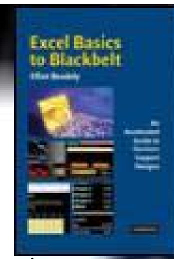


Solving Optimization Problems in Excel: The OUTCOMES Roadmap

What is the roadmap?

1) **O**bjective specification.

   What is the final result you're aiming for? E.g. maximize profit? Specify not only the measure of focus, e.g. expected profit, level of risk, etc., but also whether you are interested in either maximizing or minimizing that issue.

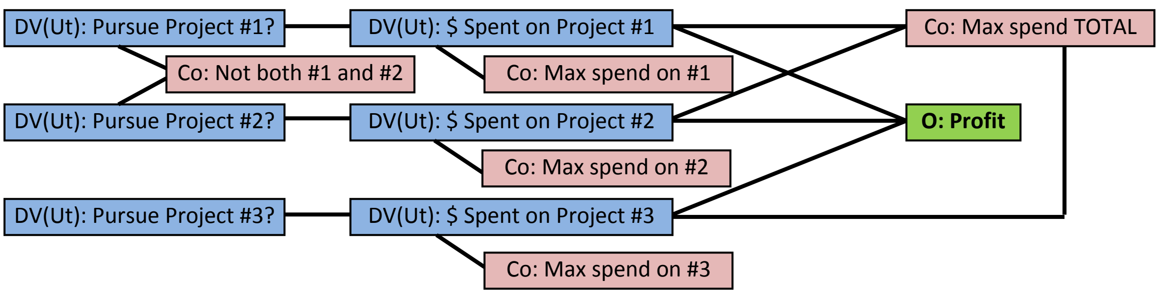
2) **UT**ility factors (or decision variables) specification.

   List all factors that you (or decision makers in question) are in control of and can use in pursuit of the objective. Note that some of these factors may be relevant indirectly, or may serve simply to assist in the accounting process for your decision-making problem, but nevertheless worth outlining.

3) **CO**nstraints specification.

   List all factors that are fixed and which limit the extent to which decision variables (utility factors) or even the objective may be modified. Note that some of these constraints may simply represent a limit (e.g. can only spend up to $X on project #1), while others may represent 'relational' limits (e.g. project #1 and project #2 cannot both be pursued simultaneously).

   Note: "CO" also represents an implied attempt at this point to draw out a COncept map of how your objective, decision variables and constraints relate to one another. Continuing with the above example, the decision to pursue project #1 and that of pursuing project #2 are LINKED (they are not independent decisions). They may also be LINKED to maximum spends, as well as the objective. A simply concept map might therefore be presented a little like this:



4) **M**athematical equation generation.

   *In part this requires creating some notation for short reference to variables (e.g. let "d1" be a 0,1 variable representing whether project #1 is pursued, let "x1" be the amount spent on project 1, let "m1" be the max spend on #1). Notation development is typically viewed as 'simple', but is not without its own pitfalls if done in a haphazard way. The more challenging task here is typically the translation of a concept map (suggesting linkages between the objective, decision variables and constraints) into specific mathematical forms using this notation. Again building on the above example, the relationship between deciding to pursue project #1 and the 'spend' on project #1 might be take on the following mathematical form, given the stated notation: "x1 <= d1*m1". The requirement for only either #1 or #2 being pursued might be stated as "d1 + d2 <= 1". For working with constraints that outline relationships between binary variables (as in this last case) considering which areas of a logic-matrix apply is often helpful (see panel on right):*

Option1

Option2	F(0)	T(1)
F(0)	= ✓	> ✓
T(1)	< ✗	= ✓

i.e. Option1>=Option2

5) **E**xcel model development.

   Actually code the equations you have developed into a model. Once you have an outline of what math applies, this is a fairly simple task (usually you just need to select cells for storing objective, decision variable values, as well as cells for specifying other "facts" that are used in you math (e.g. costs, returns, and limitations associated with specific variables). Additional cells are often used to contain intermediate calculations (you don't need to store all calculations in single cells, especially if calculations are complex). Experienced modelers often go directly to working in Excel for the earlier steps, hence this additional step becomes a given.

6) **S**earch for a solution.

   Now that the problem is structured in Excel, it should be amenable to a host of automated solution procedures. Solver and RiskOptimizer are common tools for this task, though other available tools also exist. In any case, the results of these searches should not be taken for granted. Any decent analysis must follow up with a critical examination of what the results mean. Whether the actions suggested make sense. Are the model specifications correct? Can additional improvement be pursued further?