MITx: 15.071x The Analytics Edge

SELECTING PROFITABLE HOTEL SITES

La Quinta Motor Inns is a mid-sized hotel chain headquartered in San Antonio, Texas. They are looking to expand to more locations, and know that selecting good sites is crucial to a hotel chain's success. Of the four major marketing considerations (price, product, promotion, and location), location has been shown to be one of the most important for multisite firms.

Hotel chain owners who can pick good sites quickly have a distinct competitive advantage, since they are competing against other chains for the same sites. La Quinta used data on 57 existing inn locations to build a linear regression model to predict "Profitability", computed as the operating margin, or earnings before interest and taxes divided by total revenue. They tried many independent variables, such as "Number of hotel rooms in the vicinity" and "Age of the Inn". All independent variables were normalized to have mean zero and standard deviation 1.

The final regression model is given by:

Profitability = 39.05 - 5.41*(State Population per Inn) + 5.86*(Price of the Inn) - 3.09*(Square Root of the Median Income of the Area) + 1.75*(College Students in the Area)

The R^2 of the model is 0.51.

In this problem, we'll use this regression model together with integer optimization to select the most profitable sites for La Quinta.

PROBLEM 1.1 - SELECTING THE MOST PROFITABLE HOTELS

(1 point possible)
According to the regression equation given above, which variables positively affect Profitability? Select all that apply.

- [ ] State Population per Inn
- [x] Price of the Inn ✔
- [ ] Square Root of the Median Income of the Area
- [x] College Students in the Area ✔

?

EXPLANATION

The variables with positive coefficients in the regression equation positively affect profitability: Price of the Inn, and College Students in the Area.

You have used 0 of 2 submissions

PROBLEM 1.2 - SELECTING THE MOST PROFITABLE HOTELS

(1 point possible)

Using this regression equation, La Quinta created a spreadsheet model to predict profitability, and routinely uses it to screen potential real estate acquisitions. Suppose that La Quinta is looking to expand their locations in California, and has collected data for 16 different potential sites. This data is given in the spreadsheet SelectingHotels.ods for LibreOffice or OpenOffice, and SelectingHotels.xlsx for Microsoft Excel. For each hotel, it lists the location of the hotel, the price, and the value for each of the independent variables used in the regression equation (normalized to have mean zero and standard deviation one).

Using the regression equation, what is the predicted profitability of hotel 1?

? **Answer:** 44.24

EXPLANATION

By substituting the data for hotel 1 into the regression equation, we get that:

Profitability = 39.05 - 5.41*(-1.00) + 5.86*(-0.30) - 3.09*(-0.81) + 1.75*(-0.54) = 44.24

You have used 0 of 3 submissions

PROBLEM 1.3 - SELECTING THE MOST PROFITABLE HOTELS

(1 point possible)

In your spreadsheet, compute the predicted profitability for all hotels.

Which hotel has the highest predicted profitability?

- Hotel 2 ✔
- Hotel 6
- Hotel 7
- Hotel 8
- Hotel 12
- Hotel 13

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EXPLANATION

Hotel 2 has the highest predicted profitability of 53.38. This can be computed in the spreadsheet with as:

39.05 - 5.41*(G5) + 5.86*(D5) - 3.09*(E5) + 1.75*(F5)

You have used 0 of 1 submissions

PROBLEM 1.4 - SELECTING THE MOST PROFITABLE HOTELS

(1 point possible)

Which hotel has the lowest predicted profitability?

- Hotel 2
- Hotel 6
- Hotel 7
- Hotel 8 ✔
- Hotel 12
- Hotel 13

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EXPLANATION

Hotel 8 has the lowest predicted profitability of 23.45.

This can be computed in the spreadsheet as:

39.05 - 5.41*(G11) + 5.86*(D11) - 3.09*(E11) + 1.75*(F11)

You have used 0 of 1 submissions

PROBLEM 1.5 - SELECTING THE MOST PROFITABLE HOTELS

(1 point possible)

La Quinta has a budget of $10,000,000 to spend on hotels. Suppose we just used a "greedy" approach where we selected the most profitable hotels until we ran out of budget. So we would start by buying the hotel we predict to be the most profitable, and then if we had enough budget left, we would buy the hotel we predict to be the second most profitable, etc.

How many hotels would we purchase with this approach?

- 1 ✔
- 2
- 3
- 4
- 5

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EXPLANATION

We would start by buying hotel 2 (the most profitable hotel). This hotel costs $10,000,000, which is our entire budget. Thus, we would buy one hotel.

You have used 0 of 1 submissions

PROBLEM 1.6 - SELECTING THE MOST PROFITABLE HOTELS

(1 point possible)

What would our total predicted profitability be? (This is the sum of the predicted profitability of all hotels we purchase.)

? **Answer:** 53.38

EXPLANATION

Since we just bought one hotel (hotel 2), our total predicted profitability is just the profitability of hotel 2, which is 53.38.

You have used 0 of 3 submissions

PROBLEM 2.1 - AN OPTIMIZATION APPROACH (3 points possible)

Now, build an optimization model in your spreadsheet to select hotels. The decision variables are whether or not a hotel is selected (binary variables). The objective is to maximize the total predicted profitability. We have two constraints: the decision variables should be binary, and the total cost should not exceed the budget of $10,000,000. Formulate and solve this model in LibreOffice.

What is the objective value of the solution?

? **Answer:** 269.925

EXPLANATION

Our formulation in LibreOffice has 16 decision variables (one for each hotel) and one contraint (the budget). The objective is the sumproduct of the decision variables with the profitability. If we formulate and solve this problem, the objective value of the solution is 269.925.

Suppose that you compute the predicted profitability in column H of your table (the profitability is in cells H4:H19) and you put the decision variables in column I of the table (the decision variables are located in cells I4:I19). Then the objective formula would be:

SUMPRODUCT(H4:H19;I4:I19)

And the budget constraint would be:

SUMPRODUCT(C4:C19;I4:I19) <= 10000000

Make sure to indicate that the decision variables should be binary, and that the objective should be maximized.

This is more than five times that of the greedy approach!

You have used 0 of 8 submissions

PROBLEM 2.2 - AN OPTIMIZATION APPROACH (1 point possible)

How many hotels are selected in the solution?

? **Answer:** 7

EXPLANATION

Seven hotels have decision variables equal to 1 in the solution.

You have used 0 of 3 submissions

PROBLEM 2.3 - AN OPTIMIZATION APPROACH (1 point possible)

How many hotels located in South Lake Tahoe are selected in the solution?

? **Answer:** 6

EXPLANATION

Hotels 10-16 are located in South Lake Tahoe, and 6 of these have decision variables equal to 1 in the solution.

You have used 0 of 3 submissions

PROBLEM 2.4 - AN OPTIMIZATION APPROACH (1 point possible)

La Quinta thinks that buying too many hotels in one city is probably not a good idea, and would prefer to diversify in other cities, even though it will decrease the sum of the predicted profitability. Add a constraint to limit the number of hotels selected in South Lake Tahoe to 2.

What is the objective value of the solution now?

? **Answer:** 205.7

EXPLANATION

If we add a constraint to limit the number of hotels in South Lake Tahoe (SUM(I13:I19) less than or equal to 2) and resolve the problem, the objective value of the solution is 205.7.

You have used 0 of 3 submissions

PROBLEM 2.5 - AN OPTIMIZATION APPROACH (1 point possible)

How many hotels (in total) are selected in the solution now?

? **Answer:** 6

EXPLANATION

Now, six decision variables have value 1 in the solution.

You have used 0 of 3 submissions

PROBLEM 2.6 - AN OPTIMIZATION APPROACH (1 point possible)

In which cities do we buy at least one hotel? Select all that apply.

- [x] Eureka
- [x] Fresno
- [ ] Long Beach
- [x] Los Angeles
- [x] South Lake Tahoe

?

EXPLANATION

The hotels with decision variables equal to 1 are located in Eureka, Fresno, Los Angeles, and South Lake Tahoe. The only city in which we do not buy a hotel is Long Beach.

You have used 0 of 2 submissions

PROBLEM 2.7 - AN OPTIMIZATION APPROACH (1 point possible)

In this problem, we compared the greedy approach with an optimization approach, and saw that the optimization approach was much better. This is true in many situations, but not always. In which of the following situations would the greedy approach perform as well as the optimization approach? Select all that apply.

- [x] Instead of maximizing the sum of the profitability of the hotels we select, we wanted to maximize the average profitability of the hotels we select. ✔
- [x] Instead of having a budget constraint, we had a constraint on the number of different hotels we can select (for example, we want to maximize profitability given that we can only select 2 hotels). ✔
- [ ] Instead of having a budget of $10,000,000, we had a budget of $20,000,000.

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EXPLANATION

If we want to maximize the average profitability, then it is always optimal to select the hotel that is the most profitable. Additionally, if we don't have a budget constraint, it is optimal to just select the two most profitable hotels. So in the first two situations, the greedy approach would perform as well as the optimization approach. In the third situation, the optimization approach would still perform much better than the greedy approach.

You have used 0 of 2 submissions

ACKNOWLEDGEMENTS

This problem is based on the paper "Selecting Profitable Hotel Sites at La Quinta Motor Inns" by Sheryl E. Kimes and James A. Fitzsimmons, *Interfaces* 20(2), p.12-20, March-April 1990.

Please remember not to ask for or post complete answers to homework questions in this discussion forum.
