Advance Engineering Mathematics(AEM)

Branch :Information Technology, Sem:IIIrd

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Vision of the Institute

To become a renowned centre of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities

Mission of the Institute

- Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.
- Identify, based on informed perception of Indian, regional and global needs, the areas of focus and provide platform to gain knowledge and solutions.
- Offer opportunities for interaction between academia and industry.
- Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders may emerge.

Course Outcomes

- **CO2:** To learn the formulation of different mathematical problems into optimization problems.
- **CO3:** Apply the principles of optimization using differential calculus.
- **CO4:** To understand the concepts of Linear Programming
- **CO1:** To learn the concepts and principles of Random variables and Probability distribution.

Linear Programming

- Simplex Method
- Two Phase Method,
- Duality in Linear Programming,
- Assignment Problems,
- Transportation Problems

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Simplex Method

- When decision variables are ***more than 2,*** *it is always advisable to use Simplex Method of avoid lengthy graphical procedure.*
- *The simplex method is not used to examine all the feasible solutions.*
- *I deals only with a small and unique set of feasible solutions the set of vertex pints (i.e. extreme points) of the convex feasible space that contains the optimal solution*
- *The most popular method used for the solution of Linear programming problesm (LPP) is the simplexmethod. Simplex method is developed by George Dantigin 1946*
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When decision variables are ***more than 2,*** we always use Simplex Method

- **Slack Variable:** Variable added to a ≤ constraint to convex it to an equation (=).
- A slack variable represents unused resources .
- A slack variable contributes nothing to the objective function value.

- **<u>Surplus Variable:</u>** Variable subtracted a ≥ constraint to convert it to an equation (=).

- A surplus variable represents an excess above constraint requirement level.

- surplus variables contribute nothing to the calculated value of the objective function.

- **Basic Solution (BS) :** This solution is obtained by setting any n variables (among m+n variables) equal to zero and solving for remaining ***m*** variables, provided the determinant of the coefficients of these variables is non-zero. Such ***m*** variable are called **basic variables a**nd remaining *n zero* valued variables are called **non basic variables**
- **Basic Feasbile Solutio (BFS)** : It is a basic solution which also satisfies the non negativity restrictions.

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- **BFS are of two types :**
  - ***Degenerate BFS*** : If once or more basic variables are zero
  - ***Non-Degenerate BFS*** : All basic variables are non-zero.

Optimal BFS: BFS which optimizes the objective function

Examples:

$$\text{Max. } Z = 13x_l + 11x_2$$

Subject to constraints:

$$4x_1 + 5x_2 \leq 1500$$

$$5x_1 + 3x_2 \leq 1575$$

$$x_1 + 2x_2 \leq 420$$

$$x_1 + x_2 \geq 0$$

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- **Step 1:** Convert all the inequality constraints into equalities by the use of slack variables

Let S_1, S_2, S_3 be three slack variables.

Introducing these slack variables into the inequality constrains and rewriting the objective function such that all variables are on the left-hand side of the equation. Model can rewritten as :

$$Z - 13x_1 - 11x_2 = 0$$

Subject to Constraints:

$$4X_1 + 5X_2 + S_1 = 1500$$

$$5X_1+3X_2+S_2 = 1575$$

$$X_1+2X_2+S_3 = 420$$

$$X_1 , X_2 , S_1 , S_2 , S_3 = 0$$

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- **Step II :** Find the Initial BFS.

  One Feasible solution that satisfies all the constraints is : $x_1 = 0$, $x_2 = 0$, $S_1=1500$, $S_2 = 1575$, $S_3 = 420$ and $Z=0$.

  Now, S_1, S_2, S_3 are basic variables.

- **Step III :** Set up an initial table as:

Row NO.	Basic Variable	Coefficients of:						Sol.	Ratio
		Z	x_1	x_2	S_1	S_2	S_3		
A1	Z	1	-13	-11	0	0	0	0	
B1	S_1	0	4	5	1	0	0	1500	375
C1	S_2	0	5	3	0	1	0	1575	315
D1	S_3	0	1	2	0	0	1	420	420

ep IV: a) Choose the most negative number from row A1(i.e Z row). Therefore, x_1 is a ***entering variable***.

b) Calculate Ratio = Sol col. / x_1 col. ($x_1 > 0$)

c) Choose minimum Ratio. That variable(i.e S_2) is a ***departing variable***.

Step V: x_1 becomes ***basic variable*** and S_2 becomes ***non basic variable.*** New table is:

Row NO.	Basic Variable	Coefficients of:						Sol.	Ratio
		Z	x_1	x_2	S_1	S_2	S_3		
A1	Z	1	0	-16/5	0	13/5	0	4095	
B1	S_1	0	0	13/5	1	-4/5	0	240	92.3
C1	x_1	0	1	3/5	0	1/5	0	315	525
D1	S_3	0	0	7/5	0	-1/5	1	105	75

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Next Table is :

Row NO.	Basic Variable	Coefficients of:						Sol.
		Z	x_1	x_2	S_1	S_2	S_3	
A1	Z	1	0	0	0	15/7	16/7	4335
B1	S_1	0	0	0	1	-3/7	-13/7	45
C1	x_1	0	1	0	0	2/7	-3/7	270
D1	x_2	0	0	1	0	-1/7	5/7	75

Optimal Solution is : $\mathbf{x_1 = 270, x_2 = 75, Z = 4335}$

Solve:

Solve the Simplex method

Max $z = x_1 - x_2 + 3x_3$

Sub to $x_1 + x_2 + x_3 \leq 10$

$2x_1 - x_3 \leq 2$

$2x_1 - 2x_2 + 3x_3 \leq 0$

$x_1, x_2, x_3 \geq 0$

Reference:

- https://www.slideshare.net/sachin.mk/simplex-method
- Engineering Mathematics III CS/IT Engineering

Vardhan Publication

Thank You