MANAGEMENT SCIENCE NUMERICAL PROBLEMS-

A SOFTWARE ORIENTED SOLUTION APPROACH FOR BACHELORS MASTERS AND PH.D

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PREFACE

MANAGEMENT SCIENCE NUMERICAL PROBLEMS –A SOFTWARE ORIENTED SOLUTION APPROACH FOR BACHELORS , MASTERS & PH.D.

This book is the result of my teaching experience in the subject and working experience in various softwares related to Management Science/Decision Science/Operations Research/Quantitative Techniques/Quantitative Analysis for Management to Sikkim Manipal University,Udupi students for about 8 years.It is designed to meet the requirements of research students at Masters and Ph D levels particularly Engineering and Management(BBA BCA BBM BCOM,M E, MCA MBA and Ph D in LPP,Mathematics,Engg,Computer Applications and Business Administration).

The main highlight of the book is solved problem approach with the softwares and explanations added for numerical question problems framed by the author.This book has a good number of problems solved in all 21 chapters.

I am extremely grateful to all my lecturers so far .Special thanks to Prof Srinivasan from IIT Madras who has hosted free videos in NPTEL which I referred to in learning the basics initially while working LPP numerical problems manually.

I also thank various International software makers in the field of LPP which made me enable to work on NUMERICAL PROBLEMS involving lots of complex data.

There are many problems framed by myself and can be best suitable for other Ph D students during their RESEARCH WORK in the three fields mentioned below:

ENGINEERING-ALL FIELDS.(BACHELOS LEVEL MASTERS LEVEL AND DOCTORS LEVEL)

COMPUTER APPLICATIONS. (BACHELORS LEVEL MASTERS LEVEL AND DOCTORS LEVEL)

BUSINESS ADMINISTRATION. (BACHELORS LEVEL MASTERS LEVEL AND DOCTORS LEVEL)

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ABOUT THE AUTHOR

Author's name is Srinivas R Rao, born and done his school level education in Mangalore,Karnataka in a reputed private school Canara High School and PUC(+2) from Canara PUC in Science stream with PCMB as main subjects.

Later, pursuing LL.B(5 Years) course passed the degree in 1999 and done Diploma in Export Management ,Diploma in Customs and Central Excise , Diploma in Business Adminstration and some important IT subjects like MS-Office,Internet/Email,Visual Basic 6.0,C,C++,Java,Advanced Java,Oracle with D2K,HTML with Javascript,VBscript and Active Server Pages.

Joined as a FACULTY for students in a small computer Institute in 2002 July and later after 4 months worked in a company by name CRP Technologies(I) .P.Ltd as Branch Manager(Risk Manager) for Mangalore,Udupi and Kasargod areas from January 2003 to June 11 2007.In the year 2005 pursued MBA distance education course.Currently working , as a FACULTY in Sikkim Manipal University , Udupi centre for BBA & MBA students and teaching numerical subjects like Statistics/Operations Research(Mgt Science/Quant. Techniques for Mgt)/Accounting and several numerical and difficult oriented subjects for distance education students in their weekend contact classes from July 2010 till present day.

Thanks

Regards

Author

(SRINIVAS R RAO)

ABOUT THE BOOK

This book is on Management Science which is a compulsory subject for Bachelors, M.E., B Tech, M.Tech.,B.Sc and M.Sc(Maths),MBA and Ph.D .However , any Bachelor level students can also read it as it contains a lot of numerical problems framed by me.

Linear Programmming Problem,Simplex Method , Sensitivity Analysis,Dual Method,Graphical Analysis,Project Management using PERT/CPM , Networks like Minimal Spanning Tree,Shortest Route and Maximal Flow Problem,Transportation,Assignment,Integer Linear Programming,Inventory and Waiting Lines with several models,Decision Analysis,Forecasting with 4 classic methods of forecasting,Markov Processes,Goal and Dynamic Programming,Simulation Modelling(with seeds),Work Measurement,Break Even Analysis and Cost Volume Analysis,Game Theory which involves maximin and minimax strategies finding the value of the game are the various topics covered in this book.

I feel that this is a unique book as there are only numerical problems solved using software approach with the numerical problems framed by me.

As they are tested on softwares they are correct solutions to various numerical problems used in this book

HAPPY READING.

THANKS

REGARDS

AUTHOR

SRINIVAS R RAO

MANAGEMENT SCIENCE NUMERICAL PROBLEMS –A SOFTWARE ORIENTED SOLUTION APPROACH FOR BACHELORS,MASTERS & PH.D.

CHAPTERS:

1. LINEAR PROGRAMMING-OPTIMISATION TYPES-MAXIMISATION & MINIMSATION WITH DECISION VARIABLES & CONSTRAINTS NOT INCLUDING NON NEGATIVITY.MAXIMIZE OR MINIMIZE THE VALUE OF LINEAR OBJECTIVE FUNCTION WHICH ARE SUBJECT TO A SET OF LINEAR CONSTRAINTS.

2. SIMPLEX METHOD, SENSITIVITY ANALYSIS, DUALITY & GRAPHICAL ANALYSIS.

3. TRANSPORTATION-OPTIMAL SOLUTIONS TO TRANSPORATION PROBLEMS USING NORTH WEST CORNER RULE, MINIMUM COST METHOD, VOGEL'S APPROXIMATION METHOD.

4. ASSIGNMENT-AGENTS & TASKS - HUNGARIAN ALGORITHM

5. INTEGER LINEAR PROGRAMMING-(1) ALL VARIABLES ARE 0/1 (BINARY) (2) ALL VARIABLES ARE GENERAL INTEGER (3) MULTIPLE TYPES OF VARIABLES.

6. SHORTEST ROUTE-NODES AND ARCS

7. MINIMAL SPANNING TREE-NODES AND ARCS

8. PERT/CPM-ACTIVITIES AND IMMEDIATE PREDECESSORS FOR EACH ACTIVITY.CERTAIN ACTIVITY TIMES ARE CALLED AS SINGLE TIME ESTIMATES. UNCERTAIN ACTIVITY TIMES ARE CALLED AS THREE TIME ESTIMATES.ACTIVITIES AND PREDECESSORS ARE IDENTIFIED AND REPRESENTED BY ALPHABETS.TIME (KNOWN OR UNKNOWN) IN NUMERICALS.

9. INVENTORY-OPTIMAL INVENTORY DECISIONS CONSIST OF THE FOLLOWING MODELS: ECONOMIC ORDER QUANTITY/ECONOMIC PRODUCTION LOT SIZE/EOQ WITH PLANNED SHORTAGES/EOQ WITH QUANTITY DISCOUNTS/ORDER QUANTITY-REORDER POINT WITH PROBABILISTIC DEMAND/SINGLE-PERIOD INVENTORY WITH PROBABILISTIC DEMAND.

10. WAITING LINES-MODELS: POISSON ARRIVALS WITH EXPONENTIAL SERVICE TIMES/POISSON ARRIVALS AND ARBITRARY SERVICE TIMES/POISSON ARRIVALS AND DETERMINISTIC SERVICE TIMES/POISSON ARRIVALS AND ARBITRARY SERVICE TIMES (NO WAITING)/POISSON ARRIVALS AND EXPONENTIAL SERVICE TIMES WITH A FINITE CALLING POPULATION.

11. DECISION ANALYSIS-DECISION ALTERNATIVES AND STATES OF NATURE FOR THE CHANCE EVENT WITH STATE OF NATURE POSSIBILITIES, COMPUTE DECISION STRATEGY WITH INDICATOR OUTCOMES.

12. FORECASTING - MOVING AVERAGES/EXPONENTIAL SMOOTHING/TREND PROJECTION/TREND & SEASONAL COMPONENTS

13. MARKOV PROCESSES-STATES.BOTH MARKOV PROCESSES INVOLVING STEADY STATE BEHAVIOR AND ABSORBING STATES ARE ANALYZED.TRANSIENT AND RECURRENT STATES ARE ALSO SEEN.

14. GOAL PROGRAMMING-INCLUDES PRIORITY

15. DYNAMIC PROGRAMMING-SHORTEST ROUTE PROBLEM, TRAVELLING SALESMAN PROBLEM, KNAPSACK PROBLEM.

16. SIMULATION-MODELLING USING DIFFERENT NUMBER OF SEEDS.

17. WORK MEASUREMENT-TIME STUDY/SAMPLE SIZE (TIME STUDY)/WORK SAMPLING (SAMPLE SIZE)

18. BREAK EVEN ANALYSIS & COST VOLUME ANALYSIS-ONE COST FIXED AND ANOTHER COST VARIABLE

19. GAME THEORY-TO FIND THE VALUE OF THE GAME

20. MAXIMAL FLOW PROBLEM.

21. NON LINEAR PROGRAMMING.-UNCONSTRAINED OPTIMUM/LINEARLY CONSTRAINED OPTIMUM/QUADRATIC PROGRAMMING/UNCONSTRAINED QUADRATIC PROGRAMMING/CONVEX PROGRAMMING/NON CONVEX PROGRAMMING/SEPARABLE PROGRAMMING/GEOMETRIC PROGRAMMING/LINEAR FRACTIONAL PROGRAMMING/COMPLEMENTARITY PROBLEM.-MAJOR 10 TYPES OF NONLINEAR PROGRAMMING PROBLEMS .

CHAPTER 1

LINEAR PROGRAMMING

LINEAR PROGRAMMING PROBLEM

The problems do not include non-negativity constraints.

Q1. MAX 10X1+12X2+14X3+16X4+18X5

S.T.

1) 1X1+2X2+3X3+4X4+5X5<19
2) 2X1+5X2+8X3+12X4+14X5<31
3) 4X1+7X2+2X3+9X4+5X5<55
4) 5X1+6X2+7X3+9X4+4X5<78
5) 8X1+3X2+1X3+7X4+9X5<91

OPTIMAL SOLUTION:

Objective Function Value = 129.448

Variable	Value	Reduced Costs
X1	10.724	0.000
X2	1.690	0.000
X3	0.138	0.000
X4	0.000	10.559
X5	0.000	12.103

Constraint	Slack/Surplus	Dual Prices
1	4.483	0.000

2	0.000	1.593
3	0.000	0.269
4	13.276	0.000
5	0.000	0.717

OBJECTIVE COEFFICIENT RANGES:

Variable	Lower Limit	Current Value	Upper Limit
X1	5.478	10.000	14.105
X2	10.742	12.000	19.429
X3	6.980	14.000	16.294
X4	No Lower Limit	16.000	26.559
X5	No Lower Limit	18.000	30.103

RIGHT HAND SIDE RANGES:

Constraint	Lower Limit	Current Value	Upper Limit
1	14.517	19.000	No Upper Limit
2	30.091	31.000	43.150
3	47.097	55.000	56.176
4	64.724	78.000	No Upper Limit
5	84.333	91.000	108.500

Q2. LINEAR PROGRAMMING PROBLEM

MAX 10X1+13X2+16X3+19X4

S.T.

1) 3X1+6X2+9X3+12X4<100
2) 4X1+6X2+11X3+14X4<200

3) $5X1+7X2+6X3+13X4<300$

4) $6X1+8X2+12X3+9X4<400$

OPTIMAL SOLUTION:

Objective Function Value = 333.333

Variable	Value	Reduced Costs
X1	33.333	0.000
X2	0.000	7.000
X3	0.000	14.000
X4	0.000	21.000

Constraint	Slack/Surplus	Dual Prices
1	0.000	3.333
2	66.667	0.000
3	133.333	0.000
4	200.000	0.000

OBJECTIVE COEFFICIENT RANGES:

Variable	Lower Limit	Current Value	Upper Limit
X1	6.500	10.000	No Upper Limit
X2	No Lower Limit	13.000	20.000
X3	No Lower Limit	16.000	30.000
X4	No Lower Limit	19.000	40.000

RIGHT HAND SIDE RANGES:

Constraint	Lower Limit	Current Value	Upper Limit
1	0.000	100.000	150.000
2	133.333	200.000	No Upper Limit
3	166.667	300.000	No Upper Limit
4	200.000	400.000	No Upper Limit

Q3. LINEAR PROGRAMMING PROBLEM

MAX 10X1+12X2+14X3+16X4+23X5

S.T.

1) 2X1+9X2+12X3+16X4+18X5<58
2) 6X1+7X2+9X3+12X4+25X5<64
3) 13X1+3X2+16X3+34X4+29X5<79
4) 15X1+9X2+19X3+22X4+45X5<47
5) 21X1+12X2+23X3+30X4+32X5<96
6) 16X1+14X2+25X3+23X4+21X5<70
7) 17X1+6X2+28X3+29X4+28X5<65
8) 18X1+16X2+21X3+17X4+29X5<49
9) 24X1+9X2+24X3+18X4+35X5<73

10) 28X1+19X2+31X3+24X4+40X5<69

OPTIMUM SOLUTION:

Objective Function Value = 41.829

Variable	Value	Reduced Costs
X1	0.000	4.774
X2	1.402	0.000
X3	0.000	3.628
X4	1.563	0.000
X5	0.000	6.246

Constraint	Slack/Surplus	Dual Prices
1	20.377	0.000
2	35.432	0.000
3	21.658	0.000
4	0.000	0.261
5	32.291	0.000
6	14.427	0.000
7	11.266	0.000
8	0.000	0.603
9	32.251	0.000
10	4.854	0.000

OBJECTIVE COEFFICIENT RANGES:

Variable	Lower Limit	Current Value	Upper Limit
X1	No Lower Limit	10.000	14.774
X2	6.806	12.000	15.059
X3	No Lower Limit	14.000	17.628
X4	13.292	16.000	29.333
X5	No Lower Limit	23.000	29.246

RIGHT HAND SIDE RANGES:

Constraint	Lower Limit	Current Value	Upper Limit
1	37.623	58.000	No Upper Limit
2	28.568	64.000	No Upper Limit
3	57.342	79.000	No Upper Limit
4	27.563	47.000	53.193
5	63.709	96.000	No Upper Limit
6	55.573	70.000	No Upper Limit
7	53.734	65.000	No Upper Limit
8	36.318	49.000	53.782
9	40.749	73.000	No Upper Limit
10	64.146	69.000	No Upper Limit

Q4. LINEAR PROGRAMMING PROBLEM

MAX 11X1+19X2+12X3+14X4+31X5+15X6+27X7+34X8+65X9+47X10+34X11+67X12+43X13+21X14+22X15+24X16+26X17+29X18+30X19+32X20

S.T.

1) 71X1+21X2+32X3+45X4+62X5+61X6+66X7+67X8+62X9+89X10+31X11+45X12+67X13

+89X14+90X15+91X16+92X17+93X18+98X19+99X20<1000

2) 12X1+23X2+25X3+27X4+31X5+39X6+91X7+98X8+97X9+86X10+65X11+55X12+57X13+58X14+59X15+24X16+31X17+43X18+46X19+54X20<1200

3) 13X1+29X2+32X3+20X4+45X5+46X6+48X7+97X8+86X9+67X10+69X11+51X12+34X13+38X14+41X15+47X16+67X17+78X18+89X19+90X20<1400

4) 16X1+9X2+39X3+76X4+21X5+90X6+80X7+69X8+56X9+80X10+71X11+72X12+78X13+64X14+91X15+99X16+100X17+110X18+44X19+42X20<1600

5) 14X1+20X2+11X3+20X4+21X5+23X6+29X7+30X8+43X9+44X10+46X11+49X12+50X13+51X14+52X15+90X16+99X17+87X18+80X19+70X20<1800

6) 12X1+99X2+39X3+10X4+12X5+34X6+36X7+38X8+137X9+121X10+111X11+12X12+14X13+141X14+145X15+21X16+213X17+20X18+201X19+222X20<2000

7) 76X1+89X2+49X3+43X4+100X5+120X6+37X7+121X8+111X9+11X10+10X11+11X12+109X13+91X14+27X15+28X16+31X17+34X18+211X19+213X20<2200

8) 45X1+78X2+50X3+41X4+31X5+140X6+38X7+546X8+191X9+211X10+231X11+412X12+231X13+114X14+115X15+231X16+234X17+209X18+211X19+20X20<2400

9) 55X1+64X2+66X3+20X4+18X5+190X6+66X7+345X8+200X9+199X10+17X11+107X12+213X13+240X14+210X15+120X16+100X17+80X18+60X19+40X20<2600

10) 56X1+50X2+23X3+76X4+20X5+40X6+60X7+80X8+18X9+100X10+110X11+120X12+115X13+121X14+130X15+131X16+135X17+134X18+136X19+139X20<2800

11) 43X1+20X2+143X3+500X4+109X5+900X6+800X7+700X8+5X9+600X10+500X11+400X12+300X13+200X14+100X15+50X16+40X17+30X18+20X19+10X20<3000

12) 35X1+30X2+151X3+400X4+12X5+13X6+14X7+15X8+16X9+17X10+18X11+19X12+20X13+22X14+23X15+25X16+26X17+27X18+28X19+29X20<3200

13) 37X1+41X2+150X3+300X4+654X5+100X6+100X7+200X8+300X9+400X10+500X11+600X12+700X13+800X14+900X15+986X16+786X17+345X18+238X19+1000X20<3400

14) 38X1+28X2+50X3+200X4+345X5+122X6+110X7+565X8+234X9+100X10+90X11+87X12+84X13+58X14+27X15+51X16+39X17+102X18+113X19+132X20<3600

15) 39X1+24X2+318X3+10X4+651X5+132X6+66X7+54X8+312X9+210X10+234X11+231X12+315X13+316X14+317X15+318X16+390X17+876X18+327X19+1212X20<3800

16) 21X1+23X2+305X3+100X4+456X5+144X6+245X7+876X8+765X9+310X10+121X11+190X12+214X13+289X14+256X15+309X16+903X17+405X18+504X19+678X20<4000

17) 22X1+214X2+5X3+90X4+234X5+156X6+123X7+23X8+110X9+40X10+540X11+867X12+169X13+980X14+12X15+16X16+18X17+21X18+43X19+817X20<4200

18) 23X1+312X2+7X3+96X4+233X5+198X6+120X7+230X8+234X9+20X10+844X11+789X1

2+216X13+786X14+12X15+2X16+3X17+4X18+5X19+67X20<4400

19) 21X1+99X2+91X3+95X4+211X5+123X6+31X7+312X8+543X9+100X10+890X11+560X12+215X13+444X14+234X15+213X16+432X17+567X18+765X19+312X20<4600

20) 20X1+66X2+123X3+85X4+21X5+142X6+66X7+876X8+76X9+10X10+109X11+450X12+319X13+913X14+666X15+786X16+99X17+77X18+66X19+88X20<4800

21) 27X1+98X2+341X3+5X4+201X5+189X6+34X7+123X8+131X9+10X10+1100X11+340X12+333X13+214X14+314X15+908X16+54X17+980X18+347X19+99X20<5000

22) 29X1+83X2+435X3+10X4+290X5+213X6+110X7+565X8+454X9+110X10+2100X11+123X12+321X13+412X14+1100X15+777X16+56X17+900X18+98X19+77X20<5200

23) 30X1+39X2+262X3+25X4+213X5+245X6+21X7+119X8+465X9+11X10+3145X11+141X12+329X13+378X14+110X15+879X16+678X17+87X18+11X20<5400

24) 38X1+20X2+393X3+30X4+312X5+265X6+345X7+123X8+324X9+12X10+5412X11+121X12+345X13+387X14+169X15+678X16+444X17+65X18+444X19+444X20<5600

25) 33X1+44X2+400X3+35X4+211X5+222X6+765X7+110X8+215X9+13X10+1000X11+144X12+666X13+980X14+345X15+98X16+5X17+4X18+32X19+1X20<5800

OPTIMAL SOLUTION:

Objective Function Value = 634.945

Variable	Value	Reduced Costs
X1	2.952	0.000
X2	10.937	0.000
X3	0.000	10.495
X4	0.000	2.565
X5	0.000	2.251
X6	0.000	19.232
X7	0.577	0.000
X8	0.000	72.350
X9	3.148	0.000
X10	3.528	0.000
X11	0.000	19.102
X12	0.000	3.580

X13	0.201	0.000
X14	0.000	29.820
X15	0.000	10.831
X16	0.000	19.059
X17	0.000	48.505
X18	0.000	16.243
X19	0.000	24.486
X20	0.000	13.514

Constraint	Slack/Surplus	Dual Prices
1	0.000	0.066
2	240.287	0.000
3	502.795	0.000
4	933.975	0.000
5	1222.552	0.000
6	0.000	0.024
7	570.783	0.000
8	0.000	0.097
9	325.067	0.000
10	1620.653	0.000
11	0.000	0.006
12	2646.128	0.000
13	288.400	0.000
14	2011.763	0.000
15	1597.894	0.000
16	0.000	0.045
17	1202.281	0.000
18	0.000	0.021
19	1331.891	0.000
20	3642.515	0.000
21	3314.359	0.000
22	2261.354	0.000
23	3304.028	0.000
24	3938.544	0.000
25	3923.859	0.000

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