Chapter 15

A Comprehensive Guide to Optimization Algorithms in Modern Computing

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ABSTRACT

The best solution to a problem is found via optimization algorithms, which are mathematical processes that frequently involve determining a function's lowest or maximum value. These methods are essential for increasing accuracy and efficiency in a variety of domains. Finding the best answers for a particular optimization problem may depend greatly on the optimization algorithm selection. There are many different types of optimization algorithms. The goal is usually to reduce amount of loss that occurs throughout learning process. Data samples and their corresponding results are fed into a model. Upon producing an output, a model compares it to the intended output, calculates difference between the two, and then tries to make generated output more similar to intended result. An optimization algorithm iterates over multiple cycles until it converges, increasing model's accuracy. This chapter highlights the significance of optimization algorithms in fostering creativity and efficiency in problem-solving by giving a high-level overview of their concepts, classifications, and applications.

1. INTRODUCTION

The concept of optimization is well employed both widely and routinely in defining and employing design processes in the development of products. Optimizing A design is sometimes described to enhance

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or improve a design with respect to at least one performance parameter. The concept of optimization can be given a highly technical meaning, however, by saying this: there is a good mathematical assertion called optimization (Papalambros, 2002). Relying on the Al Principles of design I will say that it is based on the fact that the design defining process is considered as the process of decision making in which a variety of identities are being considered and the most appropriate functional shape is chosen. It is possible then that appropriate values be found of the design quantities which determine completely the configuration in question which facilitates a further progression in the embodiment of the desired functional configuration. A formal optimal design model can cover the functional form (configuration or topology) of an artifact, the embodiment (proportioning and/or shape) of a particular configuration, or any combination of the two (Papalambros, 2002).

Optimization can be found everywhere, in business, in engineering design, in vacation planning, and in everyday lives. Business companies give priority to profit maximization and cost reduction. The engineering design should ensure maximum performance of the planned-out product and of course at a minimal cost. In arranging vacations, we strive to save costs on time and have more fun, as well. Due to this fact, research in the domain of optimization becomes both scientifically and pragmatically relevant, and the approach will, therefore, be utilized in a number of ways (Yang, 2008).

Majority of the local optimization algorithms are gradient-based. This type of optimization by gradient-based methods involves the use of gradient information to find out the optimum solution as their name suggests. Gradient-based methods form a common mode of solving many forms of optimization problems in engineering. The popularity of these methods is due to the fact that they have been shown to be able to solve problems with a large number of design variables, are effective (measured in the number of times that the optimization algorithm evaluates the functions to be minimized to obtain the optimal solution), and they generally require very little parameter adjustment related to the specific problem under consideration. Nonetheless, the disadvantages of these algorithms are also quite numerous including that they find only a local optimum, that they do not perform well when applied on discrete optimization problems, that they are complex algorithms that are difficult to implement and that they may be at risk of being falsely affected by numerical noise (Venter, 2010). To search out the global optimum solution of many structural optimization problems is hard or not possible because it will be too costly in terms of computation. The means to achieve the goal would be to determine a reduced search space when referring to gradient-based search methods. This paper has shown us that data mining is a simple exercise in achieving this objective. Data mining employs the classification, association, and the clustering processes to narrow down the original design space. The data mining operations on unconstrained optimization problems are aimed at finding the narrower search zone which includes the global or at least local solutions. In constrained optimization problems the feasible region or the feasible region with better objective functions is employed. Numerical illustrations indicate that the optimum solutions that are achieved sequentially quadratic programming (SQP) in the smaller design places are truly much inferior to those produced by SQP in the initial design places. In some of the instances, the optimum solutions generated by SQP in a compact space turned out to be superior as compared to those that would have been generated by integrating approximative structural analyses with a hybrid global search strategy (Chen & Huang, 2013).

Optimization is the process of selection of numerous variables but keeping in view alternative constraints to identify the minimum or maximum value of a function. Simulation tools are normally applied to compute the optimization function which is also known as objective function, cost function or fitness function. The fact that code characteristics can lead to non-linear and discontinuous solutions implies the