

Course Content- DSA 8302 Computational Techniques in Data Science

Week	Topics	Content
Week 1	Introduction to Stochastic Programs	Stochastic programming, Role of Uncertainty in Decision-Making Models, Applications in Finance, Logistics, and Healthcare. PYTHON (numpy and cvxpy packages)
Week 2	Introduction to Random Walks	Definition of random walk, 1D & 2D Random Walks PYTHON (numpy and matplotlib.pyplot packages)
Week 3	Introduction to Linear Optimization Problems	Optimizing a linear objective function with constraints. Python Implementation: Using scipy.optimize.linprog
Week 4	Introduction to Graph-theoretic Models	Graph Representation: Adjacency Matrix/List. Applications: Social networks, road maps, shortest paths. Python Implementation: Using networkx
Week 5	Introduction to Stochastic Thinking	Stochastic vs Deterministic Models. Real-life Examples: Queueing systems, stock price modeling. Python Example: Simulating stochastic demand in a warehouse
Week 6	Simple applications in solving linear problems	Examples: Production scheduling, Transportation problems. Python Example: Transportation problem using pulp
Week 7	Programming: Fibonacci Numbers, Longest Increasing Subsequence, Knapsack Problem	Different aspects of Fibonacci Sequence. Knapsack Problem (Dynamic Programming)
Week 8	DEA (Data Envelopment Analysis)	A method for efficiency measurement Python Implementation: Using pyDEA
Week 9	Monte Carlo Simulation in Data Science	Repeated random sampling for approximating distributions. Estimating Pi
Week 10	Formulation, Geometry & Algorithms	Convex Optimization Concepts Algorithms: Gradient Descent, Simplex Python Example: Simplex Method with scipy.optimize
Week 11	Defining Linear Programming problems	Mathematical Form: Maximize/Minimize: $c^T x$ Subject to: $Ax \leq b, x \geq 0$ Python Example: Using pulp
Week 12	Introduction to Integer Linear Programming (IP)	LP where variables are restricted to integer values. Python Example: Using pulp
Week 13	Optimization Problems, Dynamic	Shortest Path Problem. Inventory Management. Python Example: Solving Shortest Path Problem with Dijkstra's Algorithm