TOOLS USED IN DECISION MAKING

Demian Horia
Str. Universitatii nr 1, Faculty of Economics, University of Oradea, Romania

Bernabeu Elena Perez
Universitat Politecnica de Valencia, Spain

Abrudan Maria Madela
Str. Universitatii nr 1, Faculty of Economics, University of Oradea, Romania

Abstract: *Decision making is one of the important tasks of every manager. The process of taking decisions has to be based on knowledge. For optimizing this process some software solutions has been created. In this article we tried to summarize some of the features which exists in some software applications.*

Keywords: *decision making, risk solver*

Introduction

Knowledge is the main source of competitive advantage in the knowledge economy and innovation in organizations involved in the services sector.[1] It's really about the transformation of information into useful data management process. We must keep in mind, however, that the speed with which information circulates, accessibility, search and how their storage are critical factors to be taken into account in streamlining decision-making.

Taking into account the likelihood of achieving results, several models are developed to optimize decisions, starting from the classification of decisions: decisions in conditions of certainty, risk and uncertainty. The elements that distinguish these types of decisions is very important for all - managers and software developers.

While the development of computer applications has raised no problems using established models in case of economic consequences known with certainty - ELECTRE, for example - the real challenge for software developers is to optimize the decisions of category risk and uncertainty.

In the service sector, as in any other field of economics, all computer application are based on the distinction between definitions of risk and uncertainty:

-risk is present when future events occur with measurable probability

-uncertainty is present when the likelihood of future events is indefinite or incalculable (Frank H. Knight, 1921)

Between different algorithms used inside the software "Monte Carlo has become a standard tool of risk management" [PRO02]

According to Michele Gambera, the accuracy of the results is limited by the number of simulated histories. The process of simulation will be longer when we have more data. So, an important issue will be how fast a computer program can do all the calculations. New technologies which were developed will improve the speed of the calculations. Cloud computing is one of this technology. If we are taking into consideration cloud computing, we have to be aware that the algorithm has to be done in parallel and also if there are a mechanism of sending and receiving subsets of data between these processes. Monte Carlo algorithm is one which can be done in parallel computing.

In Monte Carlo simulation an important fact is the distribution which we used for our model. There is a lot of distribution which can be used like normal distribution, uniform distribution, triangular distribution and so on.

According to an article of S. Savage, S. Scholtes, and D. Zweidler "simulations without acceptable input distributions are like light bulbs without electricity", and they observe very well that "Only a few people within an organization have the expertise to estimate probability distributions, and even fewer have the managerial authority to get their estimates accepted on an enterprise-wide basis". One of their ideas was to manage probability distributions centrally and to replace the classical probability distributions with stochastic libraries a pre-generated random trials that approximate" stochastic inputs or can be the results of simulation and optimization models.

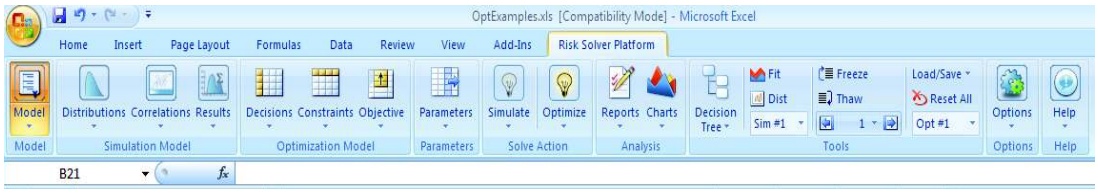
ProbabilityManagement.org has presented the DIST™ Distribution String which brings to Monte Carlo simulation, a data structure that contains thousands of Monte Carlo trials. These trials are compressed through XML, so that structure can be store in the single cell of a spreadsheet or in a field of a data base. The main advantages of DIST is that it can be generated by experts, to represent virtually any type of probability distribution, and then it can be distributed to others in a standardized format.

Other important concept is to use interactive simulation in your model.

Risk Solver Platform is developed by FrontlineSystems and is fully integrated with Microsoft Excel. This software can be used for linear and non-linear model, for conventional optimization, for decision tree model, for risk analysis and Monte Carlo simulation.

"This package was also the first, and as of this date, the most powerful interactive Monte Carlo simulation package for Microsoft Excel. For simple simulations involving a few variables, it can perform 100,000 trials essentially instantly, as the user changes parameters in the model." [http://probabilitymanagement.org/Software.htm]

Immediate after installation the menu of Excel will be improved with a ribbon with specific option for optimization and simulation, like it can be seen in the following figure.

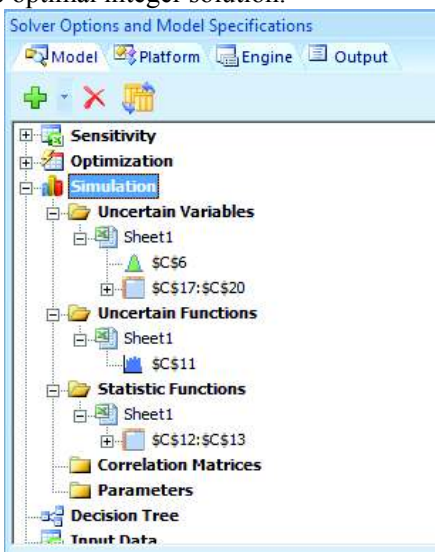


Also a Model Pane which consists of four tabs will be displayed in the right part of the screen. Model tab is used for seeing the description for the current model which can be one of Optimization, Simulation or Decision tree. Platform tab is used for defining parameters for Optimization Model, parameters for Simulation Model or parameters for decision Tree Model.

Engine tab is used for specifying engine which will be used in solving the problem. We can select from Standard GRG Nonlinear Engine, Standard LP/Quadratic Engine, Standard Evolutionary Engine, Standard Interval Global Engine, Standard SOCP Barrier Engine, Risk Solver Engine, or we can let it choose automatically which engine to use in solving the problem. Which engine should we use? Their recommendation is to try them all, and use the one that performs best on your model.[RISK01]

For every of these engine we can define some parameters which will be used, like Monte Carlo number of trials, the algorithm used for random number generations, number of iterations, Integer tolerance, Multi Start and

so on. Integer tolerance is used to stop finding a solution in Branch and Bound algorithm, when the relative difference between the best found solution and the best possible solution is less than this value. If this value is set to zero, the algorithm will be stopped with the true optimal integer solution.



When Multistart option is set to true, methods for finding global solution to the problem will be used.

Output tab is used for displaying the results.

Nonlinear problems are more difficult to solve than linear problems. In risk solver platform an important advantage is that of using  (Analyze without solving) button, which will help us in finding the model. If the nonlinear problem is convex, the global optimal solution will be found.

For using this platform we have to be familiar with Microsoft Excel. The platform came with a lot of useful examples for optimization, simulation and simulation & optimization like Simple Business Plan Forecast Model with Uncertainty, an example illustrating modeling an investment fund's growth given uncertain return rates, an example illustrating modeling multi-period Inventory problems with uncertain demand, an example illustrating the use of Monte-Carlo Simulation to estimate workforce levels required to meet demand, an example illustrating use of Monte-Carlo Simulation in Airline Yield Management; this example also shows the use of a parameterized simulation model to arrive at good decision policies under uncertainty.

It is very important to mention that a useful package named Risk Solver Engine can be used to develop and deploy application to users.

Risk Solver Platform came with a set of functions which can be used for defining optimization models and Monte Carlo simulation models. According to their documentation most of these functions will be used for Monte Carlo simulation models, or for the uncertain elements of stochastic optimization models.

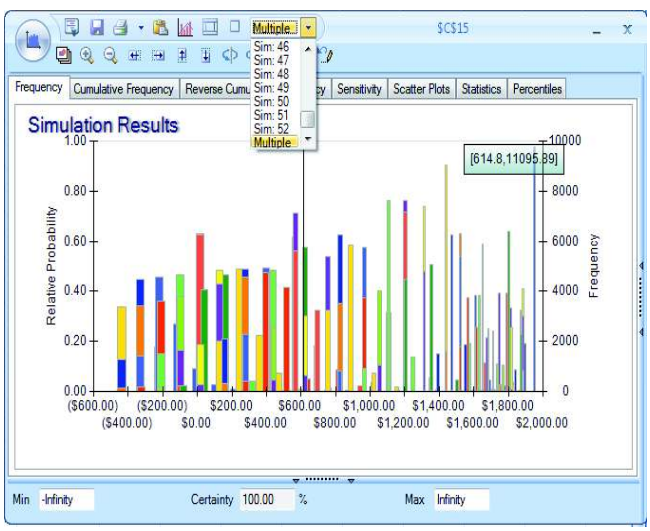
We have tried to solve a problem of making reservation to a hotel, in the following conditions. Our hotels have 50 rooms, and the price for a room is 39 EURO. In case a client will cancel the reservation, hotel will not refund the price of the first night of accommodation. In case the tourist will show up and no room will be available a compensation of 25% of the price of a room will be paid by the hotel for tourist accommodation in another hotel.

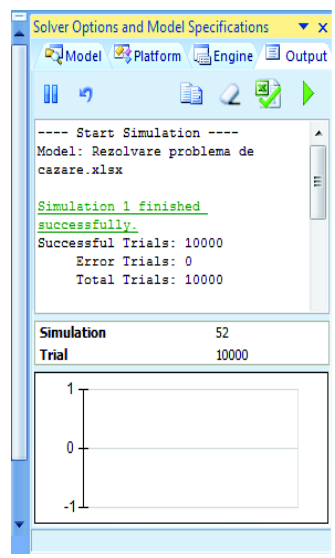
In less than 5 minutes we can create a model of our problem based on the model which is defined in YieldManagementModel2.XLS file. The distribution of cancelation will be a LogNormal distribution of 5% with a standard deviation of 2%. For this we used PSILogNormal function which generates random number of tourist cancelations. We prefer this model because we can see exactly the evolution of simulation for each particular case, and we can make an idea about the algoritm.

3	Price/room	39						
4	Number odf rooms in Hotel	50						
5	Number of cancelation	6						
6		5.945649429						
7								
8	Refund of cancelation	0%						
9	Overbooking Compensation	125%						
10								
11	Number of bookings	101						
12	Number of turist which arrive	95						
13	Number of Overbooked rooms	45						
14								
15	**Total Revenue**	**($243.75)**						
16								
17								
18	Simulation Number	1	2	3	4	5	6	7
19		50	51	52	53	54	55	56
20		1832.9727	1870.027	1906.106	1917.375	1896.368	1859.364	1816.364

For number of booking we used =PsiSimParam(C19:BB19) which tell to Solver engine that a different simulation will be made for each value of a cell from the domain C19 to BB19. We also used =PsiMean(C15,C18) do define the expected revenue in each case of simulations. We also set the number of trials per simulation to 10000 for more accuracy. In less than 3 seconds on our computer we obtain the results to our problems which indicate us to use 53 rooms in the process of making reservations.

Another very useful thing is the displaying of the results which can be viewed and analyzed in a different window like the above on. We can combine multiple simulations in our analyzing or we can see the results for only one.



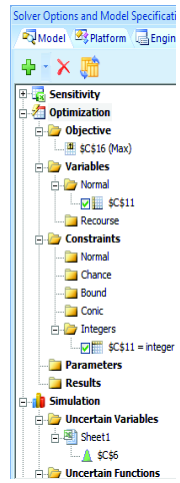


To solve this problem solver was simulate all 50 cases with 10000 of situations in 0.25 seconds.

The same problem can be solved if we define a simulation &optimization model. For this model we used only PSILogNormal and

PSIMean functions as it can be seen in the following figure.

3	Price/room	39	
4	Number odf rooms in Hotel	50	
5	Number of cancelation	2	CEILING(C6,1)
6		1.940336761	PsiLogNormal(0.05*C11,0.02*C11)
7			
8	Refund of cancelation	0%	
9	Overbooking Compensation	125%	
10			
11	Number of bookings	40	
12	Number of turist which arrive	38	
13	Number of Overbooked room	0	
14			
15	**Total Revenue**	**$1,482.00**	MIN(50,C12)*C3-C5*C3*C8-C13*C9*C3
16		1917.39	PsiMean(C15)
17			



We define an maximum objective of C16, we put a condition that number of booking has to be an integer (we cannot book 5.34 rooms), and we also set that C11 is a variable, like it can be seen in the model above in the optimization section. Another parameters of the engine is 1 simulation and 1000 of trials per simulation. We start with  button. Solver has found a solution in our case in 6.8 seconds after informing us that our model contains uncertainity, and Risk solver platform will analyze our formula to determine the best methods for solving it. Also it determine that our models is non linear in decision variables and cannot be solved by stochastic programming or robust optimization methods. At the end inform us that Branch &Bound algorithm has found the best of the locally optimal solutions. The results are 53 bookings like in the preceding solutions.

3	Price/room	39	
4	Number odf rooms in Hotel	50	
5	Number of cancelation	2	CEILING(C6,1)
6		1.301687502	PsiLogNormal(0.05*C11,0.02*C11)
7			
8	Refund of cancelation	0%	
9	Overbooking Compensation	125%	
10			
11	Number of bookings	53	
12	Number of turist which arrive	51	
13	Number of Overbooked room	1	
14			
15	**Total Revenue**	**$1,901.25**	MIN(50,C12)*C3-C5*C3*C8-C13*C9*C3
16		1917.43	PsiMean(C15)
17			
18			
19			
20			

```
---- Start Solve ----
Using: Full Reparse.
Parsing started...
Diagnosis started...
Uncertain input cells detected.
Attempting Stochastic
Transformations...
Stochastic transformation did not
succeed.
Reverting to Simulation/Optimization.
Using: Full Reparse.
Parsing started...
Diagnosis started...
Model diagnosed as "SIM NonCvx".
User engine selection: Standard GRG
Nonlinear
Model: [Rezolvare problema de cazare
2.xlsx]Sheet1
Using: Psi Interpreter
Solver found a solution.  All
constraints and optimality conditions
are satisfied.
Solve time: 6.43 Seconds.
```

Another interesting part of Risk Solver Platform are Decision Tree.