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Managerial Problem Definition

Decisions to be made – Which cities should be allocated to which of the 10 districts

Objective – Maximize republican-dominated districts

Restrictions – District populations must be between 150k and 350k. Each city can only be assigned to one district.

Nonlinear Binary

Model Formulation

Decision Variables:

X_{ij} , for i for each city from 1 to 18, and j for each district from 1 to 10

Objective Function:

Maximize: $=\text{IF}(\text{SUMPRODUCT}(\text{Republican \#s}, X_{ij}) > \text{SUMPRODUCT}(\text{Democrat \#s}, X_{ij}), 1, 0)$

Constraints:

Total # of voters in each district > 150 and < 350

$X_i = 1$ (each city can only be used once)

Solution Methodology

The image displays an Excel spreadsheet and the Solver Parameters dialog box. The spreadsheet shows a list of 18 cities (rows 1-18) and 10 districts (columns 1-10). Each cell contains a value representing the number of voters in that city-district pair. The Solver Parameters dialog box is open, showing the following settings:

- Set Objective:** \$AD\$3
- To:** ☒ Max ☐ Min ☐ Value Of: 0
- By Changing Variable Cells:** \$F\$2:\$O\$19
- Subject to the Constraints:**
 - \$F\$2:\$O\$19 = binary
 - \$F\$40:\$O\$40 <= \$F\$44:\$O\$44
 - \$F\$40:\$O\$40 >= \$F\$42:\$O\$42
 - \$F\$2:\$F\$19 = \$R\$2:\$R\$19
- ☒ Make Unconstrained Variables Non-Negative
- Select a Solving Method:** GRG Nonlinear
- Solving Method:** Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

The Solver Parameters dialog box also includes buttons for Add, Change, Delete, Reset All, Load/Save, Help, Solve, and Close.

Nonlinear with 18DVs

Model Formulation

Decision Variables:

X_i from 1 to 18 where each represents the district chosen for that particular city

Intermediate Variables

R_{ij} Republicans in each district

D_{ij} Democrats in each district

1000 if M_1 is less than 150,000

1000 if M_2 is greater than 350,000

Objective Function:

Maximize: $\text{SUM}(X_i - (M_1 + M_2))$

Constraints:

Total dem and rep in each district > 150 and < 350

$X_i = 1$ (each city can only be used once)

M_1 and M_2 for big M

$X_i \geq 1$

$X_i \leq 10$

Solution Methodology

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	City	Democrat	Republican	sum		District Assigned								Totals	D	R	District Total	R>D		Under 150	Over 350			
2	1	152	62	214		8	>=		1	<=	10			1	155	173	328	1			0	0		
3	2	81	59	140		9	>=		1	<=	10			2	160	167	327	1			0	0		
4	3	75	83	158		5	>=		1	<=	10			3	111	154	265	1			0	0		
5	4	34	52	86		10	>=		1	<=	10			4	72	83	155	1			0	0		
6	5	62	87	149		9	>=		1	<=	10			5	75	83	158	1			0	0		
7	6	38	87	125		10	>=		1	<=	10			6	114	135	249	1			0	0		
8	7	48	69	117		2	>=		1	<=	10			7	191	130	321	0			0	0		
9	8	74	49	123		8	>=		1	<=	10			8	226	111	337	0			0	0		
10	9	98	62	160		7	>=		1	<=	10			9	143	146	289	1			0	0		
11	10	66	72	138		3	>=		1	<=	10			10	72	139	211	1			0	0		
12	11	83	75	158		1	>=		1	<=	10													
13	12	86	82	168		6	>=		1	<=	10													
14	13	72	83	155		4	>=		1	<=	10													
15	14	28	53	81		6	>=		1	<=	10													
16	15	112	98	210		2	>=		1	<=	10													
17	16	45	82	127		3	>=		1	<=	10													
18	17	93	68	161		7	>=		1	<=	10													
19	18	72	98	170		1	>=		1	<=	10													
20																								
21																								
22																								

Formulas shown in the spreadsheet:

- $\text{SUMIF}(\$F\$2:\$F\$19, N11, \$B\$2:\$B\$19)$
- $\text{SUM}(O11:P11)$
- $\text{SUM}(R2:R11) - \text{SUM}(T2:U11)$
- $\text{SUMIF}(\$F\$2:\$F\$19, N11, \$C\$2:\$C\$19)$
- $\text{IF}(Q2 > 350, 1000, 0)$
- $\text{IF}(P2 > Q2, 1, 0)$
- $\text{IF}(Q11 < 150, 1000, 0)$

Solver Parameters
✕

Set Objective:

\$R\$14

⬆

To:

☒ Max
 ☐ Min
 ☐ Value Of:

0

By Changing Variable Cells:

\$F\$2:\$F\$19

⬆

Subject to the Constraints:

\$F\$2:\$F\$19 <= \$J\$2:\$J\$19
 \$F\$2:\$F\$19 = integer
 \$F\$2:\$F\$19 >= \$H\$2:\$H\$19

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Add

Change

Delete

Reset All

Load/Save

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method:

GRG Nonlinear

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Options

Solving Method

Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Help

Solve

Close

Linear with Binary variables

Model Formulation

Decision Variables:

X_{ij} , binary where i is each city from 1 to 18, and j is each district from 1 to 10

Y_i , binary where each is if district is republican dominated

Objective Function:

Maximize: $\text{SUM}(Y_i)$

[illegible]