2. Operations Research Analysis

Operations Research and the Management Sciences include a variety of problem-solving techniques focused on improved efficiency of systems and support in the decision-making process. The realm of Operations Research involves the construction of mathematical models that aim to describe and/or improve real or theoretical systems and solution methodologies to gain real-time efficiency.

The knowledge area of Operations Research is by its nature mathematical and computational. A fundamental basis in this knowledge area includes probability, statistics, calculus, algebra, and computing.

2.1. Operations Research
- 2.1.1. Modeling approaches
- 2.1.2. Heuristic versus optimization procedures

2.2. Linear Programming (LP)
- 2.2.1. LP applications
  - 2.2.1.1. Diet problem
  - 2.2.1.2. Work scheduling
  - 2.2.1.3. Capital budgeting
  - 2.2.1.4. Blending problems
- 2.2.2. LP modeling techniques
- 2.2.3. LP assumptions
- 2.2.4. Simplex method
- 2.2.5. Degenerate and unbounded solutions
- 2.2.6. Post-optimality and sensitivity analysis
- 2.2.7. Interior-point approaches
- 2.2.8. Duality theory
- 2.2.9. Revised simplex method
- 2.2.10. Dual simplex method
- 2.2.11. Parametric programming
- 2.2.12. Goal programming

2.3. Transportation Problem
- 2.3.1. Transportation model and its variants
- 2.3.2. Transportation simplex method
- 2.3.3. Transshipment problems

2.4. Linear Assignment Problem
- 2.4.1. Assignment model
- 2.4.2. The Hungarian algorithm

2.5. Network Flows and Optimization
- 2.5.1. Shortest path problem

2.5.2. Minimum spanning tree problem
2.5.3. Maximum flow problem
2.5.4. Minimum cost flow problem
2.5.5. CPM and PERT problems
2.5.6. Network simplex method

2.6. Deterministic Dynamic Programming
2.6.1. Applications
2.6.1.1. Knapsack/fly-away/cargo-loading problems
2.6.1.2. Workforce size problems
2.6.1.3. Equipment replacement problems
2.6.1.4. Investment problems
2.6.1.5. Inventory (see Operations Engineering & Management knowledge area)
2.6.2. Forward and backward recursions

2.7. Integer Programming
2.7.1. Applications and modeling techniques
2.7.1.1. Capital budgeting
2.7.1.2. Set-covering and set-partitioning problems
2.7.1.3. Fixed-charge problem
2.7.1.4. Either-or and if-then constraints
2.7.2. Branch-and-bound algorithm
2.7.3. Cutting plane algorithm
2.7.4. Traveling salesman problem and solution methods

2.8. Nonlinear Programming
2.8.1. Unconstrained algorithms
2.8.1.1. Direct search methods
2.8.1.2. Gradient methods
2.8.2. Constrained algorithms
2.8.2.1. Separable programming
2.8.2.2. Quadratic programming
2.8.2.3. Chance-constrained programming
2.8.2.4. Linear combinations method

2.9. Metaheuristics
2.9.1. Steepest ascent and descent (Greedy algorithms)
2.9.2. Tabu search
2.9.3. Simulated annealing
2.9.4. Genetic algorithms
2.9.5. Ant colony optimization
2.9.6. Particle swarm techniques

2.10. Decision Analysis and Game Theory
2.10.1. Multi-criteria decision making

2.10.2. Decision making under certainty
2.10.2.1. Analytic hierarchy process
2.10.2.2. ELECTRE
2.10.3. Decision making under risk and uncertainty
2.10.3.1. Decision tree-based expected value criterion
2.10.3.2. Utility theory
2.10.4. Two-person zero-sum and constant-sum games
2.10.5. Robust decision making

2.11. Modeling Under Uncertainty
2.11.1. Stochastic processes
2.11.2. Markov chains
2.11.3. Chapman-Kolmogorov equations
2.11.4. States and properties
2.11.5. Stochastic programming

2.12. Queuing Systems
2.12.1. Components of a queuing model
2.12.2. Relationship between the exponential and Poisson distributions
2.12.3. Birth-and-death process-based queuing models
2.12.4. Queuing models involving non-exponential distributions
2.12.5. Priority-discipline queuing models
2.12.6. Queuing networks

2.13. Simulation
2.13.1. Monte Carlo simulation
2.13.2. Continuous and discrete time models
2.13.3. Simulation methodology
2.13.3.1. Sampling from probability distributions
2.13.4. Random number generation

2.14. Fundamentals of Systems Dynamics
2.14.1. Principles of systems dynamics
2.14.2. Balancing loops
2.14.3. Feedback loops

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