Defining a Business-Driven Optimization Problem

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INTRODUCTION

In today's competitive marketplace, it has become inevitable for businesses to use big data analytics and optimization for making smatter and faster decisions. Despite the viral application of data analytics in business, many decision makers yet do not have a clear grasp of the concepts and opportunities available to them. This results to less effective collaboration from them in the process of designing analytics tools and hinders the process.

Optimization is the act of finding the best solution of a problem amongst all the possible solutions using mathematical programming. In business context, an optimization problem is usually formulated mathematically, and solved by available software packages such as R. When seeking to become an analytics-driven organization, defining and solving problems on a daily basis becomes crucial. Usually, defining the scope of a problem within an organization is a burdensome and collaborative effort; especially if it is required to be structured for optimization purposes. Often, consultants interview managers, directors of operations, marketing people, and other members of an organization to identify the pieces required for formulating an optimization problem. These pieces are objective function(s) and constraints represented by decision variables. Despite the usual belief, extensive knowledge of sophisticated mathematical programming is not required to formulate an optimization problem. This chapter provides basic information which is compulsory for proper definition of an optimization problem. This discussion is mainly based on a certain set of questions which could eventually lead to definition of a problem in a step-by-step process. This approach expedites the problem definition efforts in today's fast-paced business environment.

BACKGROUND

Since early times, optimizing the performance of systems was an abiding interest of human. Despite the optimization concept, the large-scale practical optimization has a short history (Chinneck, 2000). Dantzig (1947) developed the first practical, large-scale optimization technique –simplex- during the World War II to solve the massive logistic problems which were originated by millions of people and machine resources involved (Rao, 1996). A few years after the war and by advances in computer technology, "simplex" was completed. Since then, new optimization techniques are arriving on a daily basis. Optimization is yet an exciting hotbed of innovation with an excellent field for researchers (Richard, 2003). In the recent years, it has had a spectacular breakthrough in businesses as most of business decisions have the objective of optimizing some desirable attributes. Big companies like IBM have made huge investments on business analytics tool and optimization technology. IBM alone expects to have 16 billion dollars in revenue from business analytics and optimization tools by 2015 (Bednarz, 2011).

There are several classifications of optimization problems available. One classification divides the problems to constrained and unconstrained. In the unconstrained optimization, the system under study has no constraint and there is no limitation for the results obtained. On the other hand, in the constrained optimization, the best result

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must satisfy a set of system constraints. Most of business problems are constrained by the system restrictions as well as the relations among the system elements. The most common classification of optimization problems in literature is based on the problems mathematical formulation. Some of the classifications which tie to the mathematical formulation of problems are linear programming, non-linear programming and integer programming. These names are borrowed from the nature of relations between the system elements. For instance, a linear programming implies that there is (are) linear relation(s) among the system elements. However, in real-life situations, relations among system elements are rarely linear and thus application of nonlinear programming is required. There are several branches for both linear and non-linear programming such as integer programming. For more insight about linear and non-linear programming, one can refer to Vanderbei (2001) and Bertsekas (1999).

MAIN FOCUS

There are two phases to optimize a system with respect to an objective function: formulating the problem (modeling) and solving it. With Remarkable advances in computer and software technologies, developing sophisticated methods of problem solving such as heuristics and meta-heuristics algorithms are the current research theme in the practical optimization field. In addition to solution methods, a good modeling practice is an important aspect of the problem which is sometimes overlooked. Richard (2003) by emphasizing on the importance of the good modeling practice presents the "Ten Keys to Success in Optimization Modeling". However, the audiences of his text are mainly experts in the area of analytics and operation research. Therefore, this chapter is designed for a broader range of users and will cover the basic steps for a successful definition of an optimization problem before its translation to mathematical terms.

Business Intelligence, Business Analytics and Optimization

In literature, there are different notions of what business intelligence (BI) and business analytics (BA) mean. Often, BI and BA are used alternatively. According to Beller and Barnett (2009) business analytics is a continual exploration and inquiry of a business historical performance to gain insight about the future and to develop business plans. BA is a set of skills, technologies, applications and practices built based on data and statistical methods. In contrast, business intelligence uses a fixed set of metrics to evaluate the past performance and help future planning. Beller and Alan (2009) define the business intelligence as the ability of organization in extracting knowledge from large amounts of data. The knowledge obtained, could eventually result to development of new opportunities, where if it is implemented right gives an organization a competitive edge in the market, and sustains profitability in the long run.

Business analytics has a strong decision support capabilities. It uses the data provided by BI to make more meaningful information. Although, BI is usually capable of extracting basic information from the data, BA uses more dynamic and sophisticated methods of problem solving such as optimization. Today, most businesses have basic BI tools e.g. a database. This data is usually stored to be processed helping the decision making process in the future. However, it usually remains in data warehouses for days, months or even years. Organizations with strong BI systems can generate thousands of reports and queries from the data warehouses with no specific clue about the actions required to be taken for the improvement of their businesses. Therefore, it is necessary to have a decision support system which provides actionable decisions from the available data. To do so, business analytics could be used to analyze the data and extract meaningful information and actionable decisions. Figure 1 shows the different tools used by business intelligence and business analytics.