And different stakeholders might have different goals, one would probably come up with a list that includes: The purchase price, safety, the students or the kids would certainly want the "cool" factor, and fuel economy would be important, and probably there are a whole lot of other things.

Let's talk a bit about the "cool" factor.  Would you say the "cool" factor is measurable?  If we think of the other things in the list, the purchase price you could get out of a Blue Book.  Safety you could almost certainly find a website for.  Fuel economy you could certainly find the information for.  But what about "cool" factor?   Well, this is where what people in resource management call expert opinion comes in.  And I would suspect that if you got a group of teenagers to rank cars according to how cool they were, they would probably be less variable than you find in the Blue Book price of cars.  So measurable doesn't necessarily mean measurable by going to look up a number.  It could be measurable by expert opinion, provided expert opinion tended to be pretty cohesive.

For the purposes of this model, we are just going to go with the four goals that we have in this list.  So we've got these four measurable goals.  What's the next step?

The next step is to come up with [3] **imaginative options**.  Imaginative options in this case mean what kind of cars are on the table.  I'm going to stress the word 'imaginative' here.  And the reason that I stress 'imaginative' is because very often in doing analyses of these kinds people do an analysis where the options are do something or don't do something, and that's not very imaginative.   A good decision analysis is only as good as the options that are out there. And there have been papers written on how it is much better to have options that are "don't do this, but do that instead," "don't do this, but do that instead," "do this, this way," "do this, that way."  Then you're going to get a much richer decision analysis and reach a much better decision.

Well, in this particular example we could get the people around the table to suggest their preferred cars. And to keep the analysis short, I'm only going to allow four options. The first that probably came from the grandparents was a Honda Civic 2000. The kid, teenage kid, almost certainly went for the Mustang 1965. The parents Ford Focus 2004 would be a pretty good idea. And then one of the parents combined with the kids friend thought a Ford pickup might be quite a good idea.

So we've now done the first three steps, broad objective, measurable goal, imaginative option. The next step is to [4] **score the options against the goals**. And in scoring the options against the goals, one goes into a purely accounting mode. This isn't a question of arguing around the table. You could hire somebody to go away and do it. And the way that one does this comes out of theory, that is that underlies this whole approach. And that theory relates to utility theory and economics. And what one does is one creates thermometers, and a thermometer goes from 0 to 100. 0 is always the worst option, 100 is always the best option. So if one went to the Blue Books for these four cars and looked at the actual prices, one would convert the range - say from $5,000 to $15,000 to 0 to 100. It's exactly like converting Fahrenheit to Celsius.

In this particular case, looking at real values from the Blue Book, car number 3, which was the Ford pickup, was by far the cheapest. It was around about $5,000. The Mustang was the most expensive, around about $15,000. And the Ford Focus and the Honda fell somewhere in between. We're not going to show the thermometers for safety and for fuel efficiency, but this is what we imagine that the panel of teenage experts would come up with for the "cool" factor. By far the most cool car would be the Mustang. The least cool car is the Honda. The Ford pickup is the second most cool. And then the Focus is somewhere behind that.

Once one has these numbers, and let me stress again, there's not argument about the numbers, it's purely a question of getting the information. Then one has to do perhaps the most difficult part of the analysis, which is to [5] **choose the weights for each goal**. Now, the weights are chosen from 0 to 100, where 100 is the goal that you would value most. And if you read the literature on this technique, you will find that there are various ways described to get a group of people to agree on what the weights might be.

I've never found what people tell you to do in textbooks really works with a group of people. So what I'm going to do is imagine that around the table people came up with a set of weights. And they decided, in looking at the goals, that safety was very important, that fuel economy was very important - this is the parents throwing in how they feel about things.  The student is going to say, "Gee, cool is important," but everybody else is going to outvote the student.  And the grandparents are going to say, "But we're helping to pay for this.  Purchase price is important." So we're going come up with weights where safety is as good as you get, fuel economy is as good as you get, because everybody in the household is conservation oriented.  The poor teenage kid gets outvoted and cool factor drops to 25.  And the purchase price is put at 50 against the objections of the grandparents.

It turns out that choosing the weights is the most difficult part of the analysis, but it also turns out that choosing the weights isn't that important, as we'll see in a moment.  So let's have a look at what we still have to do in the analysis.  We scored the options against the goals. We've chosen the weights.  We then have to [6] **rank the options**.  And then we are going to do a [7] **sensitivity analysis**.  And the sensitivity analysis gives us the opportunity to look at alternative choices for the weights.  We rank the options as a weighted sum of the scores on the thermometers, and this is something that's best done on a computer.

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