UCD MICHAEL SMURFIT GRADUATE BUSINESS SCHOOL

UCD Michael Smurfit
Graduate Business School

MIS40520: Analytical Business Modelling

M(I)LP Assignment 2

Authors:
Goyal Shruti (16200726)
Gupta Deepak Kumar (16200660)

Lecturer:
Dr Paula Carroll

March 14, 2017

Contents

List of Figures

List of Tables

Executive Summary

Literature Review: Big data Analytics for Healthcare

Shruti Goyal, Deepak Kumar Gupta and Dr James McDermott

Objective: To review big data analytics in healthcare.

Methods: The review describes big data analytics and its implementation in healthcare, highlights gaps in previous studies describes analytical platforms and examples, discusses the existing challenges, offers a conclusion and, states an open question for future work.

Results: The review provides the overview of advancements and changes in big data analytics for practitioners.

Conclusion: Big data analytics implementation in healthcare has seen a tremendous growth over past 6 years. However, there are few challenges which still need to be addressed.

Keywords: Healthcare, Data Analytics, Clinics, Systematic Review, Tools and Techniques

Yayayayay

1. Background

You have been asked to help organise hotel accommodation for 150 delegates attending a conference in UCD. You use a hotel booking website to extract the data shown in the Table below for ten four star hotels in Dublin city centre. The Table shows the price for a single room per person per night, the customer satisfaction rating and the number of rooms available for each hotel. The conference organisers want to allocate the delegates to hotels at minimum cost while achieving an average customer satisfaction rate of at least 8.3. Formulate an (I)LP model of this problem.

Hotel Index	1	2	3	4	5	6	7	8	9	10
Price (euro)	89	99	119	112	143	94	130	98	155	152
Customer rating	7.8	8.3	8	8.7	8	8.1	8.6	8.9	8.9	8.4
Room Availability	35	30	15	15	15	20	15	10	10	20

Table 1: Hotel Data

2. Introduction

Discussion about research papers

Figure 1: Four V's of Big Data

Source: http://www.datasciencecentral.com/profiles/blogs/data-veracity

then discuss about integer programming take some example from internet to demostrate

3. Methodology

We have total delegates 150 and 10 four star hotels to accommodate guests We need to minimize the cost while achieving minimum average rating:
Lets say HI as $Hotel\ Index$:

Constraint 1:

$$Cost = \sum_{HI=1}^{10} Price(HI) * decVar(HI \tag{1}$$

Constraint 2:

$$Avg.Rating = \frac{\sum_{HI=1}^{10} Rating(HI) * decVar(HI))}{150} \tag{2}$$

Constraint 3:

$$decVar(HI) <= Avail(HI), HI \in \{1,10\} \tag{3}$$

Objective is:

$$minimize(Cost) \tag{4}$$

4. Analysis of Results

Compare non integer and integer solutions
Why interger programming is required
Also take previous assignment example to contrast the need on MILP

5. Conclusions

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

Quisque ullamcorper placerat ipsum. Cras nibh. Morbi vel justo vitae lacus tincidunt ultrices. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. In hac habitasse platea dictumst. Integer tempus convallis augue. Etiam facilisis. Nunc elementum fermentum wisi. Aenean placerat. Ut imperdiet, enim sed gravida sollicitudin, felis odio placerat quam, ac pulvinar elit purus eget enim. Nunc vitae tortor. Proin tempus nibh sit amet nisl. Vivamus quis tortor vitae risus porta vehicula.

Fusce mauris. Vestibulum luctus nibh at lectus. Sed bibendum, nulla a faucibus semper, leo velit ultricies tellus, ac venenatis arcu wisi vel nisl. Vestibulum diam. Aliquam pellentesque, augue quis sagittis posuere, turpis lacus congue quam, in hendrerit risus eros eget felis. Maecenas eget erat in sapien mattis porttitor. Vestibulum porttitor. Nulla facilisi. Sed a turpis eu lacus commodo facilisis. Morbi fringilla, wisi in dignissim interdum, justo lectus sagittis dui, et vehicula libero dui cursus dui. Mauris tempor ligula sed lacus. Duis cursus enim ut augue. Cras ac magna. Cras nulla. Nulla egestas. Curabitur a leo. Quisque egestas wisi eget nunc. Nam feugiat lacus vel est. Curabitur consectetuer.

Suspendisse vel felis. Ut lorem lorem, interdum eu, tincidunt sit amet, laoreet vitae, arcu. Aenean faucibus pede eu ante. Praesent enim elit, rutrum at, molestie non, nonummy vel, nisl. Ut lectus eros, malesuada sit amet, fermentum eu, sodales cursus, magna. Donec eu purus. Quisque vehicula, urna sed ultricies auctor, pede lorem egestas dui, et convallis elit erat sed nulla. Donec luctus. Curabitur et nunc. Aliquam dolor odio, commodo pretium, ultricies non, pharetra in, velit. Integer arcu est, nonummy in, fermentum faucibus, egestas vel, odio.

Sed commodo posuere pede. Mauris ut est. Ut quis purus. Sed ac odio. Sed vehicula hendrerit sem. Duis non odio. Morbi ut dui. Sed accumsan risus eget odio. In hac habitasse platea dictumst. Pellentesque non elit. Fusce sed justo eu urna porta tincidunt. Mauris felis odio, sollicitudin sed, volutpat a, ornare ac, erat. Morbi quis dolor. Donec pellentesque, erat ac sagittis semper, nunc dui lobortis purus, quis congue purus metus

ultricies tellus. Proin et quam. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Praesent sapien turpis, fermentum vel, eleifend faucibus, vehicula eu, lacus.
1

A. Code

Listing 1: Craft Brewer: LP Model

```
model Conference_Management
uses "mmxprs"; !gain access to the Xpress-Optimizer solver
        declarations
                HI = 1..10
! Index range
                PRICE: array(HI) of integer         ! Price table
                RATING: array(HI) of real                       !Customer Satsif
                AVAIL: array(HI) of integer                     !Available Rooms
                decVar: array(HI) of mpvar
!Decision Variables
        end-declarations
        Max_Guest := 150

        !Read in the data from our text file
        initializations from 'Conference_Management.txt'
                PRICE
                RATING
                AVAIL
        end-initializations

        !procedure to check problem status
        procedure print_status
                declarations
                        status: string
                end-declarations
                case getprobstat of
                XPRS_OPT: status:="LP Optimum found"
                XPRS_UNF: status:="Unfinished"
                XPRS_INF: status:="Infeasible"
                XPRS_UNB: status:="Unbounded"
                XPRS_OTH: status:="Failed"
                else status:="???"
                end-case
                writeln("Problem status: ", status)
        end-procedure

        !Minimiz cost
        Cost:= sum(i in HI) PRICE(i)*decVar(i)

        !Constraints
        !Declare that our decision variables are integers
        forall (i in HI) do
                decVar(i) is_integer
        end-do

        AvgRating:= (sum(i in HI) RATING(i)*decVar(i))/150 >= 8.3

        forall( i in HI)
                decVar(i) <= AVAIL(i)
        sum(i in HI) decVar(i)  = Max_Guest

        !Display output of solution values
        procedure print_sol
```

B. Input and Output

B.1. Case 1: Original Data (10 Variables)

Input

```
! Data file for `20. Conference Management Assignment - 2'

PRICE: [ 89, 99, 119, 112,143,94,130,98,155,152] !Constraint coefficients

RATING: [7.8,8.3,8.0,8.7,8.0,8.1,8.6,8.9,8.9,8.4] !Constraint coefficients

AVAIL:[35,30,15,15,15,20,15,10,10,20] !Values of the constraints
```

Output

```
Begin running model
-----------------------------------------------------------
Problem status: LP Optimum found
Cost is: âĆň16207
-----------------------------------------------------------
Passenger in Hotel_1 -> 35
Passenger in Hotel_2 -> 30
Passenger in Hotel_3 -> 6
Passenger in Hotel_4 -> 15
Passenger in Hotel_5 -> 0
Passenger in Hotel_6 -> 20
Passenger in Hotel_7 -> 15
Passenger in Hotel_8 -> 10
Passenger in Hotel_9 -> 10
Passenger in Hotel_10 -> 9
0.000666667
-----------------------------------------------------------
\ Using Xpress-MP extensions
Minimize
 89 decVar(1) + 99 decVar(2) + 119 decVar(3) + 112 decVar(4) + 143 decVar(5) +
94 decVar(6) + 130 decVar(7) + 98 decVar(8) + 155 decVar(9) + 152 decVar(10)

Subject To
_R1: decVar(1) + decVar(2) + decVar(3) + decVar(4) + decVar(5) + decVar(6) +
decVar(7) + decVar(8) + decVar(9) + decVar(10) = 150
AvgRating: 0.052 decVar(1) + 0.0553333 decVar(2) + 0.0533333 decVar(3) + 0.058 decVar(4) +
0.0533333 decVar(5) + 0.054 decVar(6) + 0.0573333 decVar(7) + 0.0593333 decVar(8) +
0.0593333 decVar(9) + 0.056 decVar(10) >= 8.3

Bounds
decVar(1) <= 35
decVar(2) <= 30
decVar(3) <= 15
decVar(4) <= 15
decVar(5) <= 15
decVar(6) <= 20
decVar(7) <= 15
decVar(8) <= 10
decVar(9) <= 10
decVar(10) <= 20
```

```
Integers
decVar(1) decVar(2) decVar(3) decVar(4) decVar(5) decVar(6) decVar(7) decVar(8)
decVar(9) decVar(10)

End
------------------------------------------------------------
End running model
```

B.2. Case 2: Scale Up to 20 Variables

Input

```
! Data file for `20. Conference Management Assignment - 2'

PRICE: [ 89, 99, 119, 112,143,94,130,98,155,152,55,68,99,140,87,75,78,110,96,74] !Constraint coeffici

RATING: [7.8,8.3,8.0,8.7,8.0,8.1,8.6,8.9,8.9,8.4,9.5,7.6,9.5,7.9,8.3,8.2,9.9,8.8,8.0,8.9] !Constrain

AVAIL:[35,30,15,15,15,20,15,10,10,20,2,5,6,7,9,1,2,5,4,6] !Values of the constraints
```

Output

```
Begin running model
------------------------------------------------------------
Problem status: LP Optimum found
Cost is: âĆň14061
------------------------------------------------------------
Passenger in Hotel_1 -> 35
Passenger in Hotel_2 -> 30
Passenger in Hotel_3 -> 0
Passenger in Hotel_4 -> 15
Passenger in Hotel_5 -> 0
Passenger in Hotel_6 -> 20
Passenger in Hotel_7 -> 0
Passenger in Hotel_8 -> 10
Passenger in Hotel_9 -> 0
Passenger in Hotel_10 -> 0
Passenger in Hotel_11 -> 2
Passenger in Hotel_12 -> 5
Passenger in Hotel_13 -> 6
Passenger in Hotel_14 -> 0
Passenger in Hotel_15 -> 9
Passenger in Hotel_16 -> 1
Passenger in Hotel_17 -> 2
Passenger in Hotel_18 -> 5
Passenger in Hotel_19 -> 4
Passenger in Hotel_20 -> 6
0.0306667
------------------------------------------------------------
\ Using Xpress-MP extensions
Minimize
 89 decVar(1) + 99 decVar(2) + 119 decVar(3) + 112 decVar(4) + 143 decVar(5) +
94 decVar(6) + 130 decVar(7) + 98 decVar(8) + 155 decVar(9) + 152 decVar(10) +
55 decVar(11) + 68 decVar(12) + 99 decVar(13) + 140 decVar(14) + 87 decVar(15) +
```

```
75 decVar(16) + 78 decVar(17) + 110 decVar(18) + 96 decVar(19) + 74 decVar(20)

Subject To
_R1: decVar(1) + decVar(2) + decVar(3) + decVar(4) + decVar(5) + decVar(6) +
decVar(7) + decVar(8) + decVar(9) + decVar(10) + decVar(11) + decVar(12) + decVar(13) +
decVar(14) + decVar(15) + decVar(16) + decVar(17) + decVar(18) + decVar(19) +
decVar(20) = 150
AvgRating: 0.052 decVar(1) + 0.0553333 decVar(2) + 0.0533333 decVar(3) + 0.058 decVar(4) +
0.0533333 decVar(5) + 0.054 decVar(6) + 0.0573333 decVar(7) + 0.0593333 decVar(8) +
0.0593333 decVar(9) + 0.056 decVar(10) + 0.0633333 decVar(11) + 0.0506667 decVar(12) +
0.0633333 decVar(13) + 0.0526667 decVar(14) + 0.0553333 decVar(15) + 0.0546667 decVar(16) +
0.066 decVar(17) + 0.0586667 decVar(18) + 0.0533333 decVar(19) + 0.0593333 decVar(20) >= 8.3

Bounds
decVar(1) <= 35
decVar(2) <= 30
decVar(3) <= 15
decVar(4) <= 15
decVar(5) <= 15
decVar(6) <= 20
decVar(7) <= 15
decVar(8) <= 10
decVar(9) <= 10
decVar(10) <= 20
decVar(11) <= 2
decVar(12) <= 5
decVar(13) <= 6
decVar(14) <= 7
decVar(15) <= 9
decVar(17) <= 2
decVar(18) <= 5
decVar(19) <= 4
decVar(20) <= 6

Integers
decVar(1) decVar(2) decVar(3) decVar(4) decVar(5) decVar(6) decVar(7) decVar(8)
decVar(9) decVar(10) decVar(11) decVar(12) decVar(13) decVar(14) decVar(15)
decVar(16) decVar(17) decVar(18) decVar(19) decVar(20)

End
------------------------------------------------------------
End running model
```

B.3. Case 2: Scale Up to 20 Variables

Input

```
! Data file for `20. Conference Management Assignment 2'

PRICE: [ 89, 99, 119, 112,143,94,130,98,155,152,55,68,99,140,87,75,78,110,96,74,65,5,40,30,30,17,15,8

RATING: [7.8,8.3,8.0,8.7,8.0,8.1,8.6,8.9,8.9,8.4,9.5,7.6,9.5,7.9,8.3,8.2,9.9,8.8,8.0,8.9,8.1,8.3,8.

AVAIL:[35,30,15,15,15,20,15,10,10,20,2,5,6,7,9,1,2,5,4,6,2,5,4,6,1,2,3,17,2,5] !Values of the constr
```

Output

```
Begin running model
------------------------------------------------------------
Problem status: LP Optimum found
Cost is: âĆň11395
------------------------------------------------------------
Passenger in Hotel_1 -> 35
Passenger in Hotel_2 -> 3
Passenger in Hotel_3 -> 0
Passenger in Hotel_4 -> 0
Passenger in Hotel_5 -> 0
Passenger in Hotel_6 -> 20
Passenger in Hotel_7 -> 0
Passenger in Hotel_8 -> 10
Passenger in Hotel_9 -> 0
Passenger in Hotel_10 -> 0
Passenger in Hotel_11 -> 2
Passenger in Hotel_12 -> 5
Passenger in Hotel_13 -> 6
Passenger in Hotel_14 -> 0
Passenger in Hotel_15 -> 9
Passenger in Hotel_16 -> 1
Passenger in Hotel_17 -> 2
Passenger in Hotel_18 -> 0
Passenger in Hotel_19 -> 4
Passenger in Hotel_20 -> 6
Passenger in Hotel_21 -> 2
Passenger in Hotel_22 -> 5
Passenger in Hotel_23 -> 4
Passenger in Hotel_24 -> 6
Passenger in Hotel_25 -> 1
Passenger in Hotel_26 -> 2
Passenger in Hotel_27 -> 3
Passenger in Hotel_28 -> 17
Passenger in Hotel_29 -> 2
Passenger in Hotel_30 -> 5
0.0713333
------------------------------------------------------------
\ Using Xpress-MP extensions
Minimize
 89 decVar(1) + 99 decVar(2) + 119 decVar(3) + 112 decVar(4) + 143 decVar(5) +
94 decVar(6) + 130 decVar(7) + 98 decVar(8) + 155 decVar(9) + 152 decVar(10) +
55 decVar(11) + 68 decVar(12) + 99 decVar(13) + 140 decVar(14) + 87 decVar(15) +
75 decVar(16) + 78 decVar(17) + 110 decVar(18) + 96 decVar(19) + 74 decVar(20) +
65 decVar(21) + 5 decVar(22) + 40 decVar(23) + 30 decVar(24) + 30 decVar(25) +
17 decVar(26) + 15 decVar(27) + 89 decVar(28) + 10 decVar(29) + 20 decVar(30)

Subject To
_R1: decVar(1) + decVar(2) + decVar(3) + decVar(4) + decVar(5) + decVar(6) +
decVar(7) + decVar(8) + decVar(9) + decVar(10) + decVar(11) + decVar(12) + decVar(13) +
decVar(14) + decVar(15) + decVar(16) + decVar(17) + decVar(18) + decVar(19) +
decVar(20) + decVar(21) + decVar(22) + decVar(23) + decVar(24) + decVar(25) +
decVar(26) + decVar(27) + decVar(28) + decVar(29) + decVar(30) = 150
```

```
AvgRating: 0.052 decVar(1) + 0.0553333 decVar(2) + 0.0533333 decVar(3) + 0.058 decVar(4) +
0.0533333 decVar(5) + 0.054 decVar(6) + 0.0573333 decVar(7) + 0.0593333 decVar(8) +
0.0593333 decVar(9) + 0.056 decVar(10) + 0.0633333 decVar(11) + 0.0506667 decVar(12) +
0.0633333 decVar(13) + 0.0526667 decVar(14) + 0.0553333 decVar(15) + 0.0546667 decVar(16) +
0.066 decVar(17) + 0.0586667 decVar(18) + 0.0533333 decVar(19) + 0.0593333 decVar(20) +
0.054 decVar(21) + 0.0553333 decVar(22) + 0.0546667 decVar(23) + 0.0566667 decVar(24) +
0.0593333 decVar(25) + 0.0633333 decVar(26) + 0.052 decVar(27) + 0.0606667 decVar(28) +
0.054 decVar(29) + 0.0546667 decVar(30) >= 8.3

Bounds
decVar(1) <= 35
decVar(2) <= 30
decVar(3) <= 15
decVar(4) <= 15
decVar(5) <= 15
decVar(6) <= 20
decVar(7) <= 15
decVar(8) <= 10
decVar(9) <= 10
decVar(10) <= 20
decVar(11) <= 2
decVar(12) <= 5
decVar(13) <= 6
decVar(14) <= 7
decVar(15) <= 9
decVar(17) <= 2
decVar(18) <= 5
decVar(19) <= 4
decVar(20) <= 6
decVar(21) <= 2
decVar(22) <= 5
decVar(23) <= 4
decVar(24) <= 6
decVar(26) <= 2
decVar(27) <= 3
decVar(28) <= 17
decVar(29) <= 2
decVar(30) <= 5

Integers
decVar(1) decVar(2) decVar(3) decVar(4) decVar(5) decVar(6) decVar(7) decVar(8)
decVar(9) decVar(10) decVar(11) decVar(12) decVar(13) decVar(14) decVar(15)
decVar(16) decVar(17) decVar(18) decVar(19) decVar(20) decVar(21) decVar(22)
decVar(23) decVar(24) decVar(25) decVar(26) decVar(27) decVar(28) decVar(29)
decVar(30)

End
------------------------------------------------------------
End running model
```