Multi-objective optimization is a branch of optimization that deals with problems involving multiple, often conflicting, objective functions. The goal is to find a solution that is optimal with respect to all objectives simultaneously. This approach is particularly useful in situations where a single objective function cannot adequately capture the complexity of the problem at hand.

One common method used in multi-objective optimization is the weighted sum approach, where a linear combination of the objective functions is considered. Another approach is the Pareto-optimality principle, which seeks to find a set of solutions that are not dominated by any other solution in the decision space.

Pareto-Optimality: A solution is said to be Pareto-optimal if there is no other feasible solution that is better in all objectives. The set of all Pareto-optimal solutions is known as the Pareto front.

As mentioned in the text, the solution to a multi-objective optimization problem is not a single optimum but a set of non-dominated solutions. This set is known as the Pareto front, and it provides a range of possible solutions that can be chosen based on additional criteria such as the user's preferences or additional constraints.

In practice, solving multi-objective optimization problems often involves using algorithms such as evolutionary algorithms, which mimic natural selection processes to iteratively improve solutions. These algorithms are particularly effective in finding a diverse set of Pareto-optimal solutions in a reasonable amount of time.

The mathematical formulation of multi-objective optimization problems is often complex and requires careful consideration of the problem's constraints and objectives. The goal is to develop methods that can efficiently and effectively find solutions that are optimal across a range of criteria, rather than a single objective.

In summary, multi-objective optimization is a powerful tool for dealing with real-world problems that involve multiple, often conflicting, objectives. By using appropriate algorithms and techniques, we can find a set of solutions that are optimal in the sense of Pareto-optimality, allowing decision-makers to choose the most suitable solution based on additional criteria.

References:
- Weighted Sum Approach
- Pareto-Optimality
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- Theory of Multiobjective Optimization
- Multiobjective Optimization: Interactive and Evolutionary Approaches
- Particle Swarm Optimization Method in Multiobjective Problems
- Nonlinear Multiobjective Optimization
- Multiobjective Optimization Through a Series of Single-Objective Problems
- Multiobjective Optimization Using Gaussian process emulators via
- Multiobjective Evolutionary Algorithms
- Evolutionary algorithms in multiobjective optimization
- Theory of Evolutionary Algorithms

Further Reading:
- Mathematics of Multi Objective Optimization
- Multiobjective Optimization: Interactive and Evolutionary Approaches
- Multiobjective Optimization Through a Series of Single-Objective Problems
- Multiobjective Optimization Using Gaussian process emulators via