

Classwork.
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Building a certain type of infrastructure requires a number of months that depends on the city in which we decide to place the infrastructure.

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	Seattle	Chicago	New York	L.A.	Dallas	Miami
Residential	2	5	5	4	6	8
Commercial	4	2	4	6	6	6
Mercantile	5	5	2	8	7	5
Educational	4	6	8	2	4	5
Food Storage	6	6	6	4	2	5
Industrial	8	8	5	5	5	2

Each type of building has a different cost of construction per month

<i>Type of Building</i>	Residential	Commercial	Mercantile	Educational	Food Storage	Industrial
Cost per month	\$15.000	\$25.000	\$3.000	\$22.000	\$15.000	\$3.000

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How to compute the costs

Type of Building

	Residential	Commercial	Mercantile	Educational	Food Storage	Industrial
Cost per month	\$15.000	\$25.000	\$3.000	\$22.000	\$15.000	\$3.000

	Seattle	Chicago	New York	L.A.	Dallas	Miami
Residential	2	5	5	4	6	8
Commercial	4	2	4	6	6	6
Mercantile	5	5	2	8	7	5
Educational	4	6	8	2	4	5
Food Storage	6	6	6	4	2	5
Industrial	8	8	5	5	5	2

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Commercial	4	2	4	6	6	6
Mercantile	5	5	2	8	7	5
Educational	4	6	8	2	4	5
Food Storage	6	6	6	4	2	5
Industrial	8	8	5	5	5	2

Example.

The cost of building a residential unit in Seattle is:

$$2 \times 15000$$

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Problem Statement:

If an infrastructure is built in a city, the average revenue is:

<i>Cities to be considered</i>	Seattle	Chicago	New York	L.A.	Dallas	Miami
Average revenue in the city	\$95.000	\$100.000	\$90.000	\$83.000	\$98.000	\$75.000

Classwork.

Problem Statement:

If an infrastructure is built in a city, the average revenue is:

<i>Cities to be considered</i>						
	Seattle	Chicago	New York	L.A.	Dallas	Miami
Average revenue in the city	\$95.000	\$100.000	\$90.000	\$83.000	\$98.000	\$75.000

The constructor has to decided wether to place (1) or not (0) a unit in the corresponding city

<i>Assignments of building to cities (1=yes, 0=no)</i>								
	Seattle	Chicago	New York	L.A.	Dallas	Miami	Total	
Residential	0	0	0	0	0	0	0	
Commercial	0	0	0	0	0	0	0	
Mercantile	0	0	0	0	0	0	0	
Educational	0	0	0	0	0	0	0	
Food Storage	0	0	0	0	0	0	0	
Industrial	0	0	0	0	0	0	0	
Total number of units per city	0	0	0	0	0	0	0	
							Total Months	0

Max number of units = 40

Classwork.

Problem Statement:

If an infrastructure is built in a city, the average revenue is:

<i>Cities to be considered</i>						
	Seattle	Chicago	New York	L.A.	Dallas	Miami
Average revenue in the city	\$95.000	\$100.000	\$90.000	\$83.000	\$98.000	\$75.000

The constructor has to decided wether to place (1) or not (0) a unit in the corresponding city

<i>Assignments of building to cities (1=yes, 0=no)</i>							
	Seattle	Chicago	New York	L.A.	Dallas	Miami	Total
Residential	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0
Mercantile	0	0	0	0	0	0	0
Educational	0	0	0	0	0	0	0
Food Storage	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0
Total number of units per city	0	0	0	0	0	0	0
							Total Months
							0

No more than 80 months

Create an xls files with the problem data as follows:

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F	G
1							
2							
3							
4							
6	<i>Type of Building</i>						
7		Residential	Commercial	Mercantile	Educational	Food Storage	Industrial
8	Cost per month	\$15.000	\$25.000	\$3.000	\$22.000	\$15.000	\$3.000
10	<i>Cities to be considered</i>						
11		Seattle	Chicago	New York	L.A.	Dallas	Miami
12	Average revenue in the city	\$95.000	\$100.000	\$90.000	\$83.000	\$98.000	\$75.000
14	<i>Average number of month required to build the infastrcutrue</i>						
15		Seattle	Chicago	New York	L.A.	Dallas	Miami
16	Residential	2	5	5	4	6	8
17	Commercial	4	2	4	6	6	6
18	Mercantile	5	5	2	8	7	5
19	Educational	4	6	8	2	4	5
20	Food Storage	6	6	6	4	2	5
21	Industrial	8	8	5	5	5	2

Add decision variables

	A	B	C	D	E	F	G	H	I
23	<i>Assignments of building to cities (1=yes, 0=no)</i>								
24		Seattle	Chicago	New York	L.A.	Dallas	Miami	Total	
25	Residential	0	0	0	0	0	0	0	
26	Commercial	0	0	0	0	0	0	0	
27	Mercantile	0	0	0	0	0	0	0	
28	Educational	0	0	0	0	0	0	0	
29	Food Storage	0	0	0	0	0	0	0	
30	Industrial	0	0	0	0	0	0	0	
31									
32									Total Months
33	Total number of units per city	0	0	0	0	0	0	0	0

This must be the sum of...

Add decision variables

	A	B	C	D	E	F	G	H	I
23	<i>Assignments of building to cities (1=yes, 0=no)</i>								
24		Seattle	Chicago	New York	L.A.	Dallas	Miami	Total	
25	Residential	0	0	0	0	0	0	0	
26	Commercial	0	0	0	0	0	0	0	
27	Mercantile	0	0	0	0	0	0	0	
28	Educational	0	0	0	0	0	0	0	
29	Food Storage	0	0	0	0	0	0	0	
30	Industrial	0	0	0	0	0	0	0	
31									
32									Total Months
33	Total number of units per city	0	0	0	0	0	0	0	0

This must be the sum of...

Add decision variables

	A	B	C	D	E	F	G	H	I
23	<i>Assignments of building to cities (1=yes, 0=no)</i>								
24		Seattle	Chicago	New York	L.A.	Dallas	Miami	Total	
25	Residential	0	0	0	0	0	0	0	
26	Commercial	0	0	0	0	0	0	0	
27	Mercantile	0	0	0	0	0	0	0	
28	Educational	0	0	0	0	0	0	0	
29	Food Storage	0	0	0	0	0	0	0	
30	Industrial	0	0	0	0	0	0	0	
31									
32									Total Months
33	Total number of units per city	0	0	0	0	0	0	0	0

Name all these cells as Assignments

First select all the range, then right-click on the selection and click on “Define Name”

	Seattle	Chicago	New York	L.A.	Dallas	Miami
Initial	0	0	0	0	0	0
Final	0	0	0	0	0	0
Initial	0	0	0	0	0	0
Final	0	0	0	0	0	0
Initial	0	0	0	0	0	0
Final	0	0	0	0	0	0
Initial	0	0	0	0	0	0
Final	0	0	0	0	0	0

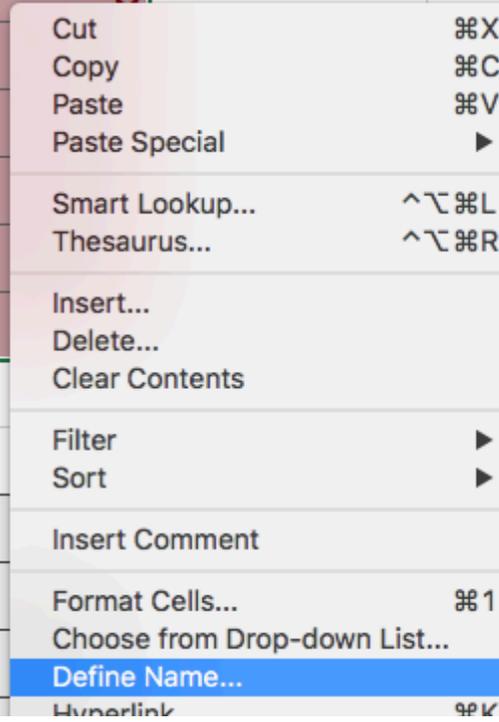
city	Seattle	Chicago	New York	L.A.	Dallas	Miami
Initial	\$0	\$0	\$0	\$0	\$0	\$0
Final	\$0	\$0	\$0	\$0	\$0	\$0
Initial	\$0	\$0	\$0	\$0	\$0	\$0
Final	\$0	\$0	\$0	\$0	\$0	\$0

- Cut ⌘X
- Copy ⌘C
- Paste ⌘V
- Paste Special... ^⌘V
- Smart Lookup... ^⌘L
- Thesaurus... ^⌘R
- Insert...
- Delete...
- Clear Contents
- Filter ▶
- Sort ▶
- Insert Comment
- Delete Comment
- Format Cells... ⌘1
- Pick From Drop-down List...
- Define Name...**

Call them **DECISION_VARIABLES**

First select all the range, then right-click on the selection and click on “Define Name”

Number of months	Seattle	Chicago	New York	L. A.	Dallas	Miami
Residential	2	5	5	4	6	8
Commerical	4	2	4	6	6	
Mercantile	5	5	2	8	7	
Educational	4	6	8	2	4	
Food Storage	6	6	6	4	2	
Industrial	8	8	5	5	5	
Average cost						
Residential	15000	15000	15000	15000	15000	
Commerical	25000	25000	25000	25000	25000	



Call them MONTHS

	A	B	C	D	E	F	G
14	<i>Average number of month required to build the infrastructure</i>						
15		Seattle	Chicago	New York	L.A.	Dallas	Miami
16	Residential	2	5	5	4	6	8
17	Commercial	4	2	4	6	6	6
18	Mercantile	5	5	2	8	7	5
19	Educational	4	6	8	2	4	5
20	Food Storage	6	6	6	4	2	5
21	Industrial	8	8	5	5	5	2

	A	B	C	D	E	F	G	H	I
23	<i>Assignments of building to cities (1=yes, 0=no)</i>								
24		Seattle	Chicago	New York	L.A.	Dallas	Miami	Total	
25	Residential	0	0	0	0	0	0	0	
26	Commercial	0	0	0	0	0	0	0	
27	Mercantile	0	0	0	0	0	0	0	
28	Educational	0	0	0	0	0	0	0	
29	Food Storage	0	0	0	0	0	0	0	
30	Industrial	0	0	0	0	0	0	0	
31									
32									Total Months
33	Total number of units per city	0	0	0	0	0	0	0	0

TOTAL MONTHS

=SUMPRODUCT(MONTHS;DECISION_VARIABLES)

Add below individual costs to compute total costs

B36 \times \checkmark *fx* $=\$B\$8*B16*B25$

	A	B	C	D	E	F	G
35	<i>Individual costs</i>	Seattle	Chicago	New York	L.A.	Dallas	Miami
36	Residential	\$0	\$0	\$0	\$0	\$0	\$0
37	Commercial	\$0	\$0	\$0	\$0	\$0	\$0
38	Mercantile	\$0	\$0	\$0	\$0	\$0	\$0
39	Educational	\$0	\$0	\$0	\$0	\$0	\$0
40	Food Storage	\$0	\$0	\$0	\$0	\$0	\$0
41	Industrial	\$0	\$0	\$0	\$0	\$0	\$0

G43



fx

=SUM(B36:G41)

A

B

C

D

E

F

G

43

Costs

\$0

44

Revenues

\$0

45

Profit

\$0

G44 *fx* =SUMPRODUCT(B12:G12;B33:G33)

	A	B	C	D	E	F	G
43					Costs		\$0
44					Revenues		\$0
45					Profit		\$0

Total_Cost \times \checkmark *fx* | =G44-G43

	A	B	C	D	E	F	G
43					Costs		\$0
44					Revenues		\$0
45					Profit		\$0

Solver Parameters

Set Objective:

To: Max Min Value Of:

By Changing Variable Cells:

Subject to the Constraints:

\$H\$33 <= 40
\$I\$33 <= 80
DECISION_VARIABLES = binary

Make Unconstrained Variables Non-Negative

Select a Solving Method:

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 solution.

Assignments of building to cities (1=yes, 0=no)

	Seattle	Chicago	New York	L.A.	Dallas	Miami	Total
Residential	1	1	1	1	0	0	4
Commercial	0	1	0	0	0	0	1
Mercantile	1	1	1	1	0	1	5
Educational	0	0	0	1	0	0	1
Food Storage	0	0	0	0	1	0	1
Industrial	1	1	1	1	1	1	6
Total number of units per city	3	4	3	4	2	2	18

Total Months 80

Individual costs

	Seattle	Chicago	New York	L.A.	Dallas	Miami
Residential	\$30,000	\$75,000	\$75,000	\$60,000	\$0	\$0
Commercial	\$0	\$50,000	\$0	\$0	\$0	\$0
Mercantile	\$15,000	\$15,000	\$6,000	\$24,000	\$0	\$15,000
Educational	\$0	\$0	\$0	\$44,000	\$0	\$0
Food Storage	\$0	\$0	\$0	\$0	\$30,000	\$0
Industrial	\$24,000	\$24,000	\$15,000	\$15,000	\$15,000	\$6,000

Costs	\$538,000
Revenues	\$1,633,000
Profit	\$1,095,000