TOOLBOX FOR QUANTITATIVE ANALYSIS

by

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An Informal Toolbox Assignment

Quantitative Analysis for Managers

Forward

This can be used as a quick reference to find definitions, equations, and general information found in both the assigned text and from the courseroom. The value comes to me from not having to retrieve the information directly from the website, as it is copied directly to this paper. The format of this paper is informal. A general APA format is applied, but not required. Capella University is the author of the majority of this material compiled in this toolbox. This toolbox is merely a reference for me. According to the Capella University OM818 course outline this course will:

> Focus on applying decision-making tools for business solutions, not on the underlying mathematical algorithms. Both the art of model formation and the science of analysis are intertwined to present possible scenarios to the astute decision-maker. The models, abstracting from reality, suggest the outcomes of certain courses of action. The computerized algorithms chug away with the fanaticism of an operations researcher slicing away unprofitable decisions and focusing down to the optimal mix of controllable variables. The solutions mechanisms to these powerful quantitative models are imbedded in basic spreadsheets, spreadsheet add-ins, and other dedicated software. Problems not amenable to tidy algorithms are explored using Monte Carlo simulations. The decision-maker combines the quantitative experience and outcomes with other insight from all possible sources to capture the preferred course of action.

Course Learning Goals

Goal I. To improve your ability to make decisions through building creative models.

Goal II. To gain an in-depth comprehension and appreciation of quantitative analysis.

Goal III. To identify organizational situations amenable to iterative quantitative analysis.

Goal IV. To harness the power of computerized solution techniques and thoroughly understand their results.

Goal V: To evaluate the assumptions underlying models and their subsequent limitations in organizational decision making.

Goal V. To develop the skills to be a creative and artful organizational model maker knowledgeable of abstracting the crucial components for analysis.

Goal VI: To use models for improving communication and facilitating teamwork.

Unit ONE - The Quantitative Modeling Path to Problem Solutions

Learning Objectives:

- Examine the quantitative philosophy for problem solving.
- Become skillful at building quantitative models and selecting the appropriate computer/spreadsheet models to perform quantitative analysis.
- Recognize the solution possibilities by applying analytical approaches.
- Anticipate implementation issues in organizations.

Chapter One, chapter 13, page 567, in Render, Stair and Hanna. Review chapter two for a refresher on basic probability concepts and applications.

Chapter 13 has a glossary of terms found on page 594, key equations are on page 595. Chapter one has a glossary and key equations on page 17. Profits = (Price per Unit)(Number of Units Sold) – Fixed Costs – (Variable Costs per Unit)(Number of Units

Sold). An equation to determine profits as a function of the price per unit, number of units sold, fixed costs, and variable costs. Number of units (BEP) = Fixed Costs/(Price per Unit – Variable Costs per Unit). An equation to determine the break-even point in units as a function of fixed costs, variable costs, and the price per unit (Render & Stair, 2000).

Unit TWO - Pragmatic Decision Making Under Risk and Uncertainty

In many instances, the major value of a quantitative approach is the analysis to clarify the decision to be made, the possible alternatives, and performance measures for each combination of decisions. Decision-making models are categorized by assumptions made about events or future states of nature. In those situations in which events and data are known with certainty, optimization models (to be explored in future units) are applicable. Stochastic models become applicable when risk concepts such as probability are added. Decisions can also be made under uncertainty. The decision-maker, when not willing to make any assumptions about states of nature, uses classic decision approaches such as the pessimistic "take the best of the worst" or optimistic "select the best of the best" for each alternative.

Unit Three - Designing and Solving Decision Tree Models

Chapter four, starting on page 117, deals with decision trees capture the essence of multistage decision making. At certain times one has to make a decision among alternatives, which is a controllable situation. The actual payoffs depend on uncontrollable future factors, called states of nature. Working with risks captured as probabilities provides a mechanism for calculating the expected payoffs for various courses of action. Even the process of building the model helps one articulate the components of the decision process while facilitating communications with team members.

More advanced decision trees include updates on information as it becomes available. One example might be how the results of a market survey might change the decision-maker's assessment or probabilities of various levels of product demand. Bayesian Analysis is the method of incorporating new information by revising probabilities.

Learning Objectives:

- Develop accurate and practical decision tree models.
- Estimate payoffs and solve decision trees using computer software.
- Appreciate the iterative value of Bayesian Analysis taking into account new information when available and judging the value of purchasing additional information.
- Understand the importance and use of utility theory in decision making.
- Use computers to solve more complex decision problems.

Chapter four's glossary of terms is found on page 135. Key equations are found on page 136.

Unit FOUR - How Well Can We Forecast the Future by Looking at the Past

Chapter five, starting on page 115, helps understand what is the Dow Jones closing average likely to be at the end of the year? How many units of your product will be purchased during the first quarter? Is how sales have been in the past the only information important in your forecast? Are more recent sales more important than those of four months ago? Can we use other economic indicators and variables to explain our demand figures? How expensive is it to forecast incorrect values? What is the best forecasting technique to use in each situation? How can the power of qualitative forecasts be captured and utilized?

These questions, and more, stress the importance of understanding how to make and analyze various forecasting schemes. The answers are usually not perfect, but the forecasts are still needed for making many decisions.

Learning Objectives:

- Distinguish forecasting techniques by types: time-series, causal, and qualitative.
- Compare moving averages, exponential smoothing, and trend time-series models and evaluate the best to use for a set of data.
- Identify independent and dependent variables and use them in a linear regression model. Forecast using computer software.
- Explore Delphi and other qualitative forecasting techniques.

Chapter five’s glossary is found on pages 185 through 186. Key equations found on pages 186 through 187.

Unit FIVE - Optimization Programming Models and Applications

Chapters seven (p.253), eight (p.305), ten (p.407) and eleven (p.519) discuss and analyze how to make decisions promise to be great. What actions might lead to disaster? Many sets of decisions, beyond the thinking capability of a single brain within a typical lifetime, can be eliminated using mathematical algorithms. A large number of different combinations of decisions can be evaluated according to an objective of minimizing costs or maximizing profits with limits on resources. The type of problems amenable to optimization with one such technique, linear programming, is staggering. Changing assumptions leads to a family of models, all of which can be optimized.

Transportation models, a special structure of linear programming, where the big picture is to minimize the overall cost of shipping goods from delineated sources to particular locations, can be solved even faster. Assigning persons to jobs is another special structure called the assignment model. If the decision variables must be whole numbers, such as decisions to locate offices in various areas, the combinatorial technique is named Integer Programming. If relations are not linear, then nonlinear programming might be possible. Goal programming captures the overall decision ideas by permitting deviations over and under benchmarks such as profits, costs, and amount of resources. The overall objective is to get as close as possible to the achievement of all the goals by making a series of decisions.

For the decision-maker, this unit should bring a host of creative ideas for solving many problems with these powerful optimization techniques. Remember the optimization is guaranteed for the model, not necessarily the problem. Therefore, the careful decision-maker must hone in on the "right" problem and then explore how sensitive the solution is to the certain assumptions made.

Learning Objectives:

- Apply the basic assumptions and properties of linear programming (LP).
- Use sensitivity analysis.
- Model a variety of LP problems in major applications areas, including marketing, production, labor scheduling, fuel blending, transportation, and finance.

- Gain experience in solving LP problems with QM for Windows and Excel Solver software.
- Structure special linear programming problems using the transportation and assignment models.

Explain the differences among linear, integer, goal, and nonlinear programs.

Glossaries found on pages, 287, 288, 446, and 506.

Unit SIX - Inventory, Just in Time, Materials Requirement Planning Models

Chapter six, starting on page 203, deals with the total costs of inventory have driven many organizations to scrutinize their control and ordering policies. When the demand for a frequently ordered product or raw material and its holding-and-ordering costs can be estimated, relatively simple models can calculate the economic order quantity to minimize the total cost. Reorder times are also a straightforward calculation. Changing the model assumptions can approximate different real-world situations. One can perform sensitivity analysis on the results. The usefulness of a model can be tested by how well it performs.

Materials Requirement models expand the modeler's repertoire to planning for items dependent on other inventory items. One example would be the ordering of a thousand components for building a personal computer. The total number of each part needed and its delivery timing are a function of the total number of finished computers to be built. Just-in-time is another popular procedure to minimize total inventory costs and increase manufacturing effectiveness by increasing the functioning of the supply chain with delivery exactly when items are needed.

Learning Objectives:

- Use the economic order quantity (EOQ) to determine how much to order.
- Compute the reorder point (ROP) in determining when to order more inventory.
- Perform sensitivity analysis on basic inventory quantities.
- Handle inventory problems that allow quantity discounts or have planned shortages.
- Understand the use of safety stock with known and unknown stockout costs. Perform ABC analysis.
- Describe the use of material requirements planning (MRP) in solving dependent-demand inventory problems.
- Apply just-in-time (JIT) inventory concepts to reduce inventory levels and costs.

Unit Six has a glossary of terms and key equations listed on pages 234 and 235.

Unit Seven - Networks and Queuing Models

Chapters twelve (p.537) and fourteen (p.615) show how roads should be planned to connect places in a city? How should a sprinkler system be designed under a golf course (or in your front yard)? What is the shortest path from your front door to your office in terms of daily commute time? How should a corporation's computer networks be configured? These are a few of the pragmatic applications for the powerful network models.

The trade-off of providing service versus hiring workers is an essential decision in the design of organizational queuing systems. The body of knowledge for waiting lines enables the probabilistic description of people or units arriving in a system, how the lines are organized, and the variations (using more probabilities) in service time. Add selected behavioral assumptions (e.g., that we do not change lines or ever leave in total frustration and that service starts to deteriorate as the length of the line increases) and you have models for studying, manipulating, and increasing productivity in organizational systems.

Learning Objectives:

- Formulate and solve using computer software the special network structures of minimal-spanning tree, maximal-flow, and shortest-route techniques.
- Describe the trade-off curves for cost-of-waiting time and cost of service provided.Identify the three parts of a queuing system: the calling population, the queue itself, and the service facility.
- Describe the basic queuing system configurations.
- Analyze by computer a variety of operating characteristics of waiting lines.

  Terms and equations are outlined and defined on pages 639 through 641

Unit 8 - Simulation Modeling: Approaches When the Analytical Models Do Not Apply

Chapter fifteen, starting on page 655, discusses models for determining what it is the decision-makers do when no models exist to fit his or her real organizational problems. An example might be deciding how to configure a queuing situation such as a hospital's emergency room. The arrivals might be indescribable with a standard probability distribution. Service times might not be a tidy probability distribution. The triage system does not adhere to first-come-first-serve rules. The most serious cases need to be seen first. Suppose there are many services needed (such as x-rays, examinations, breathing machines), and many dependent and other independent of actions that have already taken place. Reality often becomes too complex and the assumptions might be too heroic to even attempt one of the optimization models previously examined. This is the type of problem where simulation is valuable. Deterministic spreadsheet simulations might calculate fundamental "what ifs?" Adding random number generators mimicking states of nature creates the powerful Monte Carlo simulation models. The decision-maker should always question the validity of each simulation model or the degree to which the model purports to represent reality.

Learning Objectives:

- Tackle a wide variety of problems by simulation.
- Recognize when and why analytical models might be inappropriate.
- Apply the seven steps of conducting a simulation.
- Explain the advantages and disadvantages of simulation.
- Be familiar with the alternative computer simulation packages available commercially.

A glossary of key terms are found on page 683.

Conclusion

This course covers a great deal of data, systems, equations and ideas that are best covered over a longer period of time. It is good that students can work online discussing ideas of how answers can be derived at. The course probably would be much easier to learn in an actual brick-and-mortar classroom with instruction that is face to face. The instruction given in this course with hints and showing how the problems were worked out is very helpful.

References

Capella University website for OM818. http://www.capella.edu retrieved on January through March, 2003.

Render, B. & Stair, R. M. (2000). Quantitative analysis for management seventh edition. Upper Saddle River, New Jersey: Prentice Hall.