Business Analytics

Today Objective

Association Mining (unsupervised Learning)

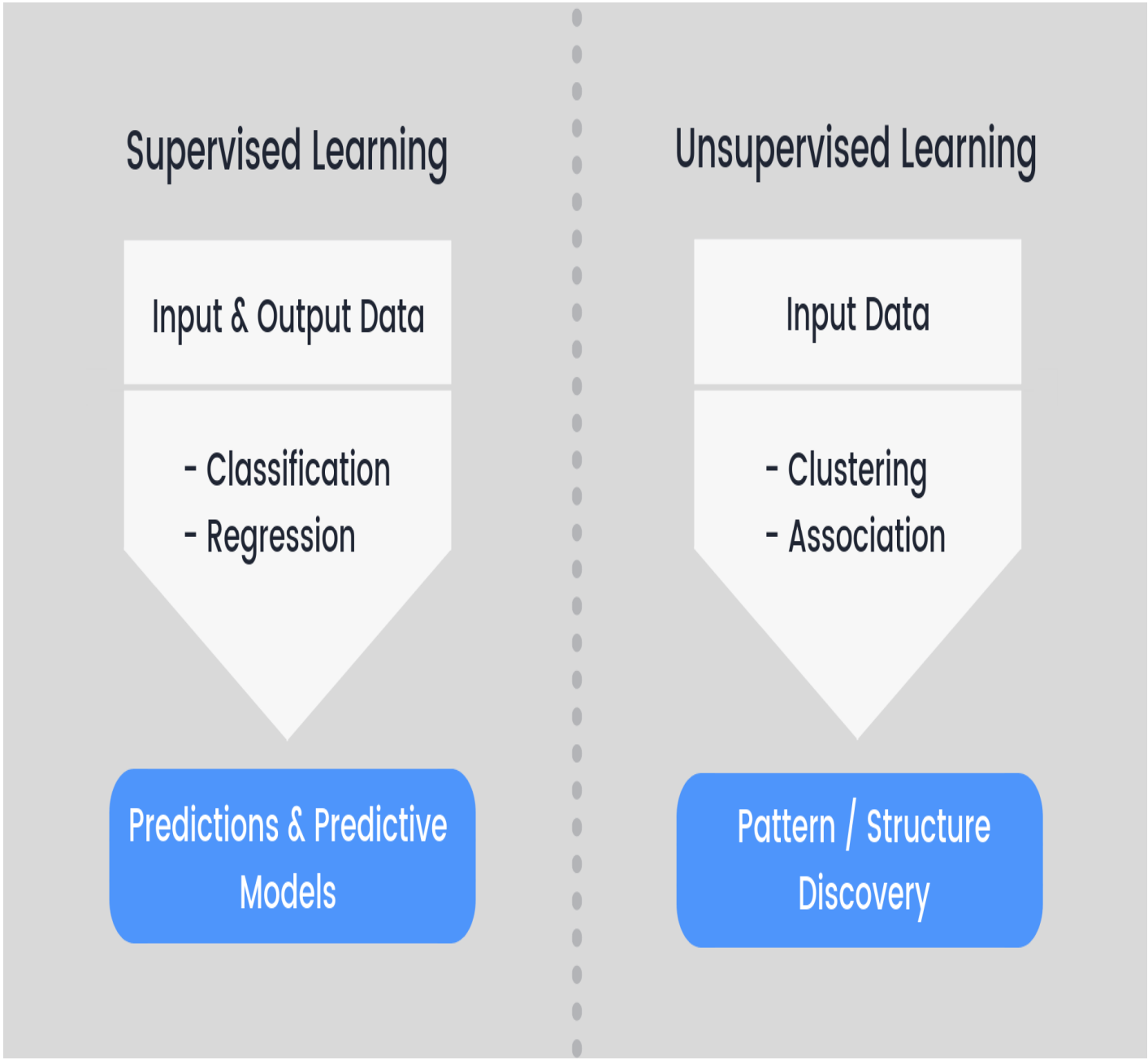
Lift Value Calculation, Market Basket Analysis(support and confidence) ,Super market design, Association Mining(apriori)

Unsupervised learning is a machine learning technique, where you do not need to supervise the model.

Instead, you need to allow the model to work on its own to discover information. It mainly deals with the unlabelled data.

Unsupervised learning algorithms allows you to perform more complex processing tasks compared to supervised learning.

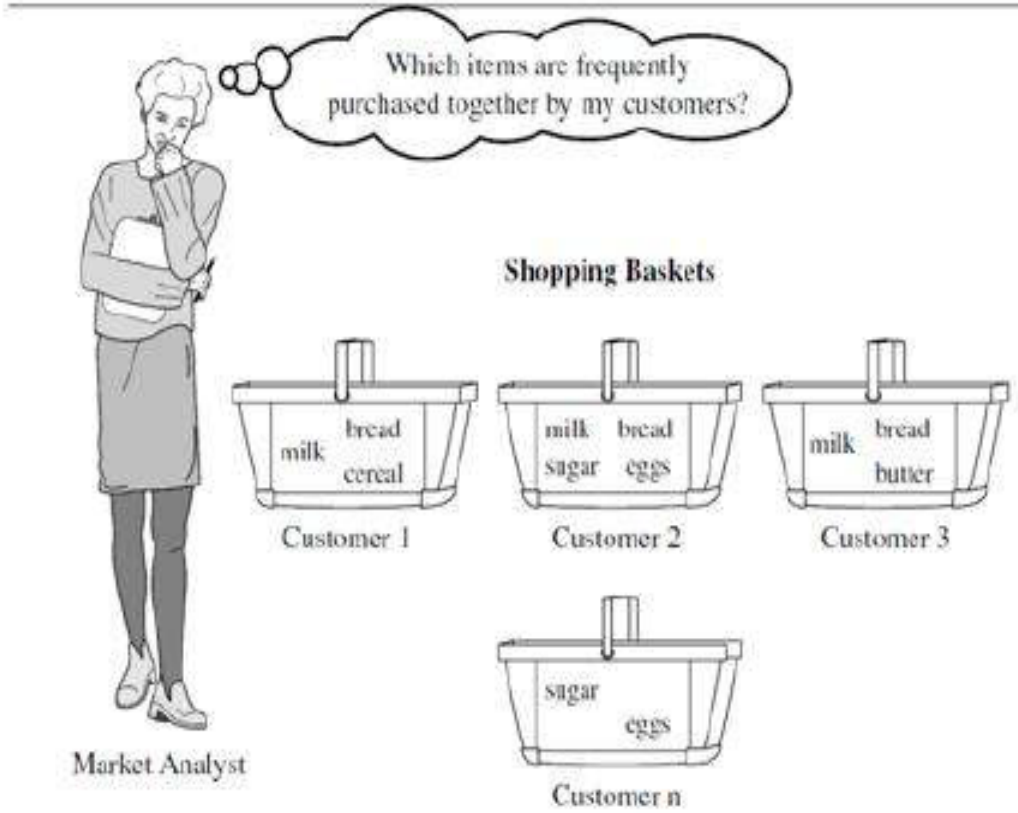
Although, unsupervised learning can be more unpredictable compared with other natural learning methods.


Supervised Learning
Input & Output Data
- Classification
- Regression
Predictions & Predictive Models
Unsupervised Learning
Input Data
- Clustering
- Association
Pattern / Structure Discovery

Association Rule a concept of Mining

Problem:

Which groups or sets of items are customers likely to purchase on a given trip to the store?



Basic Rule

A `rule' is something like this:

If a basket contains Bread and Butter , then it also contains Milk

Any such rule has two associated measures:

1. ***confidence*** – when the `if' part is true, how often is the `then' bit true? This is the same as *accuracy*.

$$\textbf{Confidence (A} \Rightarrow \textbf{B)} = \frac{\#\_tuples\_containing\_both\_A\_and\_B}{\#\_tuples\_containing\_A}$$

2. *coverage* or ***support*** – how much of the database contains

$$support(A \Rightarrow B) = \frac{\#\_tuples\_containing\_both\_A\_and\_B}{total\_\#\_of\_tuples}$$

- **Example**

  computer → antivirus_software [support = 2%, confidence = 60%]

  Means that 2% of all transaction under analysis show that computer and antivirus software are purchased together, and 60% of the customers who purchased a computer also bought the software

Market Basket Analysis

However, sometimes, simply looking at support and confidence to determine the strength of association can be misleading. For example, suppose a store in town offers the lowest prices on broccoli and milk, which attracts many customers to the store to purchase these two items. As a result, you will get high support and confidence values for the {broccoli} => {milk} association simply because a large percent of customers purchase these two items. In this case, there is not necessarily a relationship between the two items. In order to avoid this common trap in association rules, we often turn to the **lift ratio** to evaluate the strength of the association. The lift ratio explicitly compares the confidence with a benchmark value called "expected confidence." It is calculated as:

Lift

Lift (*x* => *y*) is nothing but the 'interestingness' or the likelihood of the item *y* being purchased when the item *x* is sold. Unlike confidence (*x* => *y*), this method takes into account the popularity of the item *y*.

$$\text{Lift} = \text{support}(X \,\&\, Y)/\text{Support}(X)*\text{Support}(Y)$$

- **Lift (*x* => *y*)** = 1 means that there is no correlation within the itemset.
- **Lift (*x* => *y*)** > 1 means that there is a positive correlation within the itemset, i.e., products in the itemset, *x* and *y*, are more likely to be bought together.
- **Lift (*x* => *y*)** < 1 means that there is a negative correlation within the itemset, i.e., products in itemset, *x* and *y*, are unlikely to be bought together.

Market Basket Analysis

$$= \frac{2}{5 \times {}^{3}/_{5} \times {}^{3}/_{5}} = \frac{10}{9}$$

$$Support = \frac{frq(X,Y)}{N}$$

(Actual number of transactions where meat and vegetables were purchased) / (Total number of transactions) * (Fraction of times meat was purchased) * (Fraction of time vegetables were purchased)

$$Rule: \; X \Rightarrow Y$$

$$Confidence = \frac{frq(X,Y)}{frq(X)}$$

Lift(A→B) = (Confidence (A→B)) /(Support (B))

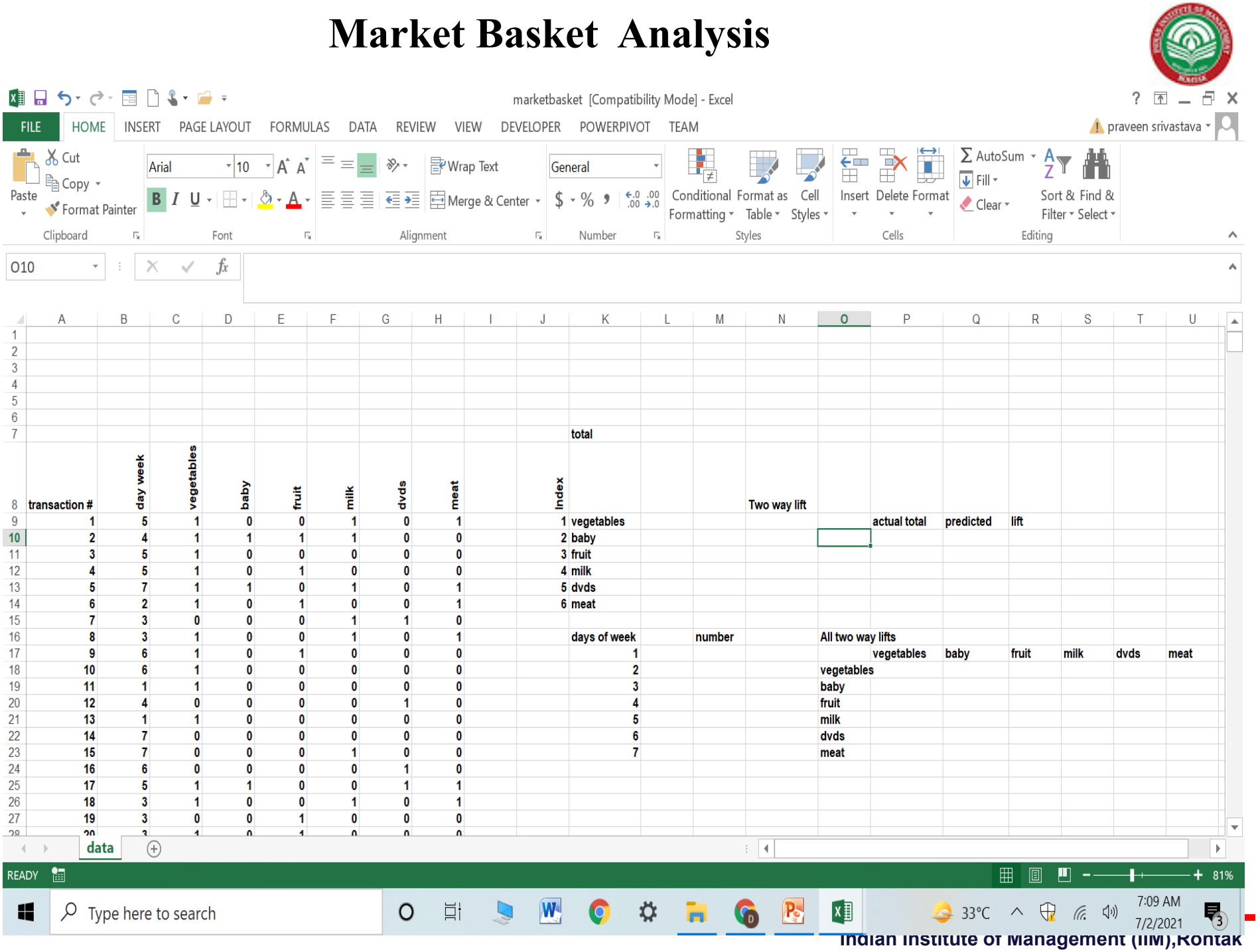
$$\frac{\frac{2}{5}}{{}^{3}/_{5} \times {}^{3}/_{5}} = \frac{10}{9}$$

$$Lift = \frac{Support}{Supp(X) \times Supp(Y)}$$

$$= \frac{\frac{2}{5}}{\frac{3}{5}} = \frac{10}{9}$$

Rule	Support	Confidence	Lift
A→D	2/5	2/3	10/9
C→A	2/5	2/4	5/6
A→C	2/5	2/3	5/6
B&C→D	1/5	1/3	5/9

Market Basket Analysis



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
7											total										
8	transaction #	day week	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift							
9	1	5	1	0	0	1	0	1		1	vegetables					actual total	predicted	lift			
10	2	4	1	1	1	1	0	0		2	baby										
11	3	5	1	0	0	0	0	0		3	fruit										
12	4	5	1	0	1	0	0	0		4	milk										
13	5	7	1	1	0	1	0	1		5	dvds										
14	6	2	1	0	1	0	0	1		6	meat										
15	7	3	0	0	0	1	1	0													
16	8	3	1	0	0	1	0	1			days of week		number		All two way lifts						
17	9	6	1	0	1	0	0	0			1					vegetables	baby	fruit	milk	dvds	meat
18	10	6	1	0	0	0	0	0			2				vegetables						
19	11	1	1	0	0	0	0	0			3				baby						
20	12	4	0	0	0	0	1	0			4				fruit						
21	13	1	1	0	0	0	0	0			5				milk						
22	14	7	0	0	0	0	0	0			6				dvds						
23	15	7	0	0	0	1	0	0			7				meat						
24	16	6	0	0	0	0	1	0													
25	17	5	1	1	0	0	1	1													
26	18	3	1	0	0	1	0	1													
27	19	3	0	0	1	0	0	0													

Market Basket Analysis

Now perform the following steps to determine the fraction of all transactions involving each type of product and the fraction of transactions taking place on each day of the week.

In cell L7 compute the total number of transactions with the formula =COUNT(B9:B2936). This formula counts how many numbers occur in Column B, which gives you the number of transactions.

SUM | =count(B:B)

Indirect function or countif function

2928

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2													
3													
4													
5													
6													
7											total	=count(B:B)	
8	transaction #	day week	vegetables	baby	fruit	milk	dvds	meat		Index			
9	1	5	1	0	0	1	0	1		1	vegetables		
10	2	4	1	1	1	1	0	0		2	baby		
11	3	5	1	0	0	0	0	0		3	fruit		

Market Basket Analysis

Copy the formula **=COUNTIF(INDIRECT(K9),1)/$L$7** from L9 to cells L10:L14 to compute the fraction of transactions involving each product. Recall that COUNTIF counts the number of entries in a range matching a given number or text string (in this case 1). Any cell reference within an INDIRECT function is evaluated as the contents of the cell. Thus INDIRECT(K9) becomes vegetables. This enables you to copy your COUNTIF statement and pick off the range names. Thus 60.7 percent of all transactions involve vegetables, and so on.

SUM | =COUNTIF(INDIRECT(K9),1)/$L$7

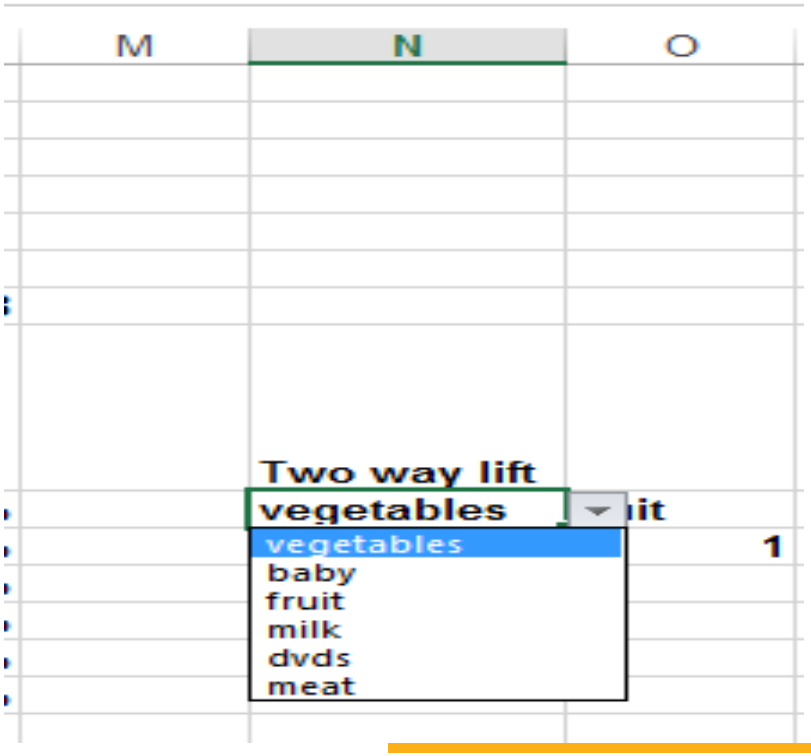
Instead of indirect function ,we can also write
=COUNTIF(vegetables,1)/$L$7

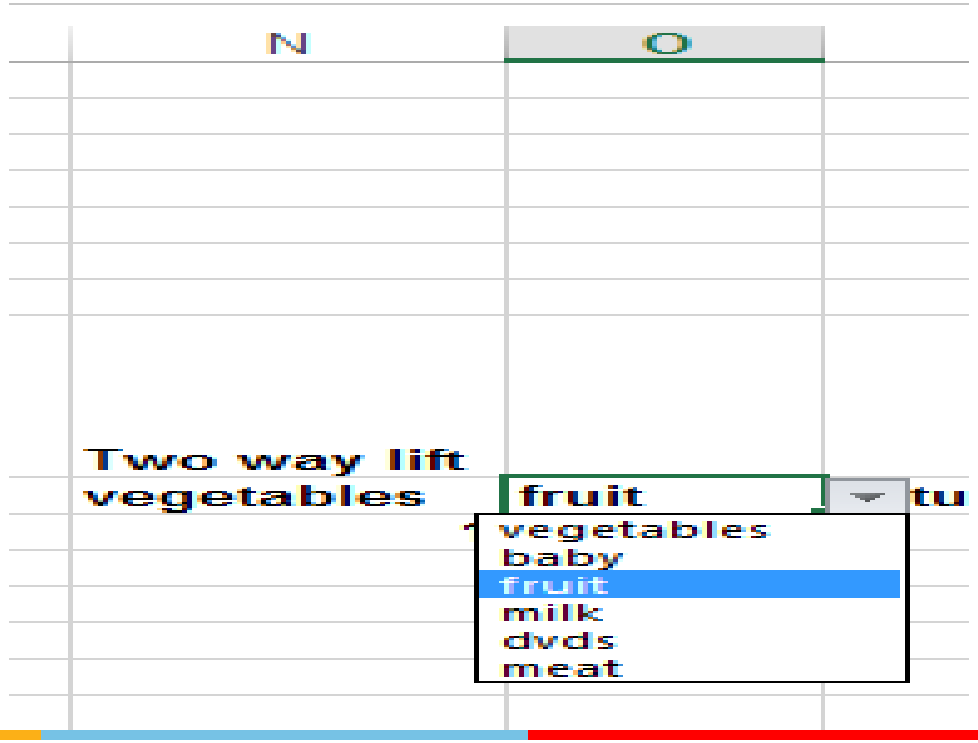
	transaction #	day week	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift
											total	2928		60.7%
														27.1%
														29.7%
														30.4%
														21.1%
														24.9%
9	1	5	1	0	0	1	0	1		1	vegetables	=COUNTIF(INDIRECT(K9),1)/$L$7		
10	2	4	1	1	1	1	0	0		2	baby			1
11	3	5	1	0	0	0	0	0		3	fruit			
12	4	5	1	0	1	0	0	0		4	milk			
13	5	7	1	1	0	1	0	1		5	dvds			

Market Basket Analysis

Calculating Lifts for Multiple Two-way Product Combinations Simultaneously

Now you can use a two-way data table to compute the lift for any combination of two products. Enter the range names for any two products in the range N9:O9. To ease the selection of products you can use the drop-down list in cells N9 and O9.





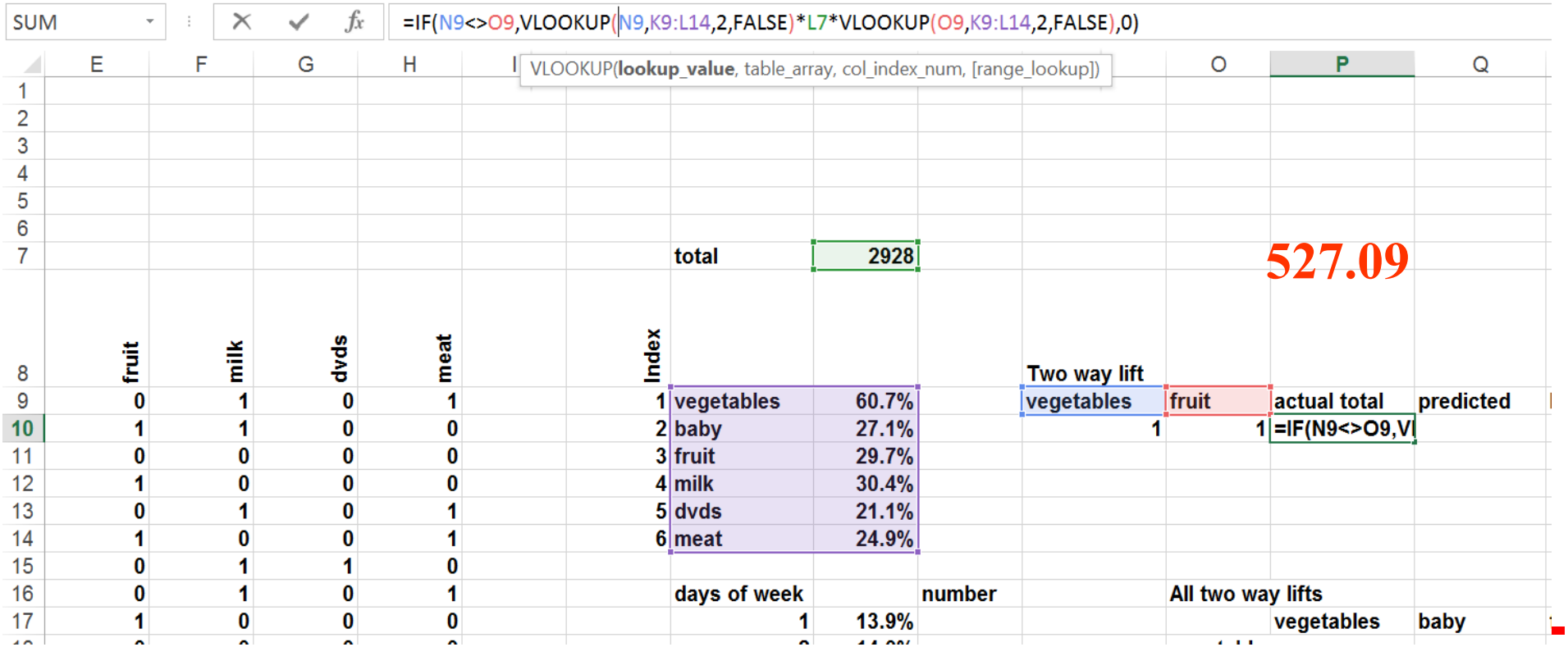
Market Basket Analysis

=SUMPRODUCT(vegetables,fruit)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1																
2																
3																
4																
5																
6																
7											total	2928				
8	transaction #	day week	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift		
9	1	5	1	0	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total
10	2	4	1	1	1	1	0	0		2	baby	27.1%		1	1	:T(O9)=1))
11	3	5	1	0	0	0	0	0		3	fruit	29.7%				
12	4	5	1	0	1	0	0	0		4	milk	30.4%				
13	5	7	1	1	0	1	0	1		5	dvds	21.1%				
14	6	2	1	0	1	0	0	1		6	meat	24.9%				
15	7	3	0	0	0	1	1	0								

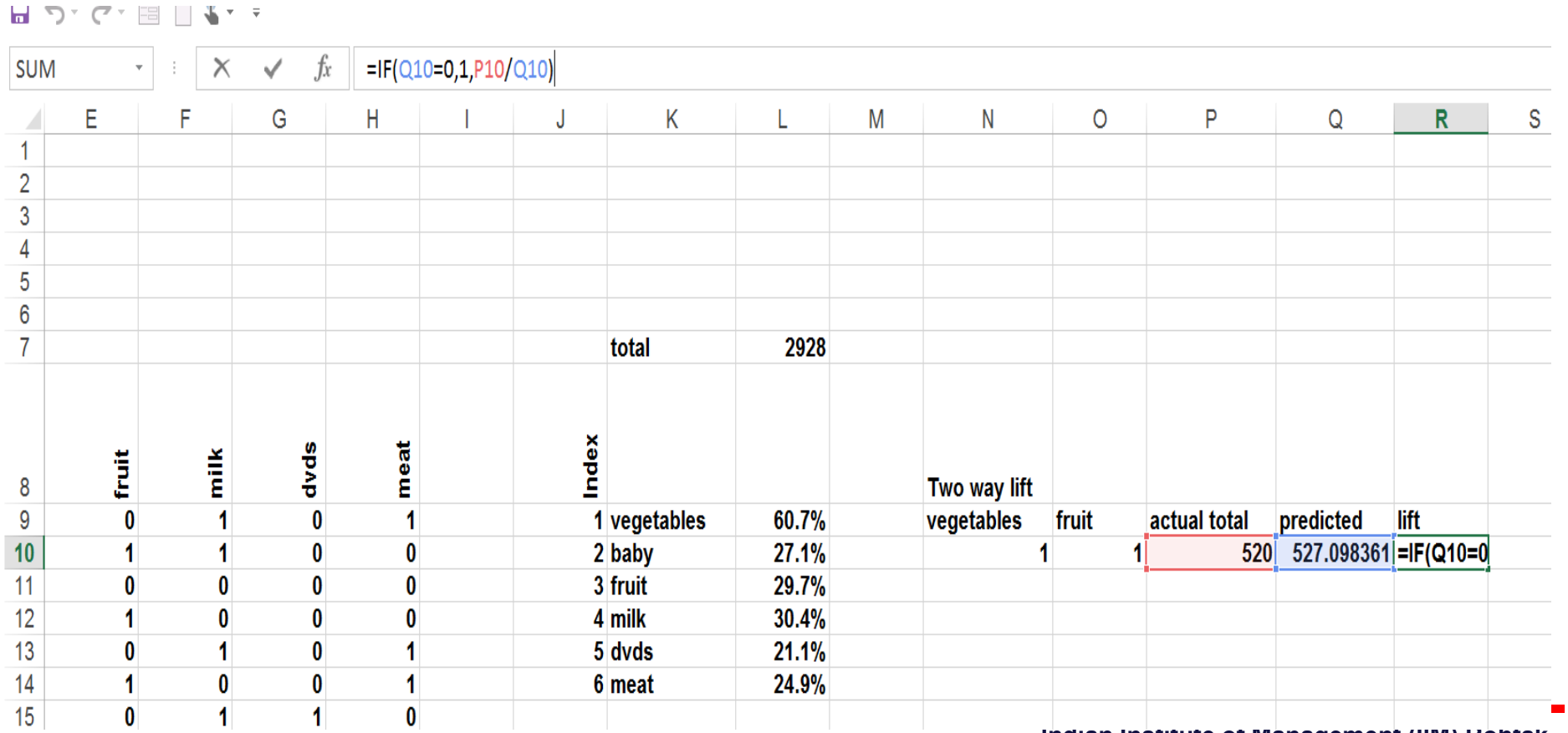
Market Basket Analysis

In cell Q10(predicted) use the formula **=IF(N9<>O9,VLOOKUP(N9,K9:L14,2,FALSE)*L7*VLOOKUP(O9,K9:L14,2,FALSE),0)** to compute the predicted number of transactions involving the two products assuming independence. This formula computes the denominator of Equation 1. If you choose the same product twice, enter a 0.



Market Basket Analysis

In cell R10 compute the total lift for these categories with the formula **=IF(Q10=0,1,P10/Q10).** If you chose the same item twice, simply set the lift to equal 1. Otherwise, divide actual occurrence of fruits and vegetables together by the predicted number of occurrences (assuming fruits and vegetables are purchased independently.)



	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1															
2															
3															
4															
5															
6															
7							total	2928							
8	fruit	milk	dvds	meat		Index				Two way lift					
9	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total	predicted	lift	
10	1	1	0	0		2	baby	27.1%		1	1	520	527.098361	=IF(Q10=0	
11	0	0	0	0		3	fruit	29.7%							
12	1	0	0	0		4	milk	30.4%							
13	0	1	0	1		5	dvds	21.1%							
14	1	0	0	1		6	meat	24.9%							
15	0	1	1	0											

Market Basket Analysis

The lift for fruits and vegetables does not indicate a lack of independence (.99 is near 1). Taking this one step further, you can use a two-way data table to compute the lift for all two-product combinations simultaneously.

In **cell O17** place the formula for lift (=R10) that you want to recalculate. R10 contains the lift for a generic two-product combination.

SUM | =R10

	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1														
2														
3														
4														
5														
6														
7							total	2928						
8	fruit	milk	dvds	meat		Index				Two way lift				
9	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total	predicted	lift
10	1	1	0	0		2	baby	27.1%		1	1	520	527.098361	0.986533
11	0	0	0	0		3	fruit	29.7%						
12	1	0	0	0		4	milk	30.4%						
13	0	1	0	1		5	dvds	21.1%						
14	1	0	0	1		6	meat	24.9%						
15	0	1	1	0										
16	0	1	0	1			days of week		number		All two way lifts			
17	1	0	0	0			1	13.9%			=R10	vegetables	baby	fruit
18	0	0	0	0			2	14.0%			vegetables			
19	0	0	0	0			3	13.4%			baby			
20	0	0	1	0			4	14.6%			fruit			

Market Basket Analysis

Select the table range O17:U23.

All two way lifts

0.986533	vegetables	baby	fruit	milk	dvds	meat
vegetables						
baby						
fruit						
milk						
dvds						
meat						

Select What-If Analysis from the Data Tools Group on the Data tab and choose Data Table .... From the Data Table dialog box enter N9 as the row input cell and O9 as the column input cell. After clicking, you now have the lift for each two-product combination For example, DVDs an d baby goods have a relatively large lift of 1.4.

NOTE

The lift matrix is symmetric; that is, the entry in row I and Column J of the lift matrix equals the entry in row J and Column I.

Market Basket Analysis

All two way lifts

0.986533	vegetables	baby	fruit	milk	dvds	meat
vegetables	1.00	0.96	0.99	1.00	0.96	1.01
baby	0.96	1.00	1.05	1.00	1.40	1.01
fruit	0.99	1.05	1.00	1.00	1.03	0.90
milk	1.00	1.00	1.00	1.00	0.98	1.06
dvds	0.96	1.40	1.03	0.98	1.00	0.96
meat	1.01	1.01	0.90	1.06	0.96	1.00

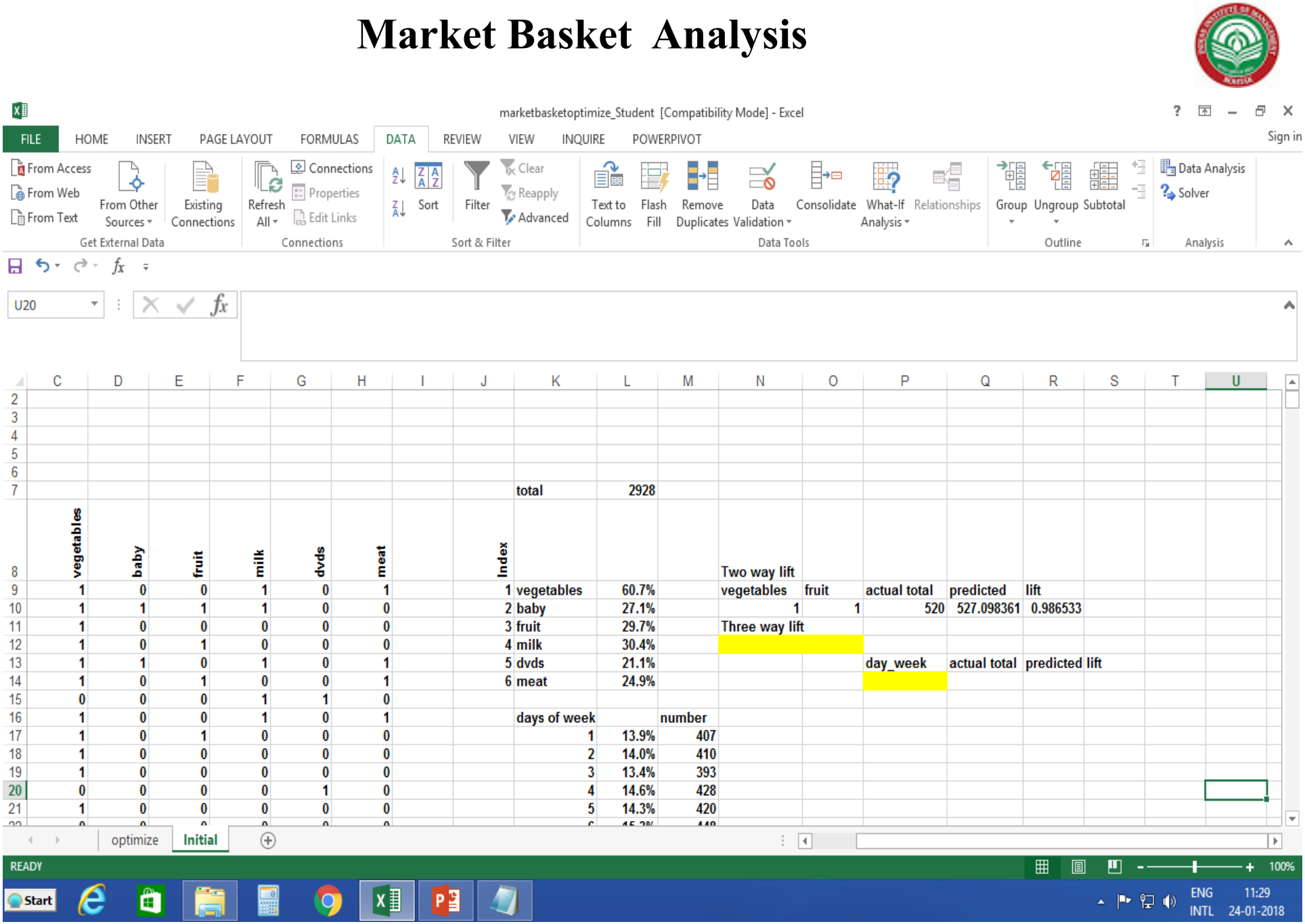
Computing Three-Way Lifts

To illustrate how the concept of lift applies to three or more attributes associated with a transaction, consider calculating the lift for the purchase of baby goods and DVDs on Thursday. This lift would be computed as follows:

$$\frac{\text{(Actual number of Thursday transactions where baby goods and DVDs were purchased)}}{\text{(Total number of transactions)} * \text{(Fraction of transactions on Thursday)} * \text{(Fraction of transactions with baby goods)} * \text{(Fraction of transactions with DVDs)}}$$

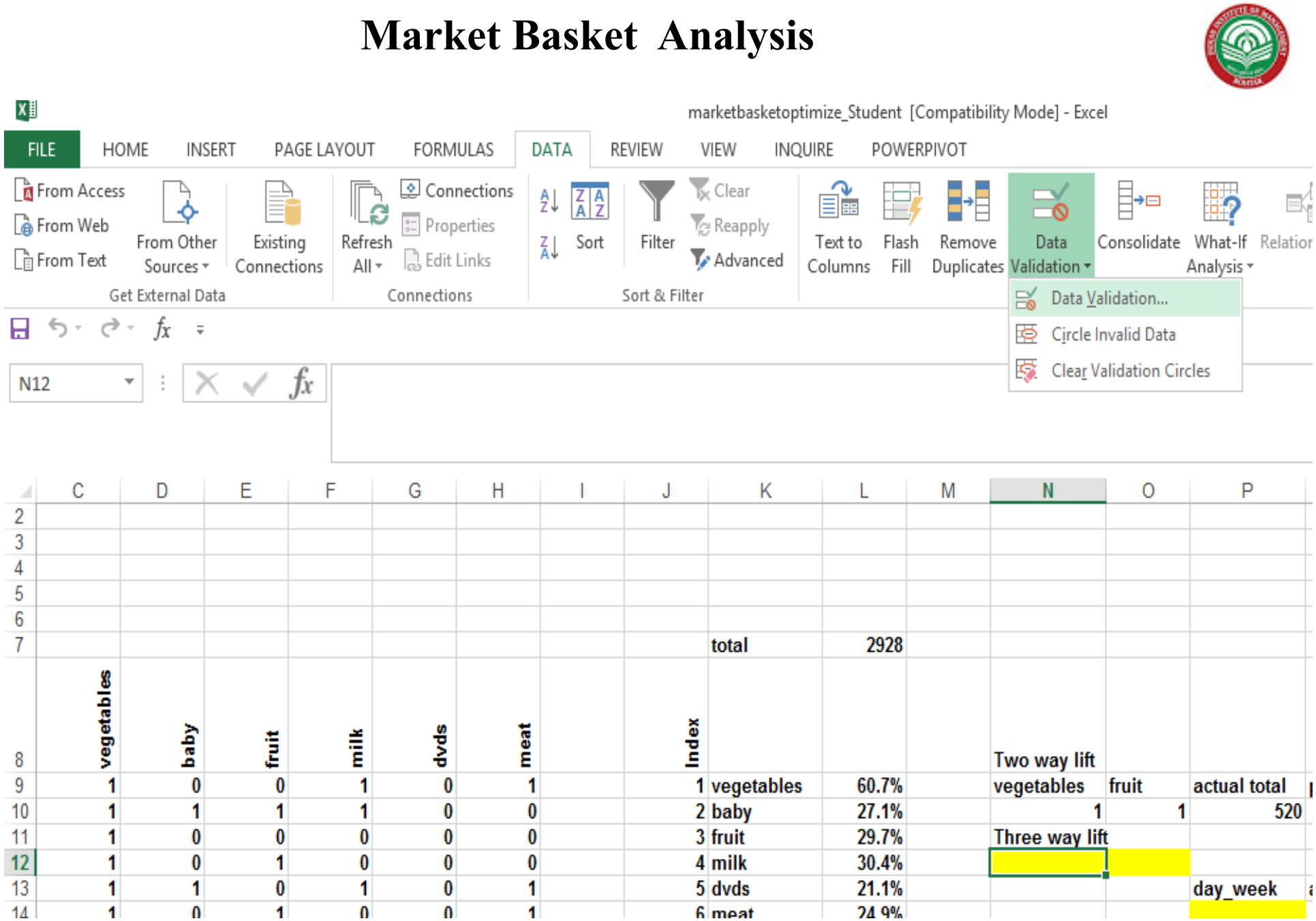
Use file :marketbasketothreeway.xlsx

Market Basket Analysis



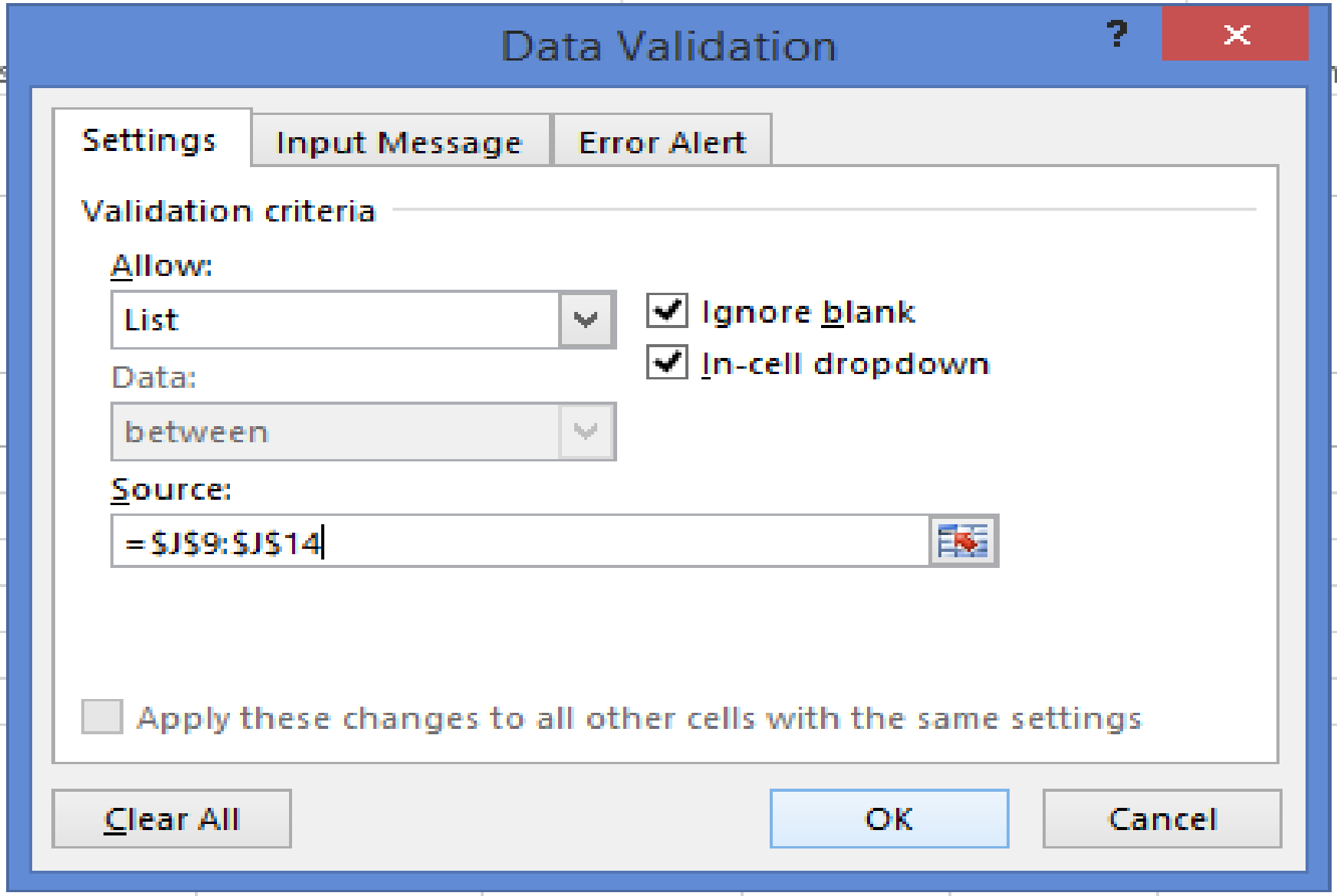
	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
2																			
3																			
4																			
5																			
6																			
7									total	2928									
8	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift							
9	1	0	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total	predicted	lift			
10	1	1	1	1	0	0		2	baby	27.1%		1	1	520	527.098361	0.986533			
11	1	0	0	0	0	0		3	fruit	29.7%		Three way lift							
12	1	0	1	0	0	0		4	milk	30.4%									
13	1	1	0	1	0	1		5	dvds	21.1%				day_week	actual total	predicted	lift		
14	1	0	1	0	0	1		6	meat	24.9%									
15	0	0	0	1	1	0													
16	1	0	0	1	0	1			days of week		number								
17	1	0	1	0	0	0			1	13.9%	407								
18	1	0	0	0	0	0			2	14.0%	410								
19	1	0	0	0	0	0			3	13.4%	393								
20	0	0	0	0	1	0			4	14.6%	428								
21	1	0	0	0	0	0			5	14.3%	420								

Market Basket Analysis

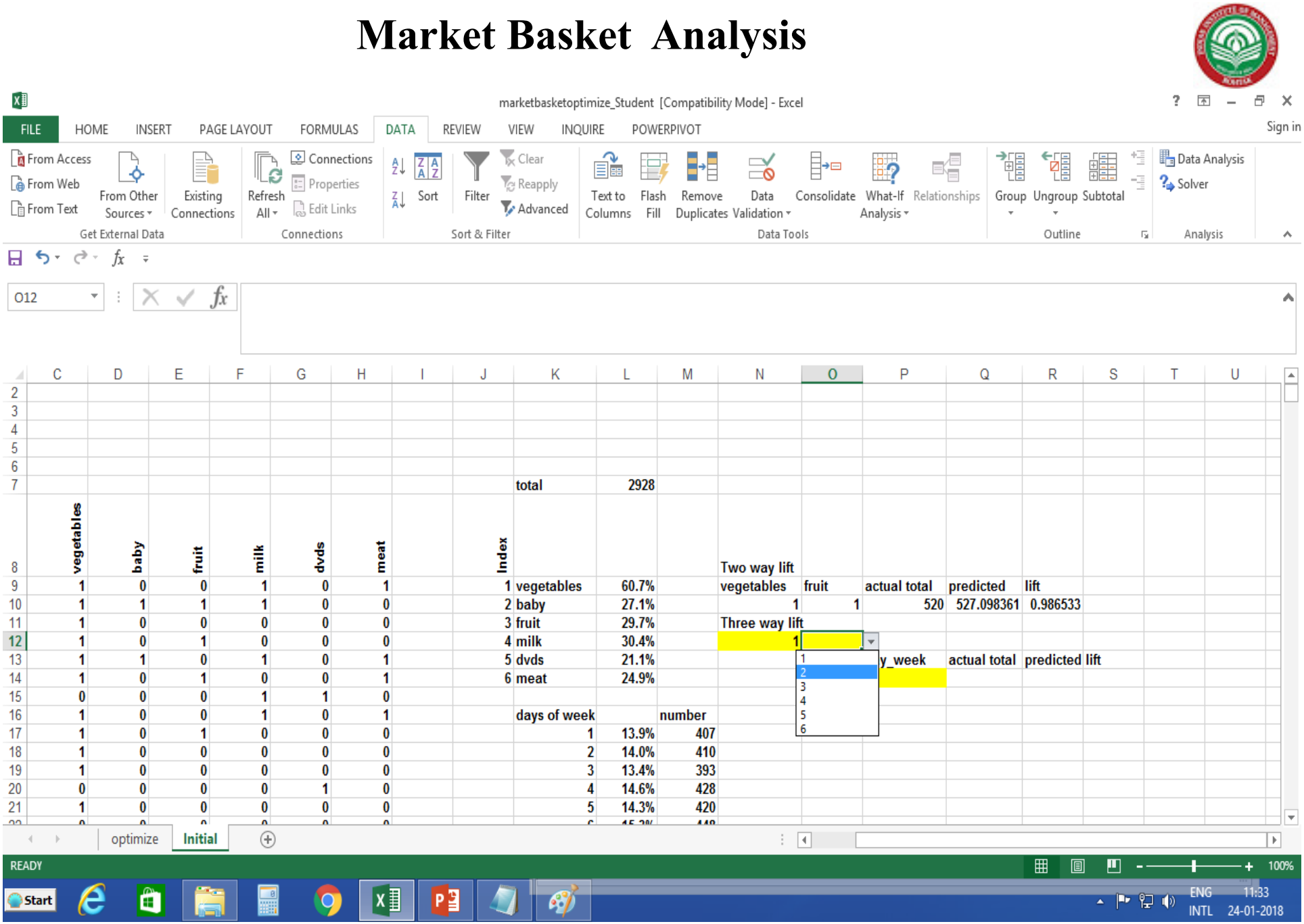


	C	D	E	F	G	H	I	J	K	L	M	N	O	P
2														
3														
4														
5														
6														
7									total	2928				
8	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift		
9	1	0	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total
10	1	1	1	1	0	0		2	baby	27.1%		1	1	520
11	1	0	0	0	0	0		3	fruit	29.7%		Three way lift		
12	1	0	1	0	0	0		4	milk	30.4%				
13	1	1	0	1	0	1		5	dvds	21.1%				day_week
14	1	0	1	0	0	1		6	meat	24.9%				

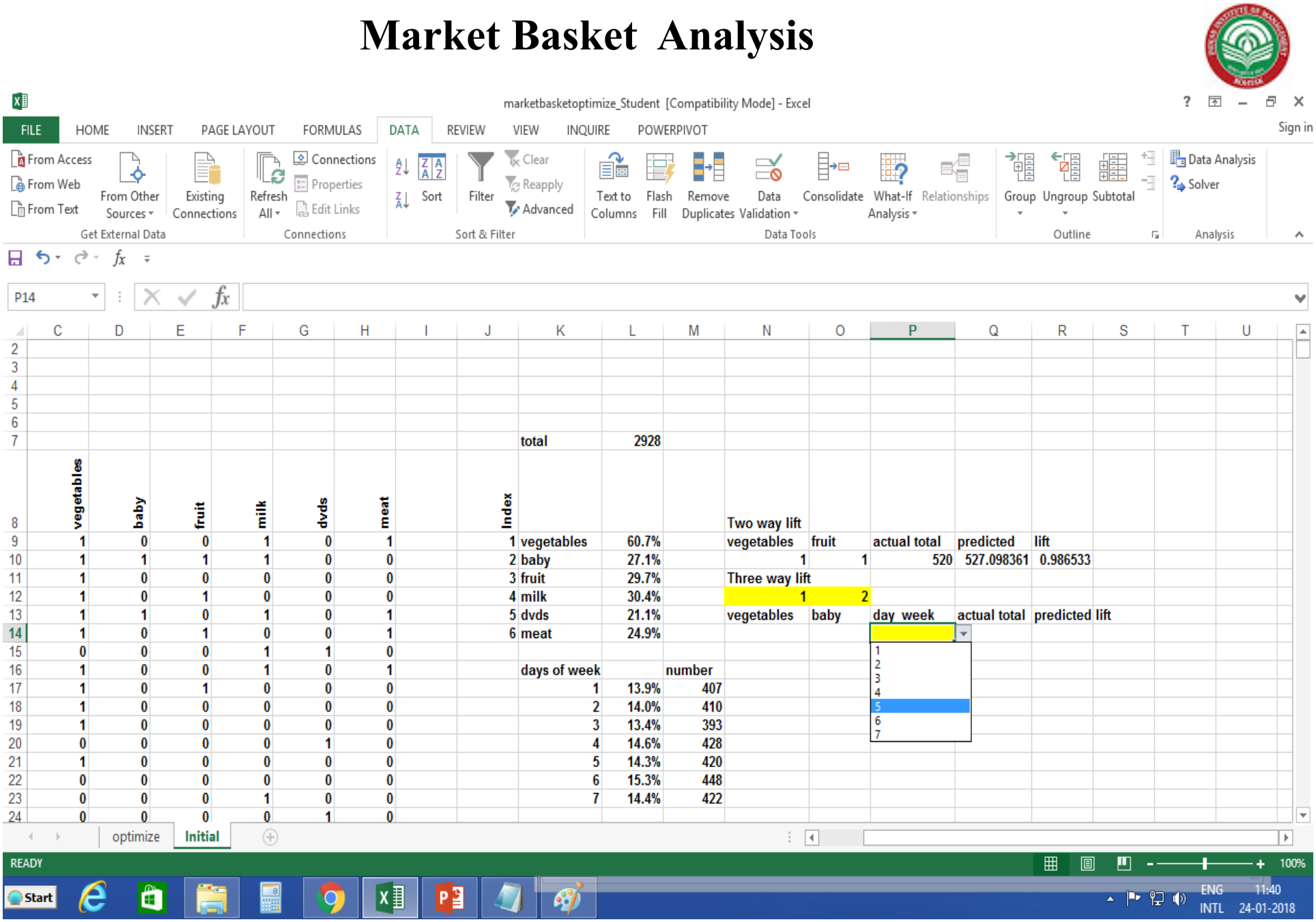
Market Basket Analysis



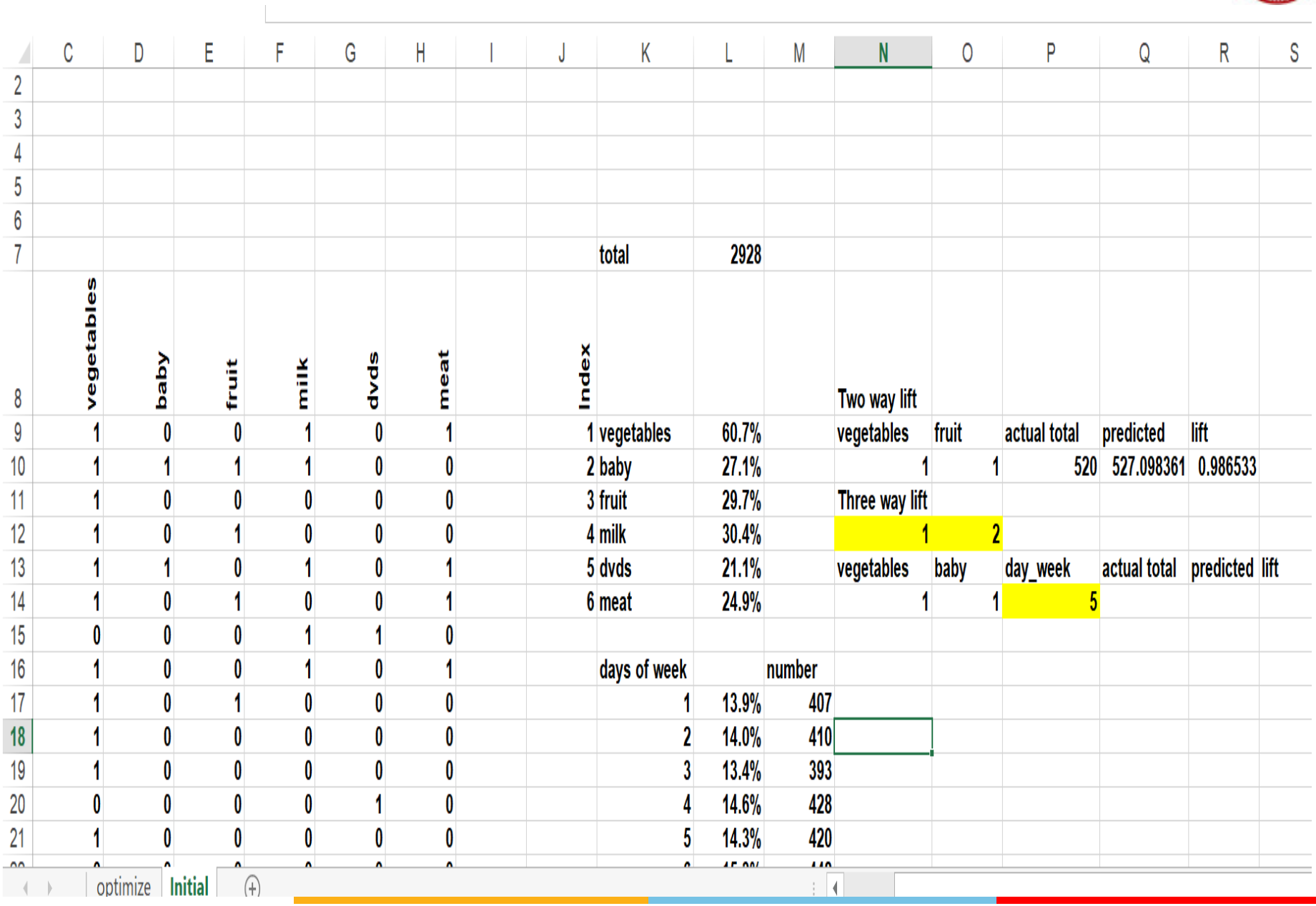
Market Basket Analysis



Market Basket Analysis



Market Basket Analysis



	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
2																	
3																	
4																	
5																	
6																	
7									total	2928							
8	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift					
9	1	0	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total	predicted	lift	
10	1	1	1	1	0	0		2	baby	27.1%		1	1	520	527.098361	0.986533	
11	1	0	0	0	0	0		3	fruit	29.7%		Three way lift					
12	1	0	1	0	0	0		4	milk	30.4%		1	2				
13	1	1	0	1	0	1		5	dvds	21.1%		vegetables	baby	day_week	actual total	predicted	lift
14	1	0	1	0	0	1		6	meat	24.9%		1	1	5			
15	0	0	0	1	1	0											
16	1	0	0	1	0	1			days of week		number						
17	1	0	1	0	0	0			1	13.9%	407						
18	1	0	0	0	0	0			2	14.0%	410						
19	1	0	0	0	0	0			3	13.4%	393						
20	0	0	0	0	1	0			4	14.6%	428						
21	1	0	0	0	0	0			5	14.3%	420						

optimize | Initial

Market Basket Analysis

You can use the same concept to compute for the superstore data the lift of an arbitrary combination of two products and a day of the week.

Complete the following steps:

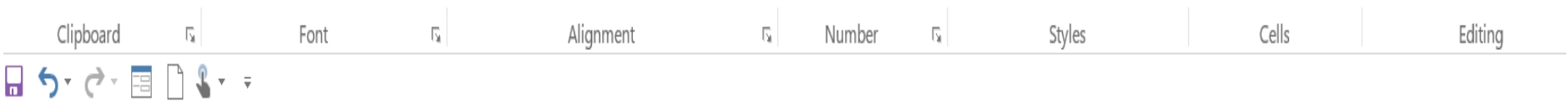
1. In cell Q14 use the array formula

=SUM((INDIRECT(P13)=$P$14)*(INDIRECT(N13)=1)*(INDIRECT(O13)=1))

to compute the actual number of transactions involving vegetables and baby goods on Friday. This formula computes three arrays:

- An array containing a 1 if the day of the week matches the number in P14 (here a 5) and a 0 otherwise.
- An array containing a 1 if the vegetables column contains a 1 and 0 otherwise.
- An array containing a 1 if the baby column contains a 1 and 0 otherwise.

Market Basket Analysis



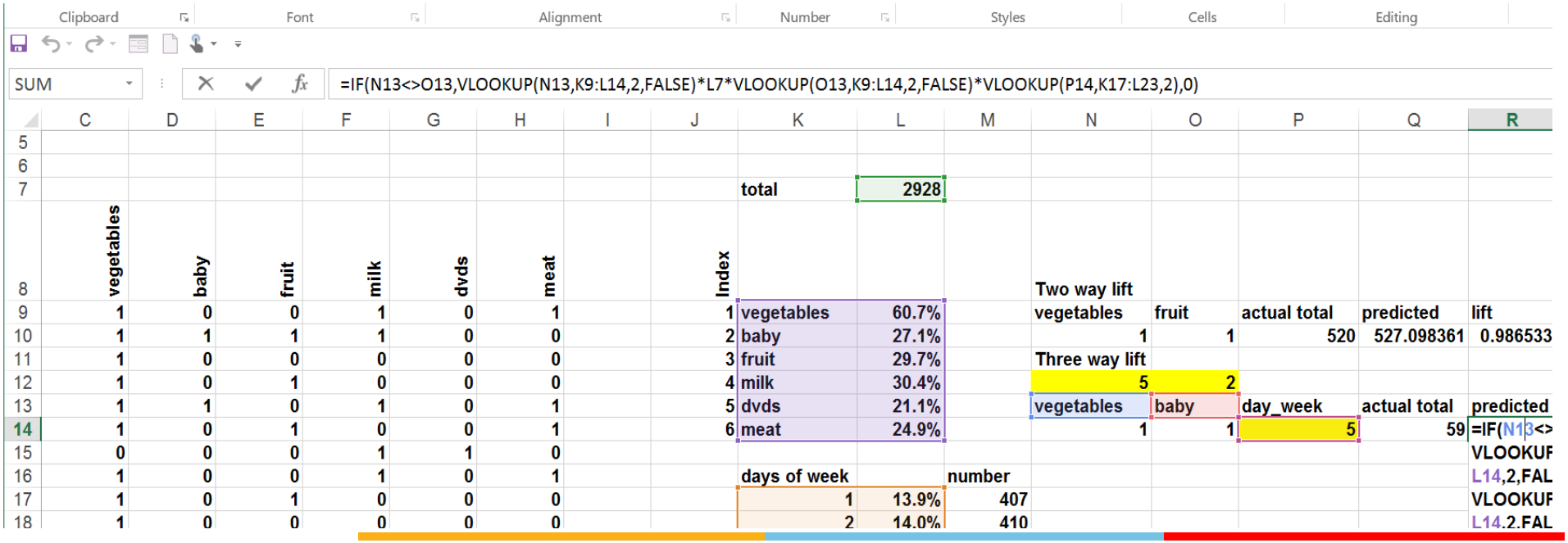
Q14 | {=SUM((INDIRECT(P13)=$P$14)*(INDIRECT(N13)=1)*(INDIRECT(O13)=1))}

	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
5															
6															
7									total	2928					
8	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift			
9	1	0	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total	predicted
10	1	1	1	1	0	0		2	baby	27.1%		1	1	520	527.098361
11	1	0	0	0	0	0		3	fruit	29.7%		Three way lift			
12	1	0	1	0	0	0		4	milk	30.4%		5	2		
13	1	1	0	1	0	1		5	dvds	21.1%		vegetables	baby	day_week	actual total
14	1	0	1	0	0	1		6	meat	24.9%		1	1	5	59
15	0	0	0	1	1	0									
16	1	0	0	1	0	1			days of week		number				
17	1	0	1	0	0	0			1	13.9%	407				
18	1	0	0	0	0	0			2	14.0%	410				
19	1	0	0	0	0	0			3	13.4%	393				

Market Basket Analysis

In cell R14 compute the predicted number of transactions involving baby goods and vegetables purchased on Friday with the following formula:

IF(N13<>O13,VLOOKUP(N13,K9:L14,2,FALSE)*L7*VLOOKUP(O13,K9:L14,2,FALSE)*VLOOKUP(P14,K17:L23,2),0)



	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
5																
6																
7									total	2928						
8	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift				
9	1	0	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total	predicted	lift
10	1	1	1	1	0	0		2	baby	27.1%		1	1	520	527.098361	0.986533
11	1	0	0	0	0	0		3	fruit	29.7%		Three way lift				
12	1	0	1	0	0	0		4	milk	30.4%		5	2			
13	1	1	0	1	0	1		5	dvds	21.1%		vegetables	baby	day_week	actual total	predicted
14	1	0	1	0	0	1		6	meat	24.9%		1	1	5	59	=IF(N13<>
15	0	0	0	1	1	0										VLOOKUP
16	1	0	0	1	0	1			days of week		number					L14,2,FAL
17	1	0	1	0	0	0			1	13.9%	407					VLOOKUP
18	1	0	0	0	0	0			2	14.0%	410					L14.2.FAL

Market Basket Analysis

Formula Bar

IF(N13<>O13,VLOOKUP(N13,K9:L14,2,FALSE)*L7*VLOOKUP(O13,K9:L14,2,FALSE)*VLOOKUP(P14,K17:L23,2),0)

	milk	dvds	meat	Index								
					total	2928						
0	1	0	1	1	vegetables	60.7%		Two way lift				
1	1	0	0	2	baby	27.1%		vegetables	fruit	actual total	predicted	lift
0	0	0	0	3	fruit	29.7%		1	1	520	527.098361	0.986533
1	0	0	0	4	milk	30.4%		Three way lift				
0	1	0	1	5	dvds	21.1%		1	2			
1	0	0	1	6	meat	24.9%		vegetables	baby	day_week	actual total	predicted lift
0	1	1	0					1	1	5	59	69.08291
0	1	0	1		days of week		number					

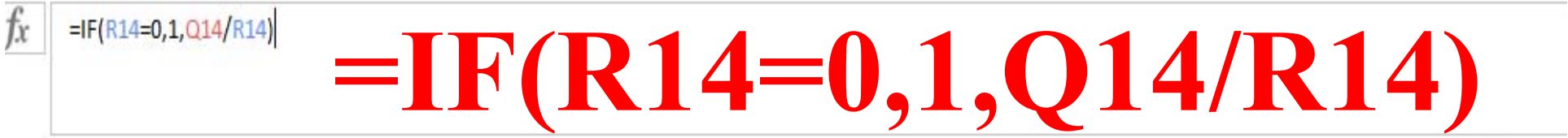
If you enter the same product class twice, this formula yields a 0. Otherwise, multiply (total number of transactions) * (fraction of baby transactions) * (fraction of vegetable transactions) * (fraction of Friday transactions).

This gives a predicted number of Monday meat and vegetable transactions (assuming independence).

Finally, in cell S14, compute the lift with the formula **=IF(R14=0,1,Q14/R14).**

The lift for vegetables and baby goods on Friday is .85. This means that on Fridays vegetables and baby goods are bought together less frequently than expected.

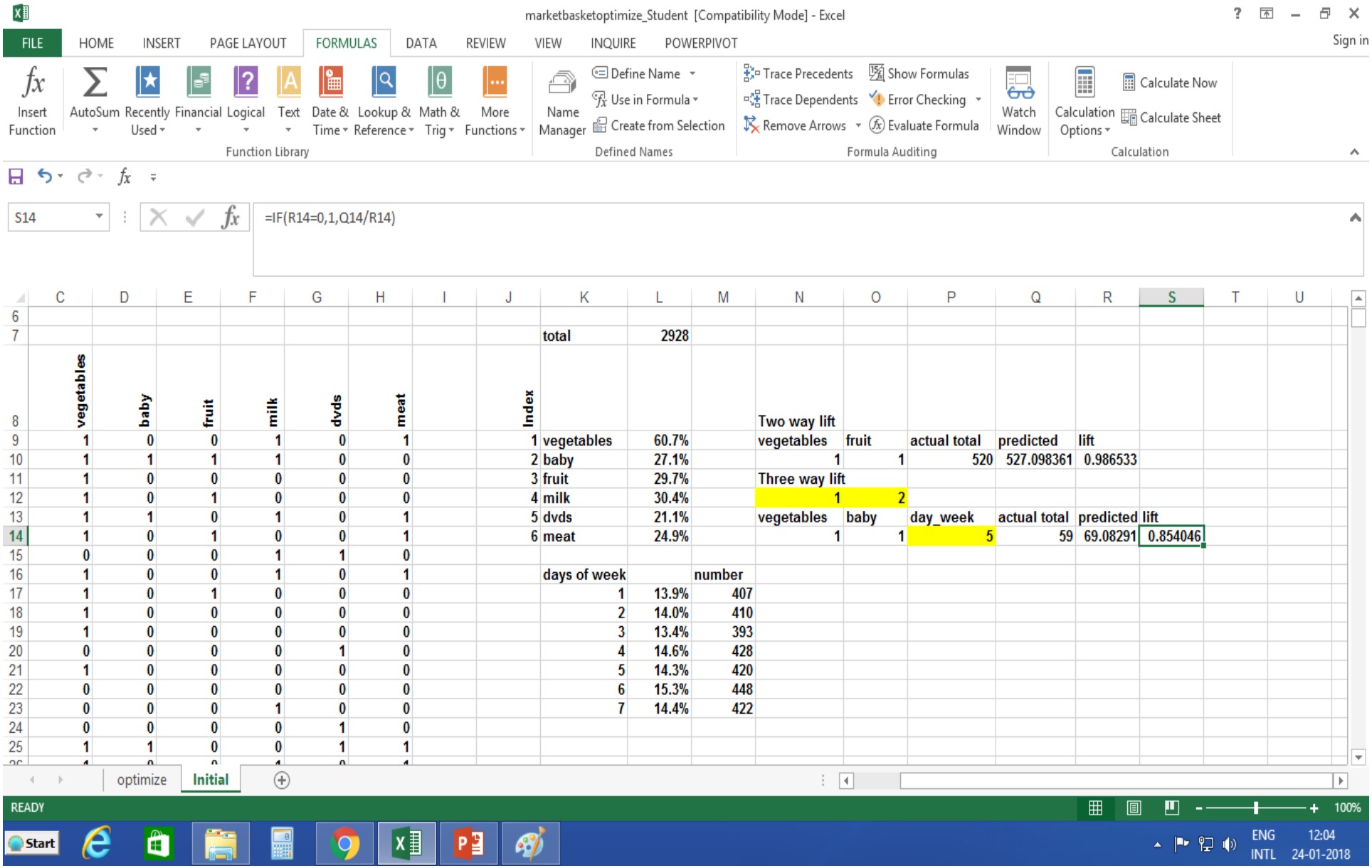
Market Basket Analysis



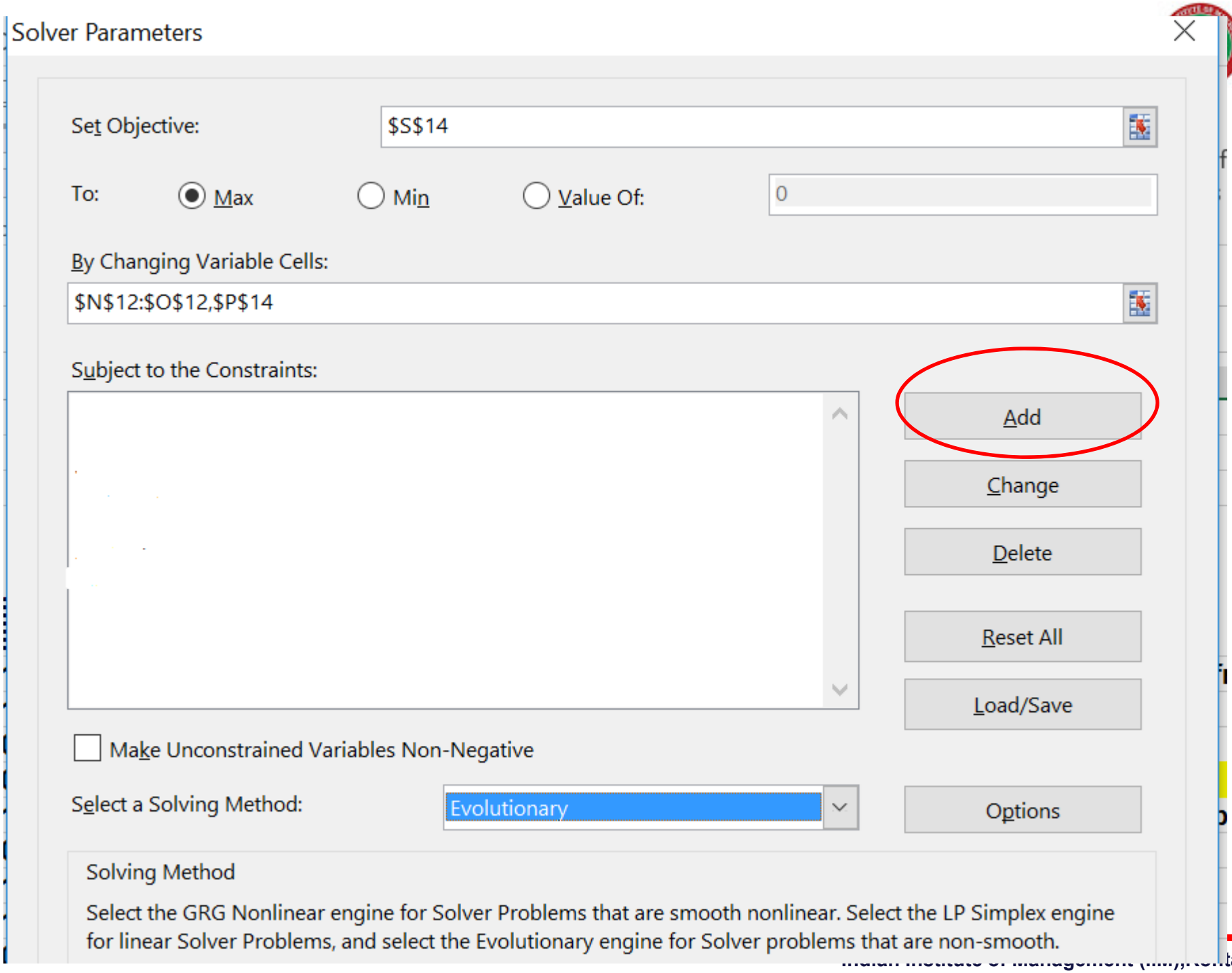
=IF(R14=0,1,Q14/R14)

F	G	H	I	J	K	L	M	N	O	P	Q	R	S
					total	2928							
milk	dvds	meat		Index				Two way lift					
1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total	predicted	lift	
1	0	0		2	baby	27.1%		1	1	520	527.098361	0.986533	
0	0	0		3	fruit	29.7%		Three way lift					
0	0	0		4	milk	30.4%		1	2				
1	0	1		5	dvds	21.1%		vegetables	baby	day_week	actual total	predicted	lift
0	0	1		6	meat	24.9%		1	1	5	59	69.08291	=IF(R14=0
1	1	0											
1	0	1			days of week		number						
0	0	0			1	13.9%	407						
0	0	0			2	14.0%	410						
0	0	0			3	13.4%	393						
0	1	0			4	14.6%	428						
0	0	0			5	14.3%	420						
0	0	0			6	15.3%	448						
1	0	0			7	14.4%	422						

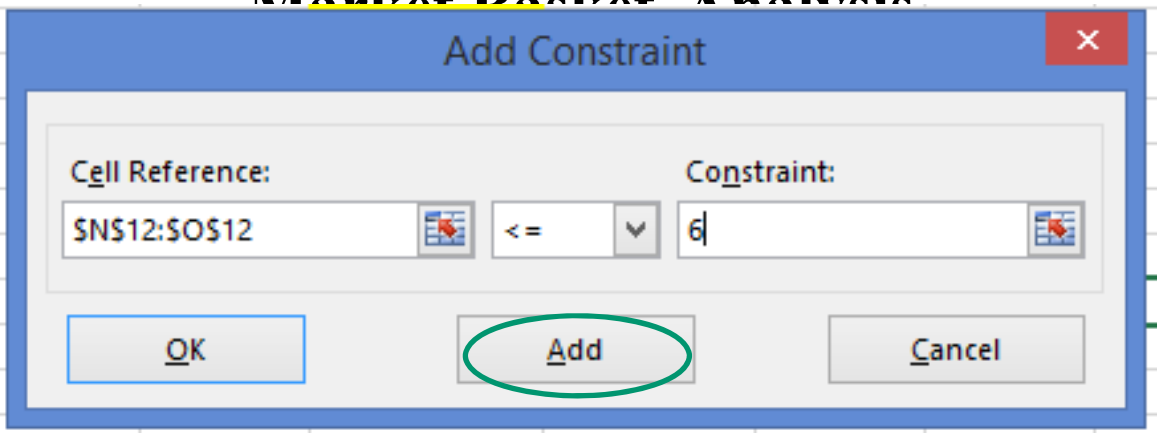
Market Basket Analysis

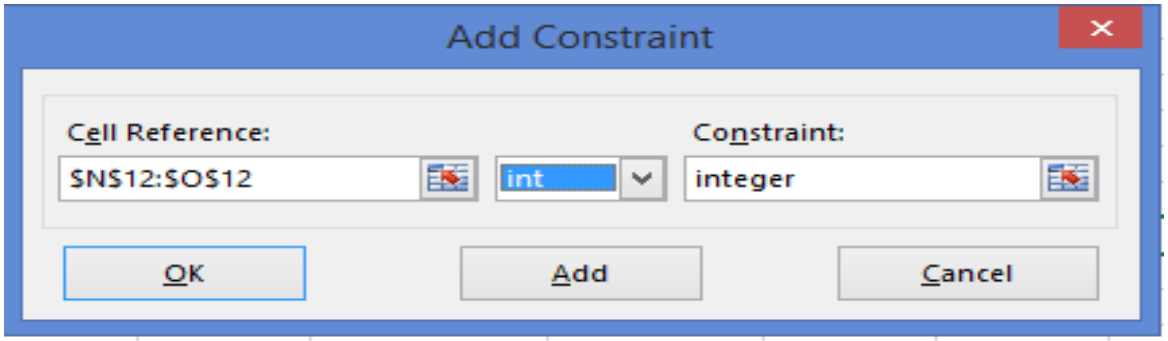


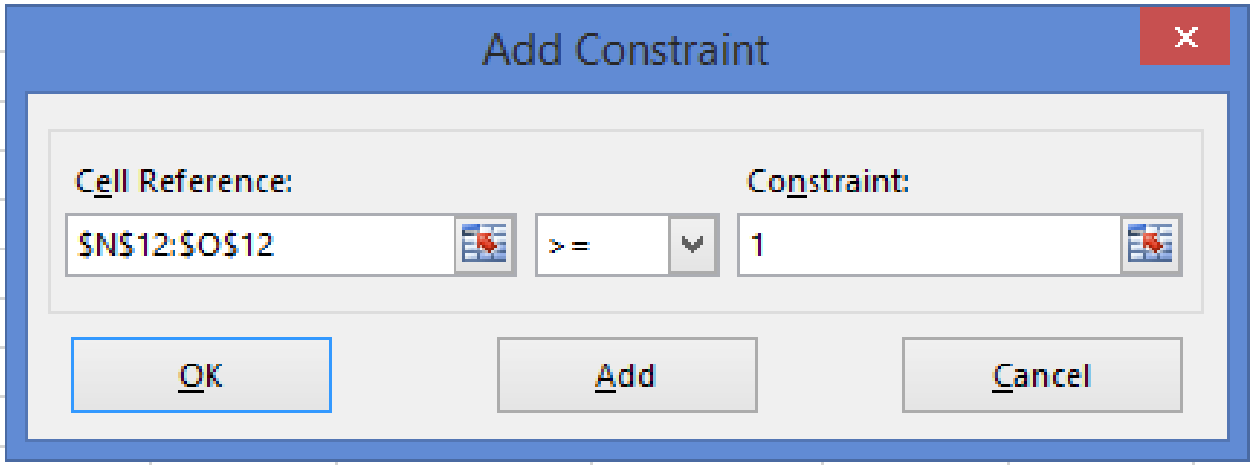
	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
6																			
7									total	2928									
8	vegetables	baby	fruit	milk	dvds	meat		Index				Two way lift							
9	1	0	0	1	0	1		1	vegetables	60.7%		vegetables	fruit	actual total	predicted	lift			
10	1	1	1	1	0	0		2	baby	27.1%		1	1	520	527.098361	0.986533			
11	1	0	0	0	0	0		3	fruit	29.7%		Three way lift							
12	1	0	1	0	0	0		4	milk	30.4%		1	2						
13	1	1	0	1	0	1		5	dvds	21.1%		vegetables	baby	day_week	actual total	predicted	lift		
14	1	0	1	0	0	1		6	meat	24.9%		1	1	5	59	69.08291	0.854046		
15	0	0	0	1	1	0													
16	1	0	0	1	0	1			days of week		number								
17	1	0	1	0	0	0			1	13.9%	407								
18	1	0	0	0	0	0			2	14.0%	410								
19	1	0	0	0	0	0			3	13.4%	393								
20	0	0	0	0	1	0			4	14.6%	428								
21	1	0	0	0	0	0			5	14.3%	420								
22	0	0	0	0	0	0			6	15.3%	448								
23	0	0	0	1	0	0			7	14.4%	422								
24	0	0	0	0	1	0													
25	1	1	0	0	1	1													


Solver Parameters
Set Objective:
$S$14
To:
Max
Min
Value Of:
0
By Changing Variable Cells:
$N$12:$O$12,$P$14
Subject to the Constraints:
Add
Change
Delete
Reset All
Load/Save
Make Unconstrained Variables Non-Negative
Select a Solving Method:
Evolutionary
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.

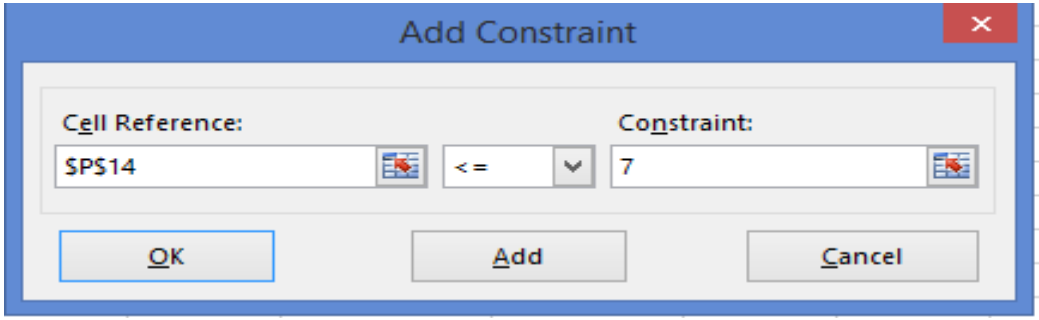
Market Basket Analysis

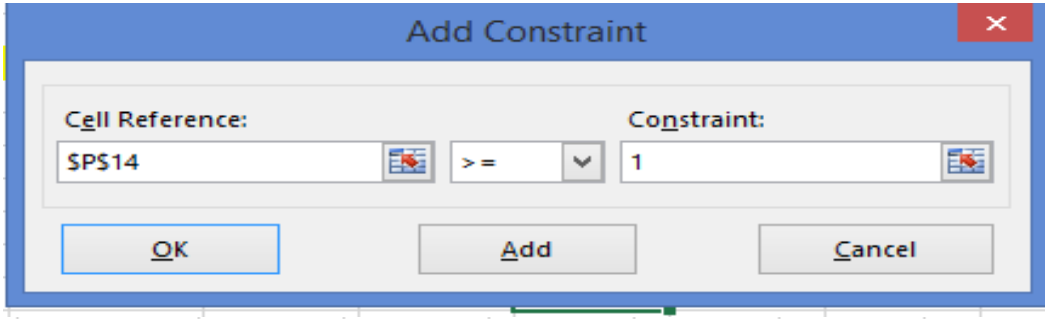


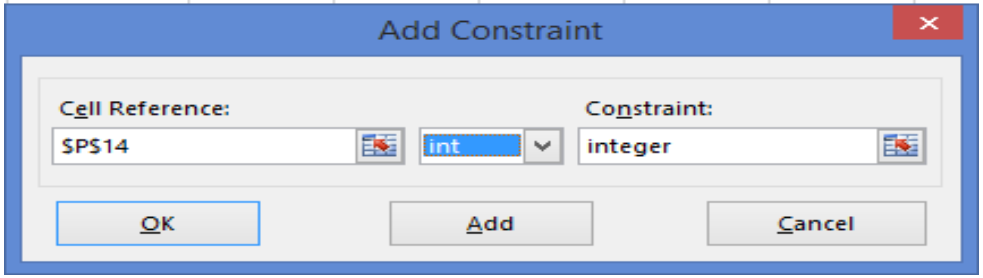


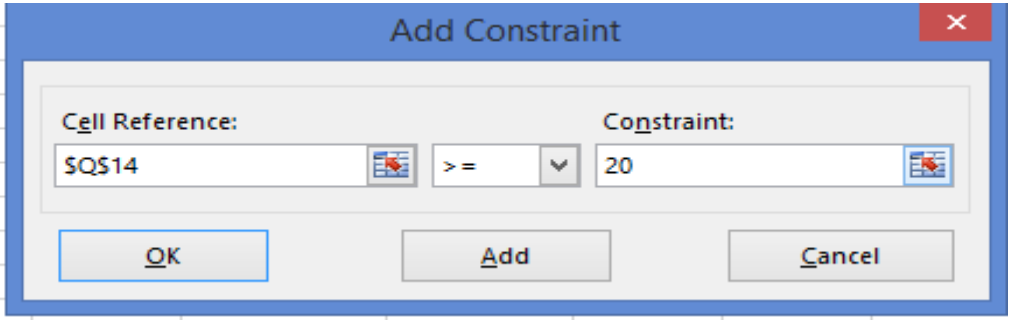


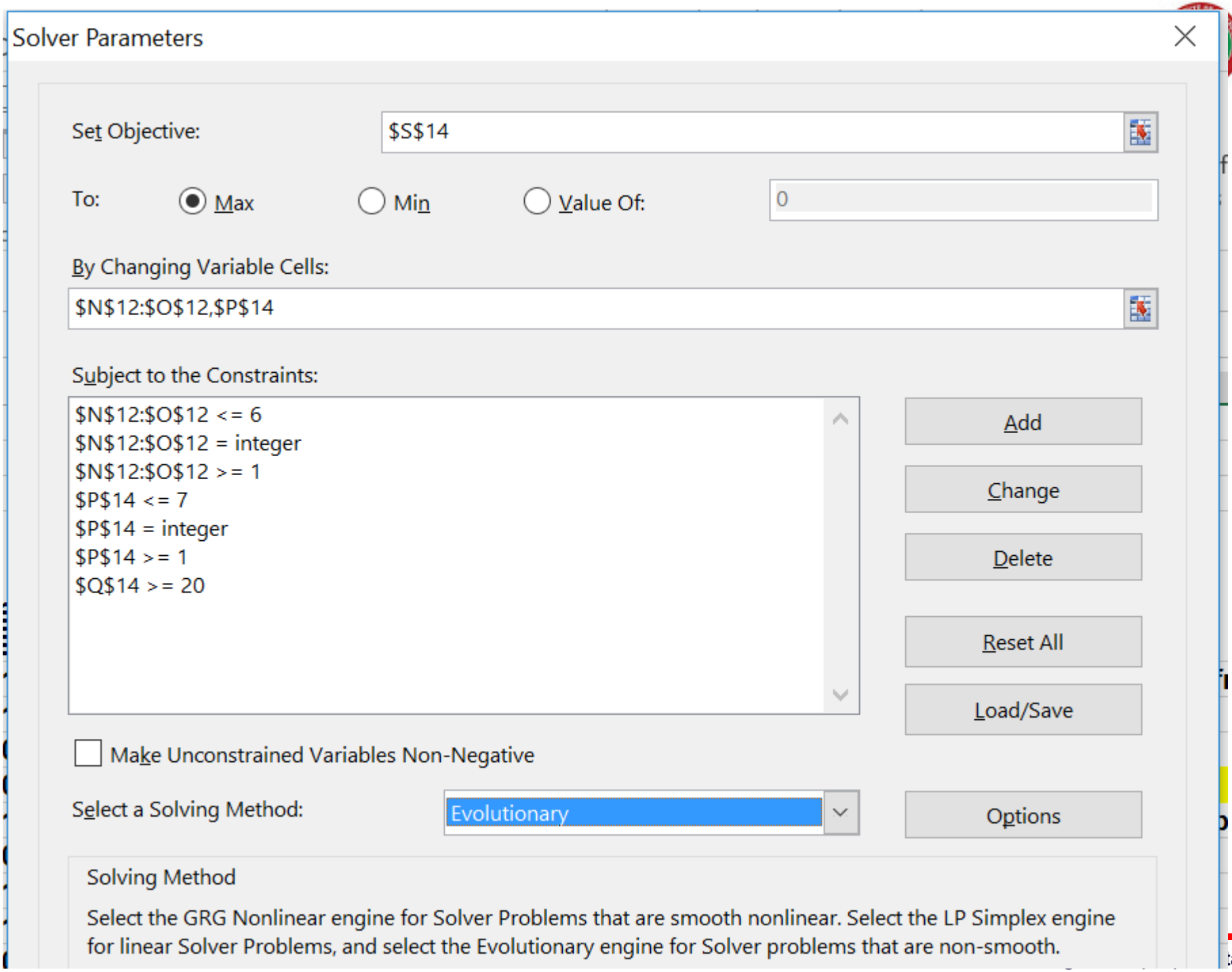
Market Basket Analysis










Solver Parameters
Set Objective:
$S$14
To:
Max
Min
Value Of:
0
By Changing Variable Cells:
$N$12:$O$12,$P$14
Subject to the Constraints:
$N$12:$O$12 <= 6
$N$12:$O$12 = integer
$N$12:$O$12 >= 1
$P$14 <= 7
$P$14 = integer
$P$14 >= 1
$Q$14 >= 20
Add
Change
Delete
Reset All
Load/Save
Make Unconstrained Variables Non-Negative
Select a Solving Method:
Evolutionary
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.

Market Basket Analysis

	J	K	L	M	N	O	P	Q	R	S
6										
7		total	2928							
8	Index				two-way lift					
9	1	vegetables	60.7%		vegetables	fruit	actual total	predicted	lift	
10	2	baby	27.1%		1	1	520	527.098361	0.986533	
11	3	fruit	29.7%		three-way lift					
12	4	milk	30.4%		5	2				
13	5	DVDs	21.1%		DVDs	baby	day_week	actual total	predicted	lift
14	6	meat	24.9%		1	1	4	155	24.49687	6.327339
15										
16		days of week		number						
17		1	13.9%	407						
18		2	14.0%	410						
19		3	13.4%	393						
20		4	14.6%	428						
21		5	14.3%	420						
22		6	15.3%	448						
23		7	14.4%	422						

Using Lift to Optimize Store Layout

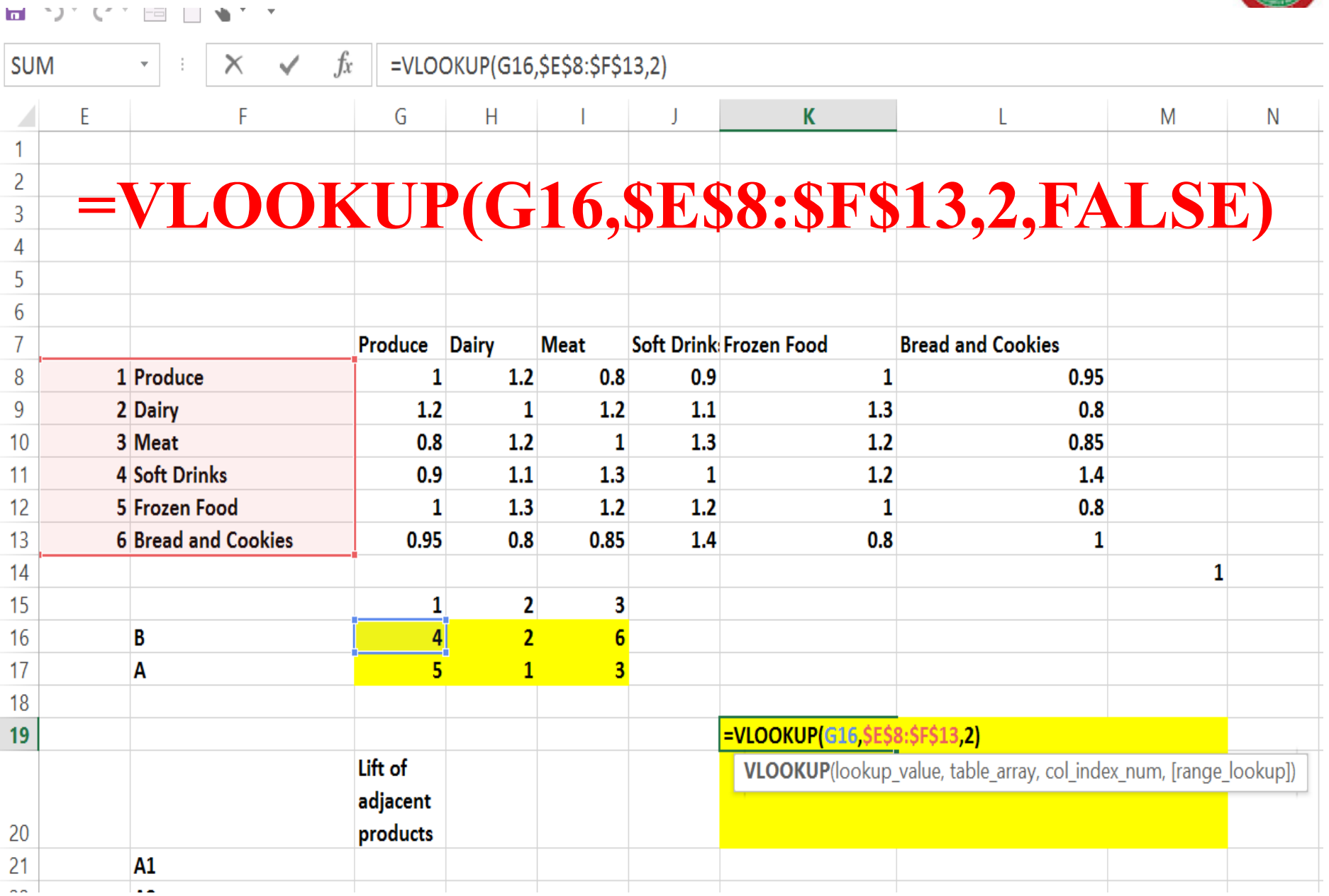
As you learned at the beginning of this class, handbags and makeup are often purchased to gather. This suggests that to maximize revenues a store should be laid out so products with high lift are placed near each other. Given a lift matrix for different product categories, you can use the Evolutionary Solver to locate product categories to maximize the total lift of proximate product categories. To illustrate the idea, consider a grocery store that stocks the six product categories shown in file name In rows 8 through 13, the two-way lifts are shown.

marketlayout.xlsx.

Market Basket Analysis

	E	F	G	H	I	J	K	L	M	N
1										
2										
3										
4										
5										
6										
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies		
8	1	Produce	1	1.2	0.8	0.9	1	0.95		
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8		
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85		
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4		
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8		
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1		
14									1	
15			1	2	3					
16		B	4	2	6					
17		A	5	1	3					
18										
19										

Market Basket Analysis



Market Basket Analysis

		Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies
1	Produce	1	1.2	0.8	0.9	1	0.95
2	Dairy	1.2	1	1.2	1.1	1.3	0.8
3	Meat	0.8	1.2	1	1.3	1.2	0.85
4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4
5	Frozen Food	1	1.3	1.2	1.2	1	0.8
6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1

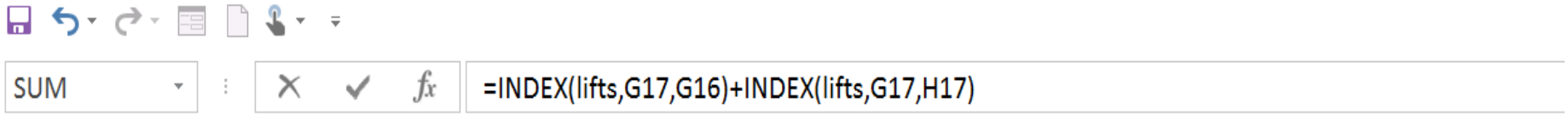
1

	1	2	3
B	4	2	6
A	5	1	3

Soft Drinks	Dairy	Bread and Cookie	
Frozen Food	Produce	Meat	

A1
A2
A3
B1

Market Basket Analysis



SUM | =INDEX(lifts,G17,G16)+INDEX(lifts,G17,H17)

=INDEX(lifts,G17,G16)+INDEX(lifts,G17,H17)

	E	F	G	H	I	J	K	L	M
5									
6									
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies	
8	1	Produce	1	1.2	0.8	0.9	1	0.95	
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8	
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85	
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4	
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8	
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1	
14									1
15			1	2	3				
16		B	4	2	6				
17		A	5	1	3				
18									
19							Soft Drinks	Dairy	Bread and Cookie
20			Lift of adjacent products				Frozen Food	Produce	Meat
21		A1	=INDEX(lifts,G17,G16)+INDEX(lifts,G17,H17)						
22		A2							
23		A3							
24		B1							

Market Basket Analysis

=INDEX(lifts,H17,G17)+INDEX(lifts,H17,H16)+INDEX(lifts,H17,I17)

SUM | =INDEX(lifts,H17,G17)+INDEX(lifts,H17,H16)+INDEX(lifts,H17,I17)

INDEX(array, **row_num**, [column_num])
INDEX(reference, **row_num**, [column_num], [area_num])

	E	F	G	H	I			M
5								
6								
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies
8	1	Produce	1	1.2	0.8	0.9	1	0.95
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1
14								1
15			1	2	3			
16		B	4	2	6			
17		A	5	1	3			
18								
19						Soft Drinks	Dairy	Bread and Cookies
20			Lift of adjacent products			Frozen Food	Produce	Meat
21		A1	2.2					
22		A2	=INDEX(lif					
23		A3						

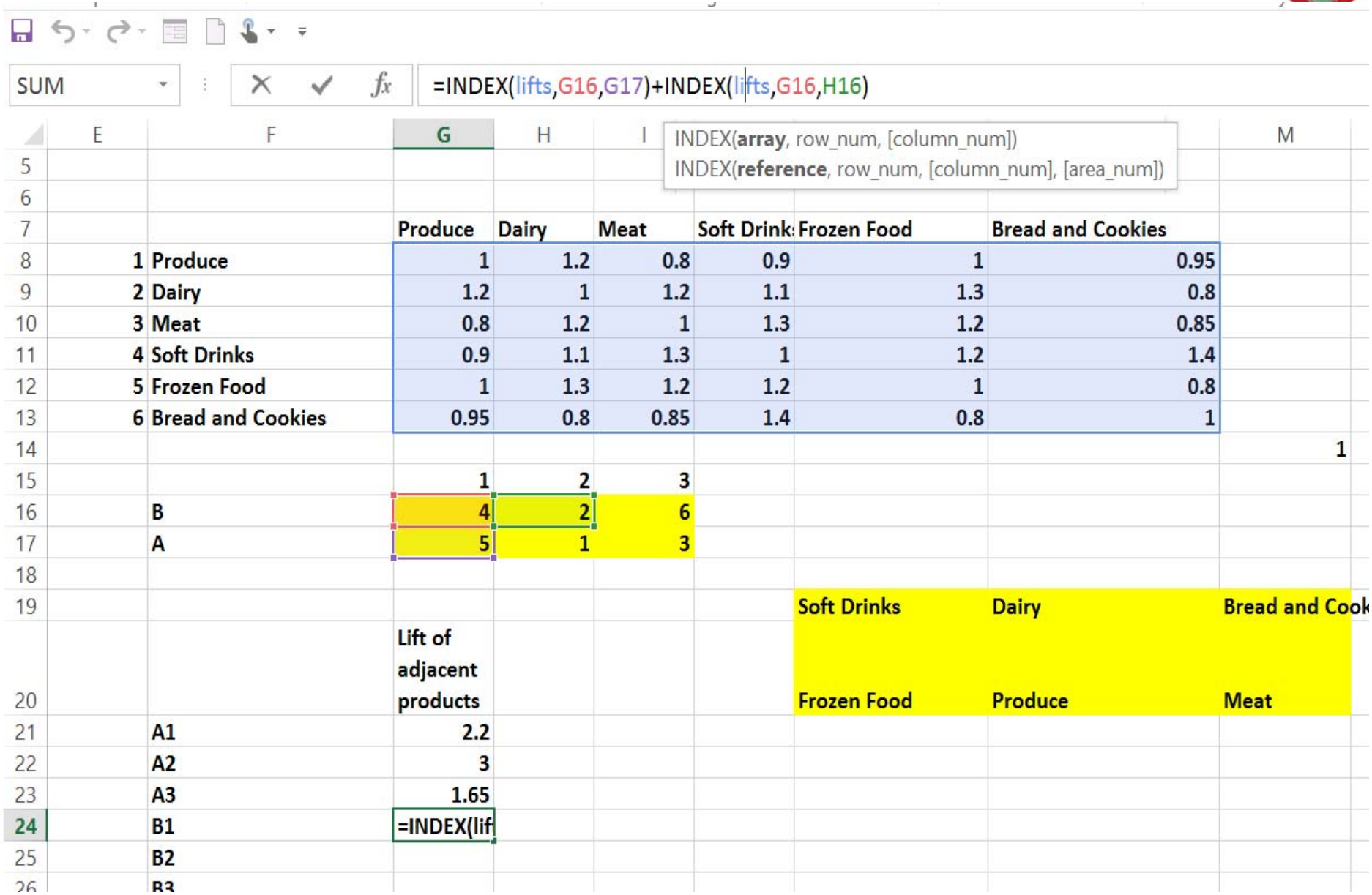
Market Basket Analysis

=INDEX(lifts,I17,I16)+INDEX(lifts,I17,H17)

SUM | =INDEX(lifts,I17,I16)+INDEX(lifts,I17,H17)

	E	F	G	H	I	J	K	L	M
5									
6									
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies	
8	1	Produce	1	1.2	0.8	0.9	1	0.95	
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8	
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85	
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4	
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8	
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1	
14									1
15			1	2	3				
16		B	4	2	6				
17		A	5	1	3				
18									
19							Soft Drinks	Dairy	Bread and Cool
20			Lift of adjacent products				Frozen Food	Produce	Meat
21		A1	2.2						
22		A2	3						
23		A3	=INDEX(lif						
24		B1							
25		B2							

Market Basket Analysis



	E	F	G	H	I			M
5								
6								
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies
8	1	Produce	1	1.2	0.8	0.9	1	0.95
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1
14								1
15			1	2	3			
16		B	4	2	6			
17		A	5	1	3			
18								
19						Soft Drinks	Dairy	Bread and Cook
20			Lift of adjacent products			Frozen Food	Produce	Meat
21		A1	2.2					
22		A2	3					
23		A3	1.65					
24		B1	=INDEX(lif					
25		B2						
26		B3						

Market Basket Analysis

SUM | =INDEX(lifts,H16,G16)+INDEX(lifts,H16,I16)+INDEX(lifts,H16,H17)

	E	F	G	H	I	J	K	L	M	N
5										
6										
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies		
8	1	Produce	1	1.2	0.8	0.9	1	0.95		
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8		
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85		
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4		
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8		
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1		
14									1	
15			1	2	3					
16		B	4	2	6					
17		A	5	1	3					
18										
19							Soft Drinks	Dairy	Bread and Cookies	
20			Lift of adjacent products				Frozen Food	Produce	Meat	
21		A1	2.2							
22		A2	3							
23		A3	1.65							
24		B1	2.3							
25		B2	=INDEX(lifts,H16,G16)+INDEX(lifts,H16,I16)+INDEX(lifts,H16,H17)							
26		B3								

Market Basket Analysis

SUM | =INDEX(lifts,I16,H16)+INDEX(lifts,I16,I17)

	E	F	G	H	I	J	K	L
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies
8	1	Produce	1	1.2	0.8	0.9	1	0.95
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1
14								
15			1	2	3			
16		B	4	2	6			
17		A	5	1	3			
18								
19							Soft Drinks	Dairy
20			Lift of adjacent products				Frozen Food	Produce
21		A1	2.2					
22		A2	3					
23		A3	1.65					
24		B1	2.3					
25		B2	3.1					
26		B3	=INDEX(lifts,I16,H16)+INDEX(lifts,I16,I17)					
27								

Market Basket Analysis

	E	F	G	H	I	J	K	L	M	N
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies		
8	1	Produce	1	1.2	0.8	0.9	1	0.95		
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8		
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85		
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4		
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8		
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1		
14									1	
15			1	2	3					
16		B	4	2	6					
17		A	5	1	3					
18										
19							Soft Drinks	Dairy	Bread and Cookies	
20			Lift of adjacent products				Frozen Food	Produce	Meat	
21		A1	2.2							
22		A2	3							
23		A3	1.65							
24		B1	2.3							
25		B2	3.1							
26		B3	1.65							
27			=SUM(G21:G26)							
28										

SUM(number1, [number2], ...)

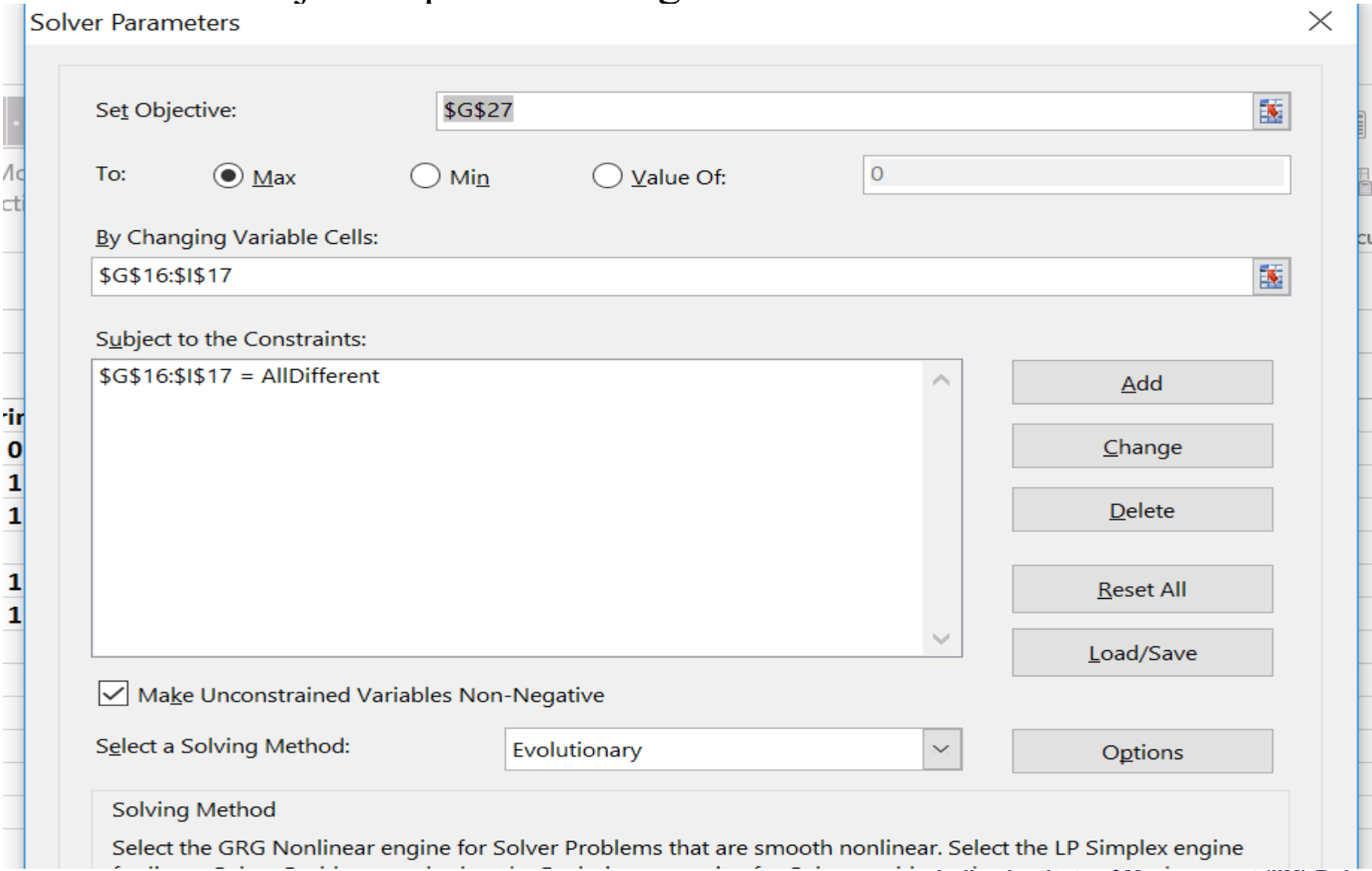
Market Basket Analysis

	E	F	G	H	I	J	K	L	M	N
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies		
8	1	Produce	1	1.2	0.8	0.9	1	0.95		
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8		
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85		
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4		
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8		
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1		
14									1	
15			1	2	3					
16		B	4	2	6					
17		A	5	1	3					
18										
19							Soft Drinks	Dairy	Bread and Cookies	
20			Lift of adjacent products				Frozen Food	Produce	Meat	
21		A1	2.2							
22		A2	3							
23		A3	1.65							
24		B1	2.3							
25		B2	3.1							
26		B3	1.65							
27			13.9							
28										

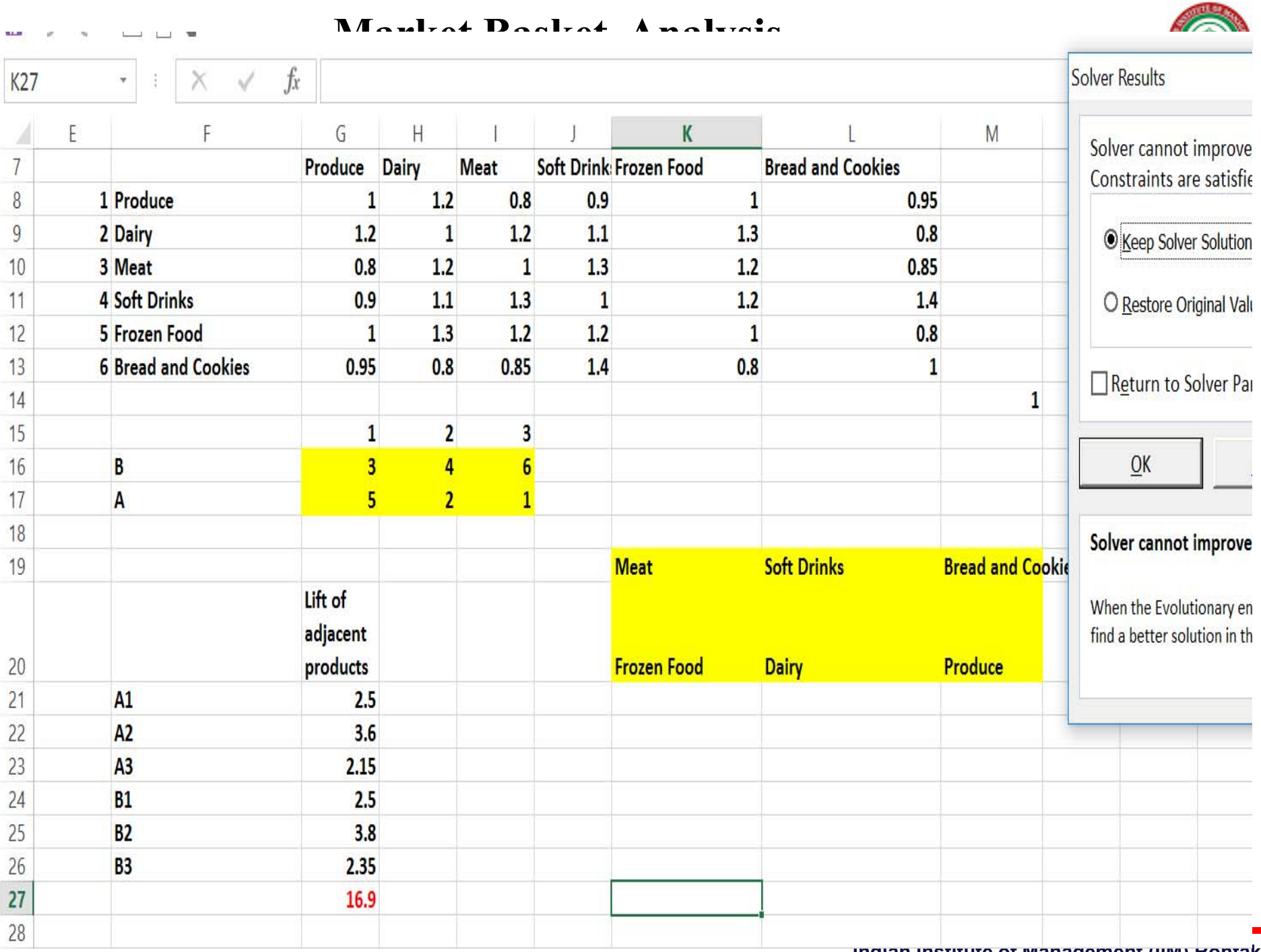
No repetition

Market Basket Analysis

Use the Solver window, to find the store layout that maximizes the total lift for adjacent product categories.



Market Basket Analysis



K27

	E	F	G	H	I	J	K	L	M
7			Produce	Dairy	Meat	Soft Drink	Frozen Food	Bread and Cookies	
8	1	Produce	1	1.2	0.8	0.9	1	0.95	
9	2	Dairy	1.2	1	1.2	1.1	1.3	0.8	
10	3	Meat	0.8	1.2	1	1.3	1.2	0.85	
11	4	Soft Drinks	0.9	1.1	1.3	1	1.2	1.4	
12	5	Frozen Food	1	1.3	1.2	1.2	1	0.8	
13	6	Bread and Cookies	0.95	0.8	0.85	1.4	0.8	1	
14									1
15			1	2	3				
16		B	3	4	6				
17		A	5	2	1				
18									
19							Meat	Soft Drinks	Bread and Cookie
20			Lift of adjacent products				Frozen Food	Dairy	Produce
21		A1	2.5						
22		A2	3.6						
23		A3	2.15						
24		B1	2.5						
25		B2	3.8						
26		B3	2.35						
27			16.9						
28									

Solver Results

Solver cannot improve
Constraints are satisfie

Keep Solver Solution

Restore Original Valu

Return to Solver Par

OK

Solver cannot improve

When the Evolutionary en
find a better solution in th

Thank you !!!