

*Using optimization Algorithms to Plan a road trip to Barcelona Wine Bar & Restaurant Locations throughout the Nation*

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*1 – Background*

The first Barcelona Wine Bar was opened by partners Andy Pforzheimer and Sasa Mahr-Batuz in Norwalk, CT in 1996, making it one of the first authentic Spanish restaurants in the U.S. The restaurant has an extensive and ever-changing wine list with over 400 selections at a given time. They cultivate their wine list from handpicked sources such that it includes biodynamic winemaking, women winemakers, and small-producers.

The business quickly took off, becoming a local favorite and soon opened up a few more locations in Connecticut. However, in the past seven years, they’ve expanded rapidly. The restaurant went from a small, local business to a nationwide chain in just a couple of years. Today, Barcelona wine bar has 18 locations, with plans to open even more.

However, something unique about this chain is that each restaurant maintains the aspect of individuality that made Barcelona Wine & Restaurant so well-loved in the first place. The owners explain this philosophy as a method of maintaining the integrity of the chef’s artistic liberty:

“Every restaurant shares the same name and culture, but unique to most ‘chains’, each location has its own Executive Chef that writes his/her menu nightly. We consider the concept chef driven, and the food inspired by simply prepared market fresh cuisine, like you would find in the food stalls of the Boqueria Market in Barcelona or Central Market in Valencia.”

This is where our project idea stemmed. We were curious to see how much the restaurants differed at various locations and how the head chef and the culture of the location of the restaurant would impact the experience of dining at a Barcelona Wine & Restaurant. Hence, we were interested in finding the best way to visit Barcelona Wine & Restaurant’s different locations. From this interest, we created our project objectives.

*2 – Project Objectives*

There are a couple important factors to consider when planning a trip, so we developed 4 different objectives. That way, we could compare the ways we would go about this trip to visit Barcelona Wine & Restaurant locations if we were to have a couple different objectives.

The first objective is to find the optimal route to drive to all 18 Barcelona Wine & Restaurant locations and back with the goal of minimizing gas expense (which is done by minimizing distance). This is done using the Traveling Salesman Problem. Then, using estimates for gas prices and MPG, use findings to estimate the cost taking this road trip if you are only considering the transportation expense.

The second objective is to find the shortest path to drive from the two locations that are furthest from each other. Again, use averages for gas prices and MPG to estimate gas expense. However, in this case, you will also have to fly back to your original location. Research to find an accurate approximation for the price of a plane ticket from the terminal back to the origin. Add the gas expense to the plane expense to calculate the transportation expense.

The third objective is the exact same as the second one, except it adds an additional constraint. In this scenario, you again use the shortest path, but you must stop at 4 Barcelona Wine & Restaurant locations on the way. Transportation expense is calculated identically to objective 2.

The fourth objective looks at optimizing the trip based on hotel expenses. Consider the prices of hotels in the cities of each of the 18 locations. Find the maximum number of locations you can visit if you have a hotel budget constraint of $800. This is done using set covering.

*3 – Problem Data*

The following data was used in our optimization problem:

**GPS Coordinates**

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The locations were found on Barcelona Wine & Restaurant’s webpage and then Google Maps was used to type in restaurant addresses and find exact GPS coordinates.

**Distance Matrix**



The distances matrix was then calculated in MATLAB using GPS coordinates and the response was transformed from radians to miles. See figure 6.1 in Appendix for code.

**Hotel Prices**

Table

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Hotel prices were found by researching on Expedia. The criteria was that the price selected for each location was for a standard room on December 15th, 2021 at a hotel that we would want to stay at in that location. So essentially, they were selected based on user preference.

**Gas Estimate**

Because a road trip to visit Barcelona Wine & Restaurant locations would involve driving through the U.S. and filling up the gas tank periodically, it wouldn’t make sense to calculate averages of gas prices just in the restaurant locations. Therefore, we instead decided to use the national average for our gas price estimate.

**Table

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https://gasprices.aaa.com/

Since this theoretical road trip is being planned for the upcoming month, we used the previous month’s average, as we felt it would be the best indicator of upcoming gas prices. We selected the price for mid-grade fuel, because it still gives a close estimate even if the vehicle used for the road trip requires premium gas or can use regular gas. This gave us our gas price estimate, which is $3.741.

**MPG Estimate**

Similarly, we elected to use national averages of vehicle MPG in 2020 for our estimate. We looked at the EPA’s 2020 national average MPG for cars and SUVs, broken down by vehicle type. Since we do not know the type of passenger vehicle that will be used for the road trip, we took the average of the different car type to get our MPG value.

( 31.7 + 28.4 + 23.8 + 23.4 + 19.2 ) / 5 = 25.3, so this is how we come up with our MPG estimate, which is 25.3.

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https://www.epa.gov/automotive-trends/highlights-automotive-trends-report

**$/Mile Estimate**

From our gas price and MPG estimates, we calculated the price per mile in dollars. We

took $3.741 / gallon and divided it by 25.3 miles per gallon to get around $0.15 / mile.

This value was then multiplied to distance to calculate the gas expense.

**Flight from terminal to origin**

We determined the cost of flying from the terminal (Denver) to the origin (South End, Boston) for objectives 2 and 3 by using Google Flights. The criteria was that the flight must be nonstop and on December 15, 2021. The flight selected based on these requirements was a JetBlue flight for $165.

*4 – Findings and IMplications*

**Objective 1:**

If the goal is to visit all 18 Barcelona Wine & Restaurant locations by road tripping, the minimal distance is 4283 miles, which makes our minimum transportation expense (miles x $/mile) $642.45.

The optimal route is:

Knox-Henderson —> Denver —> South End —> Brookline —> West Hartford —> New Haven —> Fairfield —> Norwalk —> Stamford —> Philadelphia —> 14th Street —> Cathedral Heights —> Reston —> Raleigh —> Charlotte —> Inman Park —> Westside Ironworks —> Nashville —> beginning,

where the path is a loop so it doesn’t matter where you start. Wherever you start is where you end up. I.e. Nashville —> Knox-Henderson

Chart

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Calendar

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See Figure 6.2 in Appendix for code

**Objective 2:**

If the objective is just to visit the two furthest away locations of Barcelona Wine & Restaurant to see how different they are, the shortest path also happens to involve stopping at another location. This road trip would involve going from Denver —> Brookline —> South End. The minimum distance you would have to travel to visit the two furthest away locations is 1775 miles, which computes to a gas expense (miles x $/mile) of $266.25. Then, you would have to fly back from terminal to origin, for a price of $165. Therefore, the total transportation expense associated with this objective is 431.25.

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Chart

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See Figure 6.3 in Appendix for code

**Objective 3:**

In this scenario, the objective is the exact same as objective 2 except that you must stop at 4 restaurants on the way from the two furthest destinations. This road trip would involve going from Denver —> New Haven —> West Hartford —> Brookline —> South End. The minimum distance you would have to travel to visit the two furthest away locations and stop at 4 restaurants on the way is 1818 miles, which is only 43 more miles than the previous scenario. This computes to a gas expense (miles x $/mile) of $272.70. Then, you would have to fly back from terminal to origin, for a price of $165. Therefore, the total transportation expense associated with this objective is 437.70.

Application

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\*Problem solved in MATLAB but results pasted into Excel for easier visualization.

See Figure 6.4 in Appendix for code

**Objective 4:**

Objective 4 shifts from looking at transportation expense to looking at hotel expense. A binary matrix was first created using IF statements to determine which restaurant locations were within 50 miles of each other. These restaurants were deemed close enough to share a hotel. The assumption in this problem is that you can visit multiple restaurants per day.

Table

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If you have a hotel budget constraint of $800, the maximum number of restaurants you can visit is 13, and this can be done by staying in hotels in the following 5 locations: Fairfield, Inman Park, South End, Philadelphia, and Cathedral Heights. This would be a $700 total hotel expense for this scenario.

Chart

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See Figure 6.5 in Appendix for code

*5 - conclusions*

After examining these results, we can see that the road trip to visit Barcelona Wine & Restaurant locations will look very different depending on what our objective is. We can look at the results of this project and weigh our preferences for each objective against both the importance of the factor being analyzed and the cost of that factor to determine which road trip plan we should select. For example, if we are taking a road trip and we know we have friends throughout the country whose houses we can sleep at for free, we might only be worried about transportation expense and not hotel expense.

While this application of TSP, SP, and Set Covering is very niche, as it pertains to our particular interest in Barcelona Wine & Restaurant, our same logic and process can be used when planning any road trip. Whenever someone is planning a road trip, there are several different factors and associated potential objectives that they may want to look at. Our project can be used as a blueprint for them to price out and visualize what the road trip would look like if they chose a couple different scenarios and then based on their findings and priorities, decide which to select as their plan.

*6 – Appendix*

**Figure 6.1**

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**Figure 6.2**

Graphical user interface, text, application, chat or text message

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**Figure 6.3**

Text

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**Figure 6.4**

Text

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**Figure 6.5**

Graphical user interface, text, application

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