Topics in sums with explanation

- ~~Unit 1:~~
- ~~Linear programming problem:~~
- ~~Simplex simple~~
- ~~Unit 2:~~
- ~~Artificial Variable simplex~~
- ~~Big m problem Simplex~~
- ~~Two Phase simplex - (Primal Dual)~~
- ~~Duality of Simplex~~
- ~~Replacement ratio ?~~
- ~~Unit 3 :~~
- ~~Nwcr~~
- ~~Lcm~~
- ~~Vam~~
- ~~Modi method~~
- ~~Assignment problem~~
- ~~Hungarian Method~~
- ~~Restricted~~
- ~~dummy~~
- ~~Travelling Salesman Problem~~
- Unit 4
- ~~Bisection method~~
- ~~Newton Raphson Method~~
- ~~Regula Falsi Method~~
- Newton's Forward difference interpolation (See formula for bothh)
- Newton's Backward Difference Interpolation

Topics in Theory

- ~~Unit 1~~
- ~~Introduction to operation research~~
- ~~Advantages Or~~
- ~~Applications Or~~
- ~~Drawbacks Or~~
- ~~Types of solution - feasible ,Nonfeasible ,genrate , non generate , unique~~
- ~~Alternate , infinite , bounded and unbounded solutions,mutual solutions (this and above in simplex)~~
- Unit 2
- ~~Artificial variables,~~
- ~~Big M methods,~~
- ~~bounded / unbounded solution, pseudo optimum solution, degeneracy.~~
- ~~For two phase simplex - relationship of primal and dual ,~~
- ~~formulation of dual simplex method,~~
- ~~rules for constructing dual from primal,~~
- ~~advantages.~~
- ~~For Duality of simplex - bounded / unbounded solution,~~
- ~~pseudo optimum solution, degeneracy.~~
- ~~Comparison of duality and dual simplex method.~~
- ~~Introduction to simulation : definition,~~

- ~~working area of simulation,~~
- ~~steps of simulation process,~~
- ~~advantages and disadvantages of simulation,~~
- ~~role of simulation in computer science, applications~~
- ~~Unit 3~~
- ~~advantages and applications of transportation and assignment model.~~
- ~~Unit 4~~
- ~~Working of all sums advantages and disadvantages if any~~

LPP

- If <= towards origin
- If > = away from origin
- y<= 200 make a line parallel to x at 200 and vice versa

Simplex simple

- For simplex in Cb always take main equation values always
- For ratio calculation it is selected row and Xb ka ration always
- Final answer for each variable is Xb ka value
- Prac 2 sum 11 if all are positive but x2 is 0 continue ?
- **Special Cases :**
    - **Unbounded Solution** - When all ratios are negative or infinite
    - **Infeasible Solution -** if A = artificial variable present in B column after Optimal soln is found then scam
    - **Alternate Solution -** when a variables dj is 0 but its not in b column

Unit 2

Big M Problem

- If the sub to equation has >= sign then you add - S1 and + A1
- If sub to equation has = sign only then add A1 but no S variable
- M is largest -ve number
- **If sum is about Min then convert to maximisation by multiplying main equation by -1 then add s1 and a1**

Primal Dual Problem

- Before converting to dual all max should have subject to as <= sign
- All min should have >= sign
- If not multiply by -1
- Max turn to min from primal to dual and vice versa
- Constraints are transpose of original constraints on lhs and variables of main eqn on rhs

Two Phase Method

- Phase 1 take all A as -1 one instead of -M then take all S and x variables as 0 in the cj
- Solve this till dj is all positive then take the last table
- Start phase 2 with original values in the last table of phase 1 and Answer is the Xb values

Unit 4

Formulas

Forward interpolation

- y(x) = y0 + pΔy0 + p(p-1)2! ·Δ2y0 + p(p-1)(p-2)3!:

Backward is same but its y(y+1)and so on

- y(x) = yn + p∇yn + p(p+1)2!:

Bisection
Xn = x0 + x1 /2
Newton raphson
X1 = x0- f (x0)/ d/dx (f(x0))
Regula Falsi
X2 = x0 - f(x0) **x** x1-x0/f(x1)-f(x0)
Bisection method

Find a root of an equation $f(x) = 2x^3 - 2x - 5$ using Bis

Solution:
Here $2x^3 - 2x - 5 = 0$

Let $f(x) = 2x^3 - 2x - 5$

Here

x	0	1	2
$f(x)$	-5	-5	7

1^{st} iteration :

Here $f(1) = -5 < 0$ and $f(2) = 7 > 0$

$\therefore$ Now, Root lies between 1 and 2

$$x_0 = \frac{1+2}{2} = 1.5$$

$$f(x_0) = f(1.5) = 2 \cdot 1.5^3 - 2 \cdot 1.5 - 5 = -1.25 < 0$$

2^{nd} iteration :

Here $f(1.5) = -1.25 < 0$ and $f(2) = 7 > 0$

$\therefore$ Now, Root lies between 1.5 and 2

$$x_1 = \frac{1.5+2}{2} = 1.75$$

$$f(x_1) = f(1.75) = 2 \cdot 1.75^3 - 2 \cdot 1.75 - 5 = 2.2188 > 0$$

3^{rd} iteration :

Newton Raphson

Find a root of an equation $f(x) = 2x^3 - 2x - 5$ using Newton Raphson method

Solution:
Here $2x^3 - 2x - 5 = 0$

Let $f(x) = 2x^3 - 2x - 5$

$$+ \frac{d}{dx}\left(2x^3 - 2x - 5\right) = 6x^2 - 2$$

$$\therefore f'(x) = 6x^2 - 2$$

Here

x	0	1	2
$f(x)$	-5	-5	7

1^{st} iteration :

$$f\left(x_0\right) = f(1.5) = 2 \cdot 1.5^3 - 2 \cdot 1.5 - 5 = -1.25$$

$$f'\left(x_0\right) = f'(1.5) = 6 \cdot 1.5^2 - 2 = 11.5$$

$$x_1 = x_0 - \frac{f\left(x_0\right)}{f'\left(x_0\right)}$$

$$x_1 = 1.5 - \frac{-1.25}{11.5}$$

$$x_1 = 1.6087$$

2^{nd} iteration :

$f(x_1) = f(1.6087) = 2 \cdot 1.6087^3 - 2 \cdot 1.6087 - 5 = 0.1089$

$f'(x_1) = f'(1.6087) = 6 \cdot 1.6087^2 - 2 = 13.5274$

$$x_2 = x_1 - \frac{f(x_1)}{f'(x_1)}$$

$$x_2 = 1.6087 - \frac{0.1089}{13.5274}$$

$x_2 = 1.6006$

Regular Falsi

Find a root of an equation $f(x) = 2x^3 - 2x - 5$ using False Position method (regula falsi method)

Solution:
Here $2x^3 - 2x - 5 = 0$

Let $f(x) = 2x^3 - 2x - 5$

Here

x	0	1	2
$f(x)$	-5	-5	7

1^{st} iteration :

Here $f(1) = -5 < 0$ and $f(2) = 7 > 0$

$\therefore$ Now, Root lies between $x_0 = 1$ and $x_1 = 2$

$$x_2 = x_0 - f(x_0) \cdot \frac{x_1 - x_0}{f(x_1) - f(x_0)}$$

$$x_2 = 1 - (-5) \cdot \frac{2 - 1}{7 - (-5)}$$

$x_2 = 1.4167$

$f(x_2) = f(1.4167) = 2 \cdot 1.4167^3 - 2 \cdot 1.4167 - 5 = -2.147 < 0$

2^{nd} iteration :

Here $f(1.4167) = -2.147 < 0$ and $f(2) = 7 > 0$

$\therefore$ Now, Root lies between $x_0 = 1.4167$ and $x_1 = 2$

$$x_3 = x_0 - f(x_0) \cdot \frac{x_1 - x_0}{f(x_1) - f(x_0)}$$

$$x_3 = 1.4167 - (-2.147) \cdot \frac{2 - 1.4167}{7 - (-2.147)}$$

$$x_3 = 1.5536$$

$$f(x_3) = f(1.5536) = 2 \cdot 1.5536^3 - 2 \cdot 1.5536 - 5 = -0.6076 < 0$$

3^{rd} iteration :

Here $f(1.5536) = -0.6076 < 0$ and $f(2) = 7 > 0$

$\therefore$ Now, Root lies between $x_0 = 1.5536$ and $x_1 = 2$

$$x_4 = x_0 - f(x_0) \cdot \frac{x_1 - x_0}{f(x_1) - f(x_0)}$$

$$x_4 = 1.5536 - (-0.6076) \cdot \frac{2 - 1.5536}{7 - (-0.6076)}$$

$$x_4 = 1.5892$$

$$f(x_4) = f(1.5892) = 2 \cdot 1.5892^3 - 2 \cdot 1.5892 - 5 = -0.1506 < 0$$

Find dual from primal conversion
MAX Z = 4x1 + 2x2
subject to
x1 - 2x2 >= 2
x1 + x2 <= 10
and x1,x2 >= 0

Solution:
Primal is (Solution steps of Primal by **Simplex method**)

MAX $Z_x = 4x_1 + 2x_2$

subject to

$x_1 - 2x_2 \geq 2$

$x_1 + x_2 \leq 10$

and $x_1, x_2 \geq 0$;

Since objective function is maximizing, all $\geq$ constraints (1) can be converted to $\leq$ type by multipling both sides by -1

MAX $Z_x = 4x_1 + 2x_2$

subject to

$-x_1 + 2x_2 \leq -2$

$x_1 + x_2 \leq 10$

and $x_1, x_2 \geq 0$;

MIN $Z_y = -2y_1 + 10y_2$

subject to

$-y_1 + y_2 \geq 4$

$2y_1 + y_2 \geq 2$

and $y_1, y_2 \geq 0$;

Q.1 Attempt any Three.

A Solve by simplex method (up to 4 iterations)

Maximize Z = 3x1 + 5x2 + 4x3

subject to the constraints

$2x1 + 3x2 \leq 8$

$2x2 + 5x3 \leq 10$

$3x1 + 2x2 + 4x3 \leq 15$

and x1, x2, x3 ≥ 0

B Apply LPP by graphical method to solve:

Maximize Z = 8x1 + 16x2 , subject to

x1 + x2 <= 200

x2 <= 125

x1 + 2x2 <= 300

and x1,x2 >= 0

Mention drawback of graphical method. (Show calculations and rough work if any)

Q.3 Attempt any Three. 21

A Develop an algorithm to get optimal solution from IBFS in transportation problem. Apply the same in the given IBFS. Allocations are given in square brackets. 7

	A	B	C	D	Supply
X	13	7 [200]	19	0	200
Y	17	18 [120]	15	7 [380]	500
Z	11 [180]	22	14 [100]	5 [20]	300
demand	180	320	100	400	

B A company has three factories F1 F2 and F3 with capacities of 200 units each. There are three warehouses W1 W2 W3 with demands of 175, 200 and 250 units respectively. Unit profit is given below. 7

Find the transportation cost using VAM. Write steps too.

	W1	W2	W3
F1	17	26	39
F2	15	28	32
F3	19	22	34

C **Solve following assignment problem. What is the meaning of – mentioned in th problem? Explain in brief.**

12	3	6	-	5	9
4	11	-	5	-	8
8	2	10	9	7	5
-	7	8	6	12	10
5	8	9	4	6	1

D What do you mean by travelling sales man problem and solve following? 7

∞	4	7	3	4
4	∞	6	3	4
12	11	∞	7	5
8	8	7	∞	7
9	9	5	7	∞

Q.4 Attempt any Three. 12

A Define the term Operation research and specify its characteristics. 4

B When the solution is considered as pseudo optimum? Provide example. 4

C How to check whether the solution is alternate solution or not in simplex method? 4

D Explain the term rim condition and IBFS. 4

f) Simplex up to three tables.

1. Attempt **any five** questions. 15

a) How one can use python programming language for implementing operation research problems.

b) Explain NWCR in brief.

c) Write mathematical statement for assignment problem.

d) What do you mean by integer programming model?

e) Consider following primal LPP; Write Dual of the same

Maxi $Z = x_1 - x_2 + 5x_3$

Subject to

$2x_1 + 4x_2 + 5x_3 <= 10$

$2x_1 - x_3 <= 17$

$2x_1 + 2x_2 - 3x_3 <= 16$

$x_1, x_2 >= 0$

f) Write rules for simplex phase 2 method.

g) What do you mean by objective function and constraints?

2. Attempt **any four** questions.

a) List and explain various applications and scope of OR.

b) Solve LPP by graphical

Mini :

$Z = 4x_1 - 2x_2$

Sub to

$x_1 + x_2 <= 14$

$3x_1 + 2x_2 >= 36$

$2x_1 + x_2 <= 24$

$x_1, x_2 >= 0$

2. c) Solve LPP by graphical. What is the solution space? Justify.

$\text{Max } Z = 6x_1 - 4x_2$

Sub to :

$2x_1 + 4x_2 <= 4$

$4x_1 + 8x_2 >= 16$

$x_1, x_2 >= 0$

d) Solve by Simplex.

$\text{Max } Z = x_1 + x_2 + x_3$

Sub to :

$4x_1 + 5x_2 + 3x_3 <= 15$

$10x_1 + 7x_2 + x_3 <= 12$

$x_1, x_2, x_3 >= 0$

e) Solve by simplex method.

$\text{Max } Z = x_1 + x_2 + x_3$

Sub to :

$3x_1 + 2x_2 + x_3 <= 3$

$2x_1 + x_2 + 2x_3 <= 2$

$x_1, x_2, x_3 >= 0$

f) Describe methodology of OR.

3. Attempt **any four** questions.

a) Solve by using Penalty method

$\text{Mini } Z = 3x_1 + 5x_2 + x_3$

Sub to:

$3x_1 + 4x_2 - 5x_3 <= 8$

$2x_1 + 6x_2 + x_3 >= 7$

$x_1 - 2x_2 + x_3 <= 5$

$x_1, x_2, x_3 >= 0$

b) Draw flowchart for simplex by Two Phase Method.

3. c) Consider the following primal and find the dual of the same, further solve simplex method.

Mini $Z = x_1 - x_2 + x_3$

Sub to :

$x_1 - x_3 >= 4$

$x_1 - x_2 + 2x_3 >= 3$

$x_1, x_2, x_3 >= 0$

d) Solve by Big-M method.

Minimize

$Z = 5x_1 + 2x_2 + 10x_3$

Sub to :

$x_1 - x_3 <= 10$

$x_2 + x_3 >= 10$

$x_1, x_2 >= 0$

e) Define slack, surplus, artificial variables in linear programming problem with suitable example.

f) Explain the mathematical formulation of primal and dual problem.

4. Attempt **any four** questions.

a) Consider the following assignment problem and find the cost.

16	15	13	14	15	18
18	16	12	13	17	16
14	14	17	16	15	15
13	17	19	18	14	17

b) Solve Transportation problem using VAM.

	D1	D2	D3	D4	D5	Supply
S1	6	4	4	7	5	100
S2	5	6	7	4	8	125
S3	3	4	6	3	4	175
demand	60	80	85	105	70	

c) Consider following:

12	3	6	–	5	9
4	11	–	5	–	8
8	2	10	9	7	5
–	7	8	6	12	10
5	8	9	4	6	1

Solve assignment problem.

d) **Explain Hungarian method in brief.**

e) **Explain in one or two lines with respect to transportation model. feasible solution, degenerate basic feasible, optimal solution, unbalanced problem, need of MODI.**

f) **Find optimal cost by MODI method.** Allocations are given in square brackets.

P	Q	R	S	
6	5 [28]	8	5 [2]	30
5 [35]	11	9	7 [5]	40
8	9	7 [32]	13 [18]	50
35	28	32	25	

Theory

A. Define the term Operation research and specify its characteristics.

Operation research (OR) is a quantitative approach to problem-solving that uses mathematical and statistical techniques to optimize decision-making. OR is used in a wide variety of fields, including business, engineering, healthcare, and government.

Characteristics of operation research:

OR is a problem-solving approach. It is used to solve complex problems that involve multiple decision variables and constraints.
OR is a quantitative approach. It uses mathematical and statistical techniques to model problems and analyze solutions.
OR is an interdisciplinary approach. It draws on knowledge from a variety of fields, including mathematics, statistics, economics, and engineering.

When the solution is considered as pseudo optimum? Provide example.

A pseudo-optimal solution is a solution that is not the true optimal solution, but it is close enough to be acceptable. Pseudo-optimal solutions are often used in optimization problems where the true optimal solution is difficult or impossible to find.

Example:

A company is trying to optimize its production schedule. The company has a limited number of resources, such as machines and workers. The company also has a number of constraints, such as customer demand and delivery deadlines.

The company could use OR to develop a mathematical model of its production schedule. The model would include all of the company's resources and constraints. The company could then use an optimization algorithm to find the best possible production schedule.

Explain the term rim condition and IBFS.

The rim condition is a condition that is satisfied by all feasible solutions to a linear programming problem. The rim condition states that the sum of the non-basic variables must be equal to the difference between the right-hand side and the left-hand side of the constraints.

An initial basic feasible solution (IBFS) is a feasible solution to a linear programming problem where all of the basic variables are non-negative.

The rim condition and IBFS are important concepts in the simplex method. The simplex method starts with an IBFS and then iteratively moves to better and better solutions until it reaches the optimal solution.

Example:

Consider the following linear programming problem:

Maximize: $z = 2x + 3y$
Subject to:
$x + y <= 10$
$x >= 0$
$y >= 0$
An IBFS for this problem is $x = 0$ and $y = 0$. This solution is feasible and all of the basic variables are non-negative.

The simplex method will start with the IBFS and then iteratively move to better and better solutions until it reaches the optimal solution. The simplex method will satisfy the rim condition at each iteration.

Applications and scope of organization research

Organization research (OR) is a field of study that applies scientific methods to understand and improve the performance of organizations. OR is used in a wide variety of industries, including healthcare, finance, manufacturing, and transportation.

Some common applications of OR include:

- Production planning: OR can be used to optimize production schedules to minimize costs and meet customer demand.

- Inventory management: OR can be used to determine the optimal amount of inventory to hold to minimize costs and avoid stockouts.
- Supply chain management: OR can be used to optimize the flow of goods and materials through a supply chain to minimize costs and meet customer demand.
- Transportation management: OR can be used to optimize the routing of vehicles and the scheduling of shipments to minimize costs and meet delivery deadlines.
- Customer relationship management: OR can be used to segment customers, develop targeted marketing campaigns, and optimize customer service operations.
- Human resource management: OR can be used to develop workforce planning models, design compensation and benefits systems, and improve employee productivity.

Reall theory

Unit 1

Organisational research - Definition

Organizational research is the systematic study of organizations and their members. It aims to understand how organizations work, identify problems, and develop solutions to improve performance and outcomes. Organizational research can be applied to a wide range of topics, including organizational structure, culture, leadership, decision-making, motivation, and productivity.

Applications

Organizational research is used in a variety of settings, including businesses, nonprofits, government agencies, and educational institutions. Some specific examples of how organizational research is used include:

- Improving employee engagement and productivity
- Developing more effective leadership and management practices
- Creating a more inclusive and equitable workplace
- Improving customer satisfaction
- Making better strategic decisions
- Designing more efficient and effective organizational processes

Advantages

Organizational research offers a number of advantages, including:

- Evidence-based decision-making: Organizational research can help organizations make decisions that are based on sound evidence, rather than intuition or gut feeling.
- Improved performance and outcomes: Organizational research can help organizations improve their performance and outcomes in a variety of areas, such as employee engagement, productivity, customer satisfaction, and profitability.
- Increased understanding of organizations and their members: Organizational research can help organizations and their members better understand themselves,

each other, and the world around them. This can lead to improved communication, collaboration, and decision-making.

Disadvantages

Organizational research also has some disadvantages, including:

- Cost: Organizational research can be expensive to conduct, especially for large and complex organizations.
- Time: Organizational research can take time to conduct and implement.
- Complexity: Organizational research can be complex and difficult to understand for those without training in research methods.

Types of solutions

Feasible solution

- A feasible solution is a solution that satisfies all of the constraints of a problem. For example, if a problem has the constraint that all variables must be positive, then a feasible solution is one in which all of the variables are positive.

Non-feasible solution

- A non-feasible solution is a solution that does not satisfy all of the constraints of a problem. For example, if a problem has the constraint that all variables must be positive, then a non-feasible solution is one in which one or more of the variables is negative.

Generate solution

- A generate solution is a solution that is produced by the simplex method. It is not guaranteed to be a feasible solution, but it is guaranteed to be improving, meaning that it is better than the previous solution. The simplex method will continue to generate solutions until it finds a feasible solution, or until it determines that there is no feasible solution.

Non-generate solution

- A non-generate solution is a solution that is not produced by the simplex method. It is possible for a non-generate solution to be a feasible solution, but it is not guaranteed.

Infinite solutions

- A problem has infinite solutions if there is more than one feasible solution that has the same optimal objective function value. For example, the problem of minimizing the objective function $z = x + y$ subject to the constraints $x >= 0$, $y >= 0$, and $x + y <= 10$ has an infinite number of feasible solutions, all of which have the optimal objective function value $z = 10$.

Bounded solutions

- A problem has bounded solutions if there is a finite value for the objective function that is better than all other feasible solutions. For example, the problem of minimizing the objective function z = x^2 + y^2 subject to the constraints x >= 0 and y >= 0 has a bounded solution, with the optimal objective function value z = 0.

Unbounded solutions

- A problem has unbounded solutions if there is no finite value for the objective function that is better than all other feasible solutions. For example, the problem of minimizing the objective function z = x subject to the constraint x >= 0 has an unbounded solution, with the optimal objective function value z = -∞.

Mutual solutions

- Two solutions are mutual if they are both feasible and both have the same optimal objective function value. For example, the problem of minimizing the objective function z = x + y subject to the constraints x >= 0, y >= 0, and x + y <= 10 has an infinite number of mutual solutions, all of which have the optimal objective function value z = 10.

Important terms

Slack variables

Slack variables are used to convert inequality constraints into equality constraints in the simplex method. They represent the unused capacity of a resource constraint.

For example, consider the following inequality constraint:

2x + 3y <= 12

We can convert this constraint into an equality constraint by adding a slack variable, s, as follows:

2x + 3y + s = 12

The slack variable, s, represents the unused capacity of the constraint. In this case, it represents the amount of the resource that is not being used.

Surplus variables

Surplus variables are used to represent the unused capacity of a greater-than-or-equal constraint in the simplex method. They are also called negative slack variables.

For example, consider the following inequality constraint:

x + y >= 5

We can convert this constraint into an equality constraint by subtracting a surplus variable, t, as follows:

x + y - t = 5

The surplus variable, t, represents the unused capacity of the constraint. In this case, it represents the amount of the resource that is not being used.

Artificial variables

Artificial variables are used to convert inequality constraints into equality constraints in the simplex method when there is no feasible solution to the original problem. They are used to create a starting point for the simplex method.

For example, consider the following inequality constraint:

x + y >= 5
This problem has no feasible solution because the sum of x and y cannot be greater than or equal to 5. To make the problem feasible, we can add an artificial variable, a, as follows:

x + y + a = 5
The artificial variable, a, is used to create a feasible starting point for the simplex method. Once the simplex method has found a feasible solution, the artificial variable is removed from the problem.

Unit 2

Bounded and unbounded solutions in the Big M method

A bounded solution in the Big M method is a solution that has a finite optimal objective function value. An unbounded solution is a solution that has an infinite optimal objective function value.

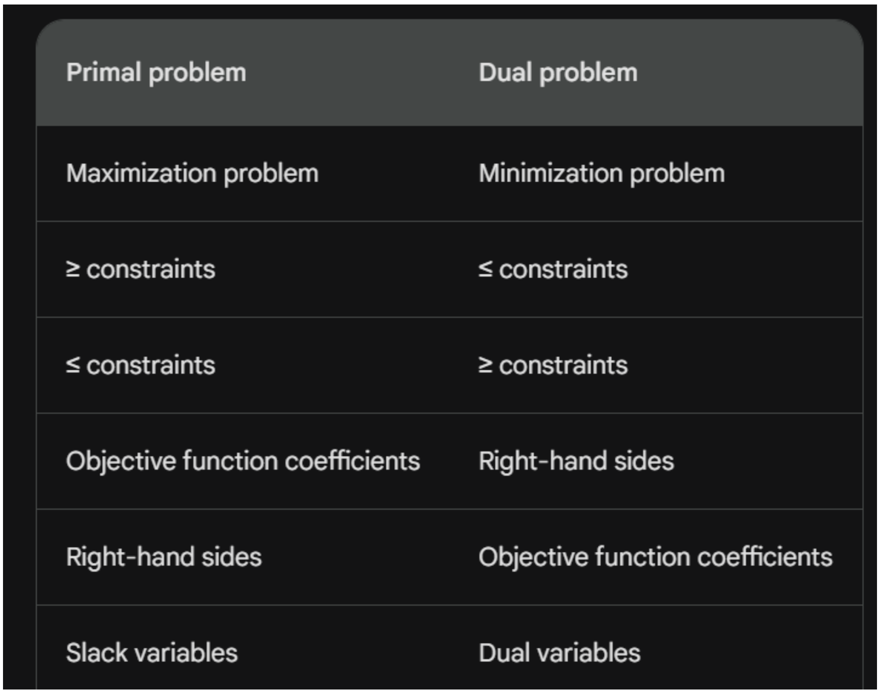
Pseudo-optimal solutions in the Big M method

A pseudo-optimal solution in the Big M method is a solution that is feasible and has an optimal objective function value, but it contains artificial variables with positive values. Artificial variables are used in the Big M method to convert inequality constraints into equality constraints. They are not part of the original problem, and they should be equal to zero in any optimal solution. Therefore, a pseudo-optimal solution is not a true optimal solution.

Degeneracy in the Big M method

Degeneracy in the Big M method occurs when the basis at a given iteration contains a variable with a value of zero. Degeneracy can cause the simplex method to cycle, which means that it can repeat the same iterations over and over again without making any progress towards an optimal solution.

Relationship between primal and dual in simplex



Primal problem	Dual problem
Maximization problem	Minimization problem
≥ constraints	≤ constraints
≤ constraints	≥ constraints
Objective function coefficients	Right-hand sides
Right-hand sides	Objective function coefficients
Slack variables	Dual variables

Duality Simplex solutions

Bounded / unbounded solution

A bounded solution in duality of the simplex method is a solution that has a finite optimal objective function value. An unbounded solution is a solution that has an infinite optimal objective function value.

Pseudo-optimal solution

A pseudo-optimal solution in duality of the simplex method is a solution that is feasible and has an optimal objective function value, but it contains artificial variables with positive values.

Degeneracy

Degeneracy in duality of the simplex method occurs when the basis at a given iteration contains a variable with a value of zero. Degeneracy can cause the simplex method to cycle, which means that it can repeat the same iterations over and over again without making any progress towards an optimal solution.

Characteristic	Duality	Dual simplex method
Type of problem	Theoretical concept	Solution algorithm
Relationship between primal and dual problems	Essential equivalence	Uses the primal problem to solve the dual problem
Starting solution	Not required	Infeasible but dual feasible solution required
Objective	To identify the optimal solution to the primal or dual problem	To find the optimal solution to the dual problem
Termination condition	Primal problem has an optimal solution	Dual problem has an optimal solution
Advantages	Provides a theoretical framework for understanding the simplex method	Can be used to solve problems with infeasible primal solutions
Disadvantages	Not a practical solution algorithm	Can be less efficient than the primal simplex method for problems with large numbers of variables

Simulation

Introduction to simulation

Definition

Simulation is the imitation of the behavior of a real-world system or process over time. It is a powerful tool that can be used to understand, predict, and improve the performance of systems in a wide range of fields, including engineering, business, manufacturing, and healthcare.

Working area of simulation

Simulation can be used to model and analyze a wide range of systems, including:

- Physical systems, such as manufacturing plants, transportation networks, and energy systems
- Biological systems, such as human bodies, ecosystems, and disease spread
- Social systems, such as customer behavior, economic trends, and traffic flow
- Steps of the simulation process

The general steps of the simulation process are as follows:

- Define the system or process to be simulated. This includes identifying the key components of the system, their relationships, and the desired outcomes.
- Build a model of the system. This involves creating a mathematical or computer representation of the system that captures its behavior over time.

- Experiment with the model. This involves running the simulation under different conditions to observe the system's response.
- Analyze the results of the simulation. This involves interpreting the data generated by the simulation to gain insights into the system and make recommendations for improvement.

Advantages and disadvantages of simulation

Advantages:

- Simulation can be used to study systems that are too complex, dangerous, or expensive to experiment with in the real world.
- Simulation can be used to predict the future behavior of systems under different conditions.
- Simulation can be used to identify and evaluate potential problems with systems before they are implemented in the real world.
- Simulation can be used to train people on how to operate and maintain systems.

Disadvantages:

- Building and running simulations can be time-consuming and expensive.
- Simulations are only as accurate as the models on which they are based.
- It can be difficult to interpret the results of simulations and draw valid conclusions.
- Role of simulation in computer science
- Simulation is widely used in computer science to research and develop new algorithms and technologies. It is also used to evaluate the performance of existing systems and to design and test new systems before they are deployed.

Applications of simulation

Simulation is used in a wide range of fields, including:

- Engineering: Simulation is used to design and test new products and processes, such as aircraft, automobiles, and manufacturing systems.
- Business: Simulation is used to model and optimize business processes, such as supply chains, customer service, and marketing campaigns.
- Manufacturing: Simulation is used to plan and schedule production, identify bottlenecks, and improve efficiency.
- Healthcare: Simulation is used to train medical staff, develop new treatments, and model the spread of diseases.

Here are some specific examples of how simulation is used in computer science:

- To evaluate the performance of new network routing protocols
- To design and test new algorithms for artificial intelligence
- To simulate the behavior of large crowds for video games and disaster preparedness
- To model the spread of computer viruses and develop new defense mechanisms

UNIT3

Feasible solution in transposition model

A feasible solution in a transposition model is a solution that satisfies all of the constraints of the model. This means that the solution must be non-negative and that the total supply of each resource must be equal to the total demand for that resource.

Degenerate basic feasible solution

A degenerate basic feasible solution in a transposition model is a feasible solution in which at least one basic variable has a value of zero. Degenerate basic feasible solutions can cause the simplex method to cycle, which means that it can repeat the same iterations over and over again without making any progress towards an optimal solution.

Optimal solution in transposition model

An optimal solution in a transportation model is a feasible solution that minimizes the total transportation cost.

Unbalanced problem in transposition model

An unbalanced problem in a transportation model is a problem in which the total supply of resources does not equal the total demand for resources. This can happen when there is more supply of a resource than demand, or when there is more demand for a resource than supply.

Assignment 1

[Assume each question is of 7 marks] [use J K Sharma]

1	Define the OR. Explain how it is applicable in Marketing Field? Pg 6 , 20
2	State and explain main features of OR. Pg 5
3	Discuss various drawbacks of OR.
4	Explain different applications of OR.
5	Case Study : Software for Operation Research a) COIN-OR b) QM for windows c) NCSS (DATA analysis) d) R [Introduction , uses of software ,commands , advantages]
6	List and explain various models/ methods for solving operation research problems. Pg 14
7	Discuss various steps for performing operation research. [page 15]
8	What are the various models for operation research? Pg. 21
9	Operation research is an inter-disciplinary approach. Justify the statement.