

# Chapter 5

## Portfolio Optimization and Asset Allocation With Metaheuristics: A Review

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### ABSTRACT

*Portfolio optimization stands to be an issue of finding an optimal allocation of wealth to place within the obtainable assets. Markowitz stated the problem to be structured as dual-objective mean-risk optimization, pointing the best trade-off solutions within a portfolio between risks which is measured by variance and mean. Thus the major intention was nothing else than hunting for optimum distribution of wealth over a specific amount of assets by diminishing risk and maximizing returns of a portfolio. Value-at-risk, expected shortfall, and semi-variance measures prove to be complex for measuring risk, for maximization of skewness, liquidity, dividends by added objective functions, cardinality constraints, quantity constraints, minimum transaction lots, class constraints in real-world constraints all of which are incorporated in modern portfolio selection models, furnish numerous optimization challenges. The emerging portfolio optimization issue turns out to be extremely tough to be handled with exact approaches because it exhibits nonlinearities, discontinuities and high-dimensional, efficient boundaries. Because of these attributes, a number of researchers got motivated in researching the usage of metaheuristics, which stand to be effective measures for finding near optimal solutions for tough optimization issues in an adequate computational time frame. This review report serves as a short note on portfolio optimization field with the usage of Metaheuristics and finally states that how multi-objective metaheuristics prove to be efficient in dealing with portfolio selection problems with complex measures of risk defining non-convex, non-differential objective functions.*

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## **INTRODUCTION**

Portfolio optimization or asset allocation is found to be of immense importance within classical investigation issues within financial philosophy along with operations research. Managing funds and their optimum allocation by selecting an optimal portfolio is an all-time problem been faced by the financial organizations like Banks, insurance companies, and fund management organizations. Markowitz (1952) is the pioneer in this research domain propounding the mean-variance portfolio model established over quadratic optimization issue based on linear restraints. Numerous theoretical progresses been tried for developing Markowitz model and resolving it, alluding to mathematical modeling techniques. Researches done by Nishimura (1990), Figueroa-Lopez (2005) and Bolshakova et al., (2009) furnish elaborate information on these advances. The model still experienced efficiency in its applicability to real life scenarios. Actually, the progress been done to this model with the usage of transaction costs, complex constraints and by the usage of alternative objective function creates more complexities to the model thereby making it much more computationally improbable. Thus by the usage of numerous classical optimization techniques for solving similar pattern of issues some mathematical conditions can be executed. If any objective function and restraints are indicated by a linear function of conclusion variables then, linear programming proves to be feasible in that case. Further, applicability of non-linear programming can be done in the case of nonlinear objective function and constraints. To a matter of regret these classical methods become outmoded in any situation experienced which usually involve single or additional complications. Viz. the objective function can become non-homogeneous, or is impossible to be expressed analytically in terms of the specifications, or else the issues may desire further cogitation of dual or numerous conflicting purposes which in turn is defined as multi-objective optimization procedure.

The evolution of an advanced category of optimization techniques, named as Metaheuristics, imprint a tremendous revolution in the terrain of optimization. The approaches are pertinent in every category of combinatorial issues, and even proving to be suitable to continuous issues or problems. They let on researchers in finding an adequate result customarily along with a legitimate computational time frame, in spite of assuring the optimality of acquired resolution. Metaheuristic techniques happen to be most fortunately utilized for resolving huge issues. These techniques can be prorated within dual categories. At the begining, the particular algorithms are outlined by the usage of understanding realm for a stated problem. Next, the common or accepted algorithms can be utilized for far-reaching sort of problems. Subsequently, numerous research studies targeted on the portfolio optimization problem have been initiated for the application of the meta-heuristics in determining practical solutions and conquering the complications of the stated problems.

This chapter targets in acquiring the knowledge about the practice of Metaheuristic optimization approaches meant both for the single-objective as well as the multi-objective issues altogether and its utilization within the portfolio optimization. This review work is fragmented into three sections exploring the principal methods of mono-objective Metaheuristics and their usage in portfolio optimization domain, investigating the principal system of multi-objective Metaheuristics and its utilization within portfolio optimization problem and finally concluding.

## **Portfolio Optimization with Metaheuristics**

Within the domain of finance, Portfolio optimization stands to be very vital area of investigation. Commonly, the problem dwells for probing an optimal allocation of the accessible capital within numerous

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