THE MATHEMATICS OF REAL-LIFE OPTIMIZATION. PROBLEMS AND THEIR SOLUTION

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Optimization is an intrinsic part of life and of human activity. In so far as human activity is concerned, the situations when one needs to optimize abound. Manufacturers seek maximum efficiency in the design of their production processes. Investors aim at creating portfolios that avoid high risk while yielding a good return. Traffic planners need to decide on the level and ways of routing traffic to minimize congestion. Governments and organizations seek to form coalitions that best represent their interests and that would be successful in the bargaining that characterizes a conflict resolution process. Finding the 'best' solution for processes of these kinds commonly involves constructing a mathematical model to describe such problems. The resulting models are usually complex and depend on a large number of variables. It is therefore imperative to implement the model on a computer and to use (computer) algorithms for investigating it (approximately). The scientific field of optimization lies at the crossroads between mathematics and computer science, as it tries to understand the mathematical structure and properties of the models and construct algorithms that yield accurate, robust and efficient software for the use and benefit of the non-specialists in need of solving such optimization models. The work of the optimization community is being used in a variety of areas such as cancer radiotherapy, structural design, revenue management, operations research, etc. In this talk, I will describe the optimization problem classes that we know how to solve, those that are still open to finding efficient solution techniques and the challenges that lie ahead in this field.