1. Linear Programming

Linear programming is a mathematical method for finding the optimal solution to a problem where the objective is to maximize or minimize a linear function, subject to a set of linear constraints.

1.1. Various definitions, statements of basic theorems and properties, Advantages and Limitations

Linear programming is a mathematical model that can be used to represent a wide variety of real-world problems. The model consists of a linear objective function, a set of linear constraints, and a set of decision variables. The objective function is the quantity that we want to maximize or minimize, and the constraints represent the limitations on the values of the decision variables.

The basic theorems of linear programming state that if a linear programming problem has a solution, then it will have at least one optimal solution. The properties of linear programming state that the optimal solution to a linear programming problem is unique if the objective function is strictly convex and the constraints are all strictly feasible.

The advantages of linear programming include the fact that it is a relatively simple and easy-to-understand model, and that it can be solved using a variety of efficient algorithms. The limitations of linear programming include the fact that it can only be used to solve problems that can be represented by a linear model, and that the solution to a linear programming problem may not be the globally optimal solution.

1.2. Application areas of Linear programming

Linear programming is a versatile tool that can be used to solve a wide variety of problems in a variety of fields. Some of the application areas of linear programming include:

•Production planning

•Transportation planning

•Inventory management

•Finance

•Marketing

•Economics

1.3. Linear Programming - Concept

The concept of linear programming is based on the following idea:

•We can represent a real-world problem as a linear model.

•We can use a variety of efficient algorithms to solve the linear model.

•The solution to the linear model will be the optimal solution to the real-world problem.

1.4. Simplex Method and Problems

The simplex method is an algorithm for solving linear programming problems. The simplex method works by iteratively improving the solution to the problem, until the optimal solution is reached.

The simplex method is a relatively simple and easy-to-understand algorithm, but it can be computationally expensive for large problems.

1.5. Two Phase Simplex Method and problems

The two-phase simplex method is a variation of the simplex method that is specifically designed for problems with non-negative variables. The two-phase simplex method works by first solving a feasibility problem, and then solving the original problem.

The two-phase simplex method is more efficient than the simplex method for problems with non-negative variables.

2. Markov Chains & Simulation Techniques

Markov chains are a mathematical model for describing the evolution of a system over time. A Markov chain is a discrete-time stochastic process, which means that the state of the system at any time depends only on its state at the previous time.

Simulation techniques are a set of tools for modeling and simulating the behavior of a system. Simulation techniques can be used to study the behavior of Markov chains, as well as other types of systems.

2.1 Markov chains: Applications related to technical functional areas

Markov chains have a wide variety of applications in technical functional areas, such as:

•Queueing theory

•Reliability engineering

•Economics

•Finance

•Biology

2.2 Steady state Probabilities and its implications

The steady state probabilities of a Markov chain are the probabilities that the system will be in each state in the long run. The steady state probabilities can be used to analyze the long-term behavior of the system.

2.3 Decision making based on the inferences Monte Carlo Simulation

Monte Carlo simulation is a technique for generating random samples from a probability distribution. Monte Carlo simulation can be used to make decisions about systems that are modeled by Markov chains.

3. Sequential model and related Problems

Sequential models are a type of Markov chain that is used to model systems where the order of events matters. Sequential models can be used to study the behavior of systems such as production lines, transportation systems, and computer networks.

3.1 Processing n jobs through 2 machines

The problem of processing n jobs through 2 machines is a classic sequential model problem. The problem is to find the optimal sequence for processing the jobs so that the total processing time is minimized.

3.2 Processing n jobs through 3 machines

The problem of processing n jobs through 3 machines is a more complex sequential model

3.3 Processing n jobs through m machine

The problem of processing n jobs through m machines is the most general sequential model problem. The problem is to find the optimal sequence for processing the jobs so that the total processing time is minimized.

4. PERT & CPM

PERT and CPM are two project management techniques that are used to plan, schedule, and control projects. PERT stands for Program Evaluation and Review Technique, and CPM stands for Critical Path Method.

4.1 Basic differences between PERT and CPM

The main difference between PERT and CPM is that PERT uses a probabilistic approach to estimating project duration, while CPM uses a deterministic approach.

4.2 Network diagram

A network diagram is a graphical representation of a project. The network diagram shows the activities that need to be performed, the dependencies between the activities, and the estimated duration of each activity.

4.3 Time estimates (Forward Pass Computation, Backward Pass Computation)

The forward pass computation is used to calculate the earliest start date and earliest finish date for each activity. The backward pass computation is used to calculate the latest start date and latest finish date for each activity.

4.4 Critical Path

The critical path is the path through the network diagram that has the longest duration. The critical path activities are the activities that must be completed on time in order to meet the project deadline.

4.5 Probability of meeting scheduled date of completion

The probability of meeting the scheduled date of completion can be calculated using the PERT method. The PERT method uses a beta distribution to estimate the project duration.

4.6 Calculation on CPM network

The CPM network can be used to calculate the following:

•The earliest start date and earliest finish date for each activity.

•The latest start date and latest finish date for each activity.

•The critical path.

•The slack time for each activity.

•The probability of meeting the scheduled date of completion.

4.7 Various floats for activities

The various floats for activities are:

•Free float: The amount of time that an activity can be delayed without delaying the start of any subsequent activities.

•Total float: The amount of time that an activity can be delayed without delaying the completion of the project.

•Independent float: The amount of time that an activity can be delayed without delaying the start of any subsequent activities, but with the possibility of delaying the completion of the project.

4.8 Event Slack

Event slack is the amount of time that an event can be delayed without delaying the completion of the project.

4.9 Calculation on PERT network

The PERT network can be used to calculate the following:

•The earliest start date and earliest finish date for each activity.

•The latest start date and latest finish date for each activity.

•The critical path.

•The slack time for each activity.

•The probability of meeting the scheduled date of completion.

4.10 Application of schedule based on cost analysis and crashing

The schedule for a project can be optimized by using cost analysis and crashing. Cost analysis is used to determine the cost of crashing each activity. Crashing is the process of shortening the duration of an activity by adding resources.

4.11 Case study-based problems

PERT and CPM can be used to solve a variety of case study-based problems. For example, PERT and CPM can be used to:

•Plan and schedule a construction project.

•Plan and schedule a software development project.

•Plan and schedule a marketing campaign.

5. Game Theory

Game theory is a branch of mathematics that studies strategic decision-making in competitive situations. Game theory can be used to analyze a variety of games, including:

•Zero-sum games: Games where one player's gain is the other player's loss.

•Non-zero-sum games: Games where the players can both gain or both lose.

•Cooperative games: Games where the players can cooperate to achieve a common goal.

5.1 Introduction

Game theory is a mathematical model for studying strategic decision-making in competitive situations. The model consists of a set of players, a set of strategies for each player, and a payoff function that determines the payoff to each player for each combination of strategies.

5.2 n X m zero sum game with dominance

A zero-sum game is a game where one player's gain is the other player's loss. An n X m zero-sum game is a zero-sum game with n players and m strategies for each

5.3 Solution using Algebraic, Arithmetic and Matrix strategy

A zero-sum game with dominance can be solved using algebraic, arithmetic, or matrix strategies.

•Algebraic strategy: In algebraic strategy, we solve the game by writing down the payoff matrix and then using algebra to find the optimal solution.

•Arithmetic strategy: In arithmetic strategy, we solve the game by simply adding up the payoffs for each player and then choosing the strategy that gives the highest payoff.

•Matrix strategy: In matrix strategy, we solve the game by using a matrix to represent the payoffs and then using a mathematical algorithm to find the optimal solution.

6. Decision Analysis

Decision analysis is a branch of mathematics that studies decision-making under uncertainty. Decision analysis can be used to make decisions in a variety of situations, including:

•Investment decisions: Decisions about whether to invest in a particular project.

•Product design decisions: Decisions about the features of a new product.

•Marketing decisions: Decisions about how to market a product.

6.1 Introduction to Decision Analysis

Decision analysis is a mathematical model for studying decision-making under uncertainty. The model consists of a set of possible outcomes, a set of decision alternatives, and a utility function that determines the value of each outcome to the decision-maker.

6.2 Types of Decision-making environment

Decision-making environments can be classified into two types: deterministic and stochastic.

•Deterministic environments are environments where the outcome of a decision is known with certainty.

•Stochastic environments are environments where the outcome of a decision is uncertain.

6.3 Decision making under uncertainty and under risk

Decision making under uncertainty is decision making in a situation where the outcome of a decision is not known with certainty. Decision making under risk is decision making in a situation where the outcome of a decision is uncertain, but the probabilities of the different outcomes are known.

6.4 Concept of Decision Tree

A decision tree is a graphical representation of a decision-making problem. The decision tree shows the possible outcomes of a decision, the decision alternatives, and the probabilities of the different outcomes.