

# **Classwork.**

## **Problem Statement:**

**Classwork.**  
**Problem Statement:**

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

# Classwork.

## Problem Statement:

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

	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

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

# Classwork.

## 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

# Classwork.

## 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

### Example.

The cost of building a residential unit in Seattle is:

$$2 \times 15000$$

# 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

## 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

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

# 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:

Decision_on_Building						
Home	Insert	Page Layout	Formulas	Data	Review	View
From FileMaker	From HTML	From Text	New Database Query	Refresh All	Connections	Properties
				Edit Links	Sort	Filter
					Advanced	Clear
						Text to Columns
						Remove Duplicates
						Data Validation
						Consolidate
						What-If Analysis
J10						
	A	B	C	D	E	F
1						
2						
3						
4						
6	Type of Building					
7		Residential	Commercial	Mercantile	Educational	Food Storage
8	Cost per month	\$15.000	\$25.000	\$3.000	\$22.000	\$15.000
10	Cities to be considered					
11		Seattle	Chicago	New York	L.A.	Dallas
12	Average revenue in the city	\$95.000	\$100.000	\$90.000	\$83.000	\$98.000
14	Average number of month required to build the infastrcutrue					
15		Seattle	Chicago	New York	L.A.	Dallas
16	Residential	2	5	5	4	6
17	Commercial	4	2	4	6	6
18	Mercantile	5	5	2	8	7
19	Educational	4	6	8	2	4
20	Food Storage	6	6	6	4	2
21	Industrial	8	8	5	5	5

# Add decision variables

	A	B	C	D	E	F	G	H	I
23	Assignments of building to cities (1=yes, 0=no)								
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

## Add decision variables

	A	B	C	D	E	F	G	H	I
23	Assignments of building to cities (1=yes, 0=no)								
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	Assignments of building to cities (1=yes, 0=no)								
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									
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	Assignments of building to cities (1=yes, 0=no)								
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”

trial

8

8

5

5

5

2

cities (1=yes, 0=no)

Seattle

Chicago

New York

L.A.

Dallas

Miami

ntial

rcial

ntile

nal

rage

trial

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

0

city

0

0

0

0

0

0

Seattle

Chicago

New York

L.A.

Dallas

Miami

ntial

rcial

ntile

nal

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

\$0

ing

Answer Report 1

Decision on building solved

+

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
Commercial	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	
Commercial	25000	25000	25000	25000	25000	

Cut	⌘X
Copy	⌘C
Paste	⌘V
Paste Special	▶
Smart Lookup...	⌘L
Thesaurus...	⌘R
Insert...	
Delete...	
Clear Contents	
Filter	▶
Sort	▶
Insert Comment	
Format Cells...	⌘1
Choose from Drop-down List...	
Define Name...	
Hyperlink	⌘K

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									
33	Total number of units per city	0	0	0	0	0	0	0	0

Total Months

TOTAL MONTHS

=SUMPRODUCT(MONTHS;DECISION\_VARIABLES)

Add below individual costs to compute total costs

B36		fx		=\$B\$8*B16*B25							
	A	B	C	D	E	F	G				
35	Individual costs	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		✖ ✓ <i>fx</i>   =SUM(B36:G41)					
	A	B	C	D	E	F	G
43					Costs		\$0
44					Revenues		\$0
45					Profit		\$0

G44		✕ ✓ <i>fx</i>   =SUMPRODUCT(B12:G12;B33:G33)					
	A	B	C	D	E	F	G
43					Costs		\$0
44					Revenues		\$0
45					Profit		\$0

Total_Cost		✕	✓	<i>fx</i>	=G44-G43		
	A	B	C	D	E	F	G
43					Costs		\$0
44					Revenues		\$0
45					Profit		\$0

Solver Parameters

Set Objective:

\$I\$49

To:

☒ Max

☐ Min

☐ Value Of:

0

By Changing Variable Cells:

DECISION\_VARIABLES

Subject to the Constraints:

\$H\$33 <= 40

\$I\$33 <= 80

DECISION\_VARIABLES = binary

Add

Change

Delete

Reset All

Load/Save

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method:

Simplex LP

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.

Close

Solve

# The solution.

<i>Assignments of building to cities (1=yes, 0=no)</i>							
	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
<i>Individual costs</i>	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	
<b>Costs</b>						\$538,000	
<b>Revenues</b>						\$1,633,000	
<b>Profit</b>						\$1,095,000	

Total Months

80