MATH 223

Some Thoughts About the Location Problem

These are ideas/ suggestions/questions gleaned from the initial team reports. Some may be more useful than others. Some may be incorrect.

1. Since there are more trips to Middlebury than to Monterey and more trips to Middlebury than to Oracle, the best location for the office is likely to be in Eastern half of the country.

2. Since there are more trips to west (California, Arizona) than to the east (Middlebury, Vermont), the best location for the office is likely to be in the Western half of the country.

3. Missouri

4. Z = Total Cost = (Cost per mile)(total miles traveled) = (Cost per mile)(miles traveled to Vermont + miles traveled to Monterey + miles traveled to Oracle) = (Cost per mile) [(number of trips to Vermont)(miles between office and Vermont) +(number of trips to Monterey)(miles between office and Monterey) + (number of trips to Oracle)(miles between office and Oracle) = (Cost per mile) [(6)(miles between office and Vermont) +(4)(miles between office and Monterey) + (3)(miles between office and Oracle)] = (Cost per mile) [6 d(A,V) + 5 d(A,M) + 4 d(A,O)]where the notation d(A,B) represents the distance in miles between office location (A) and city B. Questions: (1) Should we double Z because we have to account for round trips? (2) If the cost per mile changes, then the total cost changes but does the ideal location for the office change? Can we ignore the cost per mile?
   (3) Does it matter if the distance between cities is measured in miles rather than kilometers or some other unit of distance?

5. Consider the United States as lying on a flat plane and use standard rectangular coordinates (*x,y*) to describe locations of points. Flatten a map of the country on a table, pick an arbitrary point in the center of the country as the origin, and then use a rule to get (*x,y*) coordinates for Middlebury, Monterey, and Oracle.

6. Suppose (x_V, y_V) are the coordinates of Middlebury and (x, y) are the unknown coordinates of the office. Isn't the distance *d(A,V)* then given by || A – V|| = $\sqrt{(x - x_V)^2 + (y - y_V)^2}$?

7. Since all the cities lie on the surface of the earth which is a two-dimensional surface, we should be able to describe the position of each city by 2 numbers; that is, a pair of coordinates. Is there some way to get coordinates for Middlebury, Monterey, and Oracle other than the method suggested in Number 4 above? Perhaps latitude and longitude?

8. If we use latitude and longitude, which is x and which is y? How do we find latitude and longitude for a given city? Can Google Maps help? What other references might have this information? What units do they use for latitude and longitude? Degrees, Minutes and Seconds? Or are Degrees and Minutes converted to decimal percentages of Degrees? Should Degrees be converted to Radians?

9. Treating the United States as a flat piece of the plane may be unrealistic (How unrealistic?). The Earth is more realistically modeled as a sphere. Then the latitude and longitude numbers are more accurate locaters for points. If we consider the U.S. as lying on a sphere, then we should use the orthodromic distance (distance along a great circle, which is how an airplane flies) as the measure of the shortest distance between two points. See "Program for distance between two points on earth" for such an approach. It involves the so-called *haversine* function.

10. No matter what approach you take, you should wind up with a real-valued function of two variables whose value you want to want to minimize. In our case, our goal is to find the values of the variables which will produce the minimum. This will involve using techniques we have been studying.

11. Once you have solved for the best values of the coordinates, how do you locate the spot in the country that has those coordinates?

12. Here is a different approach to the problem that a couple of teams proposed: Divide the problem into two separate problems. First, look at Oracle and Vermont only: the headquarters *H1* will be on a straight line between the two, closer to Vermont because we travel there more often. Similarly, looking at Monterey and Vermont only, the headquarters *H2* will be on the straight line between the two, also closer to Vermont. Then we should locate the headquarters at the midpoint of the segment between *H1* and *H2*.

Be Careful About Averaging Averages

Example: Let $a = 60$, $b = 80$ and $c = 100$. Then the average *H1* of a and c is 80. The average *H2* of b and c is 90 so the average of *H1* and *H2* is 85. The average of a, b and c, however is 80.