Volume 6, Issue 4, April 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Historical and Recent aspect of Computational Optimization Techniques

Dr. A.S. Khandelwal
Head of the Department, Computer Science, Hislop College, R.T.M. Nagpur University,
Nagpur, Maharashtra, India

Abstract- Most operation research studies support the construction of a mathematical model. The model is nothing but a collection of mathematical and logical relationships. This relationship depicts the various aspects of the situation under study. The models illustrate the important relationships among variables, which includes an objective function, with which alternative solutions are evaluated and the constraints, that restrict solutions to feasible values. Researchers heavily uses computational optimization techniques such as linear programming and the simplex method, which is becoming at most important. A real world problem is transformed into a mathematical formulation that is solvable using different methods is termed as modeling. In this paper we aim at studying various optimization techniques which are computational by nature. The recent approach Robust optimization technique looks fascinating and extremely helpful for solving complex problems with uncertainties. This paper aims to highlight the journey from linear Optimization to Robust Optimization.

Keywords: computational optimization techniques, linear Optimization, Robust optimization, mathematical model

I. INTRODUCTION

For proper formulation of optimization problems an objective function is required to be defined. And for defining an objective function, the design objectives and behaviors of a system are required to be re-formulated in mathematical expressions (or functions) such that, the co-relation between the system performance and the values of the designable parameters can be ascertained. This relationship in some cases is represented in a form of a scalar function which can be minimized. In many cases a set of competing objectives, can be formulated, which leads to a multi objective optimization problem. Even if the solution sets to a multi-objective problem is found, it leads to decision making process through which, the best combination out of a feasible set of objectives can be chosen. These collections depends on the decision criteria or utility and are not trivial[1].

II. COMPUTATIONAL OPTIMIZATION TECHNIQUES

Gill has defined computational optimization as an area which is different from traditional ways of science and engineering i.e. the theory and laboratory experiments. The computational optimization technique (COT) is, "applying and implementing them for approaching highly efficient results"[2].

III. ORIGIN AND HISTORICAL VIEW OF COT

Earlier in 1928 the game theory were laid by von Neumann. Game theory was applied to solve numerous military, economic and mathematical problems.

1940	Linear programming	Invented by George Dantzig	Was used to propose training and logistics schedules to military in United States
1947	simplex method	Dantzigin	for linear programming problems
1951	non-linear programming.	Kuhn and Tucker	laid the foundation for later research
1957	dynamic programming	Bellman	enunciation of the principle of optimality
1960	nonlinear programming	Zoutendijkand	Further advancement in research
1960	nonlinear programming	Carroll and Fiaccoand McCormick	complex problems can be solved using the popular techniques of unconstrained optimization.
1960	Geometric programming	Duffin, Zener, and Peterson	Became popular technique
1960	integer programming	Gomory	The most real world applications fall under this category of problems.
1960's	stochastic programming	DantzigandCharnesand Cooper	Useful technique for implementation of unconstraint problem

	techniques		
1960's	Goal programming		The desire to optimize multiple objectives or a goal while fulfilling the physical restrictions led to the development of multi-objective programming methods

The desire to optimize more than one objective while satisfying all underlying physical limitations became the main cause for the development of multi-objective programming methods. Genetic algorithms, evolutionary algorithms, Simulated annealing and neural network method are few new class of mathematical programming techniques that have come into prominence during the last decade. LP became popular very soon as it was associated with high-technology research areas that were considered important. Lagarange developed the method of optimization for constrained problems. Later on it was High-speed digital computers which opened the door for implementation of the complex optimization procedures. This also stimulated further research on newer methods making a road towards Computational Optimization Techniques. The recent trends in computational optimization are far apart from the traditional methods[3,4,5]. Although traditional methods are still be an important part of the solution techniques.

IV. THEORETICAL BACKGROUND OF COT

Computational methods have laid a way out and have been found highly successful for solving complicated factors in various practical applications almost in every field. Theoretical analysis of COT gives a clear understanding in terms of whether the problem in hand can be optimized efficiently using a given algorithm.

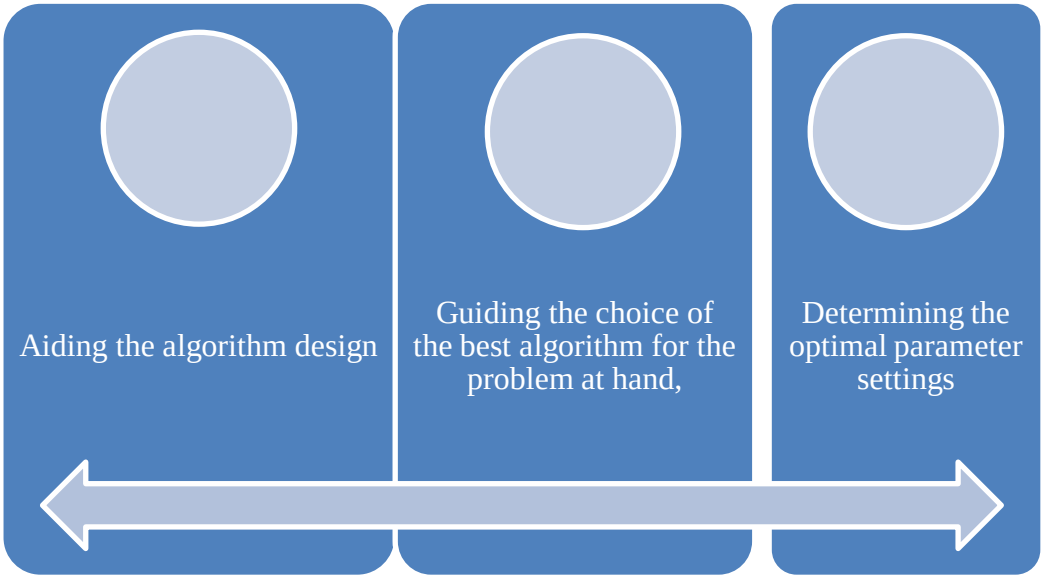


Fig. The Three fold benefits of theoretical understanding for practitioners

COT helps to understand

- Theoretical foundations techniques
- Exact and approximation runtime analysis
- Black box complexity
- Statistical approaches for understanding the behavior

Above aspects facilitates the Computational studies of a foundational nature.

V. ROLE OF COMPUTATIONAL OPTIMIZATION TECHNIQUES IN CONSTRUCTING MATHEMATICAL MODEL

For developing a mathematical model Computational Optimization Techniques are widely used. The model is a representation of logical and important mathematical relationships that highlights the aspects of the situation under study. The irrelevant elements, unimportant to the problem are needed to be ignored. However sufficient details required for obtaining the solution using the model, with regard to the original problem should not be maintained[6]. Models must be tractable as well as capable of being solved. In addition, they should, represent original situation, which should be valid These dual goals are often contradictory and are not always attainable. It is generally observed that the most powerful solution methods can be applied to the simplest, or most abstract, model.

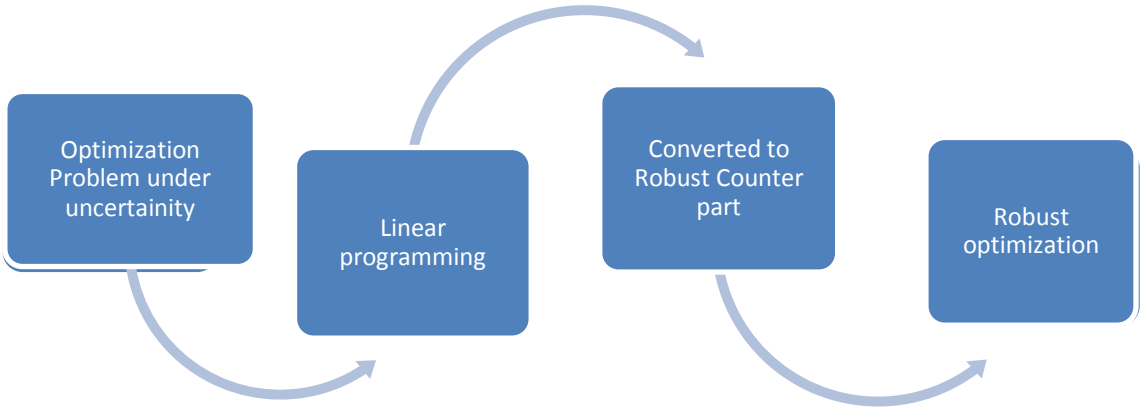
In recent past, a surge of interest has been observed, in applying COT in constraint satisfaction methods developed by the computer science communities as it has roots in logic programming. They also facilitate a more flexible modeling approach than traditional mathematical programming using computational optimization technique [7].

In this work we focused on one famous example, which is the robust linear programming problem with uncertainty. Robust optimization attempts to capture uncertainty in the data underlying the optimization problem. This is solved by taking into account inaccuracies in the input data instead of using random variables. This in turn yielded remarkable

results. It is because of this ROT (Robust Optimzation Technique) which is in fact is an extension of earlier well established OT's (Optimization Techniques) is getting exponential popularity.

VI. A RECENT APROACH- ROBUST OPTIMIZATION TECHNIQUE-

For modeling optimization problems under uncertainty, Robust optimization, the latest approach, gaining popularity. It easily shows the way, where the modeler aims to find decisions that are optimal for the worst-case realization of the uncertainties within a given set. The original uncertain optimization problem is converted into an equivalent deterministic form. This form is known as the robust counterpart. It uses strong duality arguments and then solves using standard optimization algorithms[8].



VII. DISCUSSSION

The digital computer has served as a powerful tool in the field of numerical optimization. The scientist felt the need to develop the linear programming (LP) in order to solve crucial military applications. LP emerged out as a method, which studies optimization problems with linear objective function and constraints. The simplex method was invented by Dantzig for solving linear programs arising in U.S. Air Force operations. Although Dantzig is widely acknowledged as the father of linear programming, but earlier in 1939 the Soviet scientist Leonid Kantorovich emphasized the significance of certain classes of linear programs applications in use of complex resources management, equipment work distribution, cutting of rational substance, the best possible use of sowing region, and transportation. The Kantorovich's work in the area of applied optimization got recognition in 1975 and he was awarded Nobel Prize in Economics. Robust optimization works as an intermediate layer between the modeler and Computational optimization, working as a solver engines, facilitating modelers to express their problems in a mathematically meaningful way.

VIII. CONCLUSION

Emergence of Robust Optimization Technique as a Research tool. The aim is to find an optimal solution that is negligibly sensitive to uncertain factors. Uncertain factors can include problem input, such as parameters decision variables, or both. Given several combination of probable uncertain factors, a solution is said robust "if it is feasible and variation in its objective function value is tolerable within a given user-specified range". To solve "twice-differentiable functions, unconstrained problems the stationary points are required to be found, where the gradient of the objective function is zero". The overall objective in this work is to promote an efficient robust optimization technique that is scalable and provides a better approach to overcome challenges in uncertainty problems and has a capability to become an integral component for researchers.

REFERENCES

[1] D Nagesh Kumar, IISc Optimization Methods: Lecture Series M1L1 *optimization*, time traveler. *lizwang.wordpress.com* November 2008

[2] Gill, Philip E., Walter Murray and Margaret H. Wright (2004).Practical Optimization.Elsevier. Amsterdam,p. 295).

[3] Talbi, E. G., *Metaheuristics: From Design to Implementation*, John Wiley & Sons, (2009).

[4] Yang, X. S. and Deb, S., Eagle strategy using Lévy work and firefly algorithms for stochastic optimization, in: Nature motivated Cooperative Strategies for Optimization (NICSO2010), Springer, pp. 101-111 (2010).

[5] Yang, X. S. and Gandomi, A. H., Bat algorithm: a novel approach for global engineering optimization, Engineering Computations, vol. 29, no. 5, pp. 464-483 (2012).

[6] Yang, X. S., Introduction to Computational Mathematics, World Scientific Publishing Co. Inc., Singapore, (2008).

[7] A. Ben-Tai, S. Boyd, and A. Nemirovski Extending scope of robust optimization: Comprehensive robust counterparts of indecisive problem *Math.ProgrammingSeries B*, 107(1-2) :63-89, 2006.

[8] Robust Optimization Made Easy with ROME,JoelGoh,Stanford Graduate School of Business; NUS Business School, National University of Singapore,Singapore 119245, Melvyn Sim, NUS Risk Management Institute, National University of Singapore.

