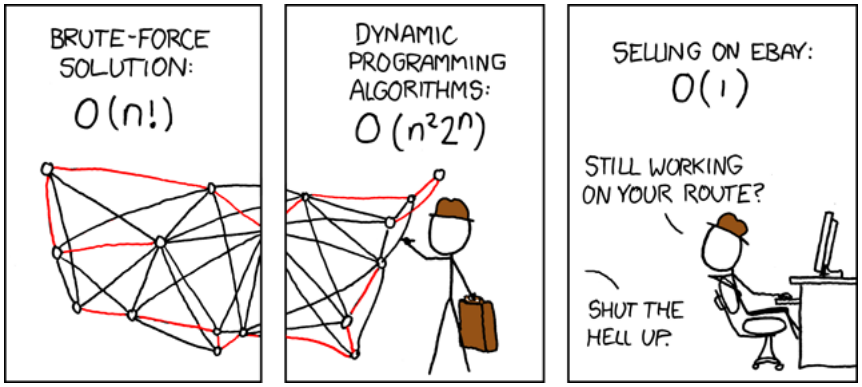
CS325: TSP project

Prof. Glencora Borradaile

Due: Tuesday, November 27 at 10 AM



from: `http://xkcd.com/399/`

This project is rather open-ended, and I hope you will have fun trying out ideas to solve a very hard problem: the *travelling salesperson problem* or TSP.

> You are given a set of n cities and, for each pair of cities c_1 and c_2, the distance between them $d(c_1, c_2)$. Your goal is to find an ordering (called a *tour*) of the cities so that the distance you travel is minimized. The distance your travel is the sum of the distance from the first city in your ordering to the second plus the distance from the second city in your ordering to the third and so on until you reach the last city and finally add the distance from the last city to the first city. For example, say the cities are Chicago, New York, New Orleans and San Francisco. The total distance travelled visiting the cities in this order is:

d(Chicago, New York)+d(New York, New Orleans)+d(New Orleans, San Francisco)+d(San Francisco, Chicago)

In this project, you will only need to consider the special case where the cities are locations in a 2D grid (given by their x and y coordinates) and the distances between two cities $c_1 = (x_1, y_1)$ and $c_2 = (x_2, y_2)$ is given by their Euclidean distance. So that we need not worry about floating point precision problems in computing the square-root (and so that everyone will get the same answer), we will always round up this distance. In other words, you will compute the distance between city c_1 and c_2 as:

$$d(c_1, c_2) = \left\lceil \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \right\rceil$$

For example, if three cities are given by the coordinates $(0, 0), (1, 3), (3, 1)$, then a tour that visits these cities in this order has distance $\lceil\sqrt{10}\rceil + \lceil\sqrt{8}\rceil + \lceil\sqrt{10}\rceil = \lceil 3.16\ldots\rceil + \lceil 2.82\ldots\rceil + \lceil 3.16\ldots\rceil = 11$.

Project specification

Your group is to design and implement a method for finding the best tour you can. TSP is not a problem for which you will be able to find optimal solutions. It is *that* difficult. But your goal is to find the best solution you can. You may want to start with some *local search heuristics* as described in section 9.3.1: `http://www.cs.berkeley.edu/~vazirani/algorithms/chap9.pdf`
Beyond that you may:

- read as much as you want about how to solve the travelling salesperson problem (so long as you cite any resources you use)
- use which ever programming language you want (so long as all group members are comfortable with it)

You may **not**:

- use existing implementations or subroutines
- extensive libraries (if you are unsure, ask in the discussion forum for this project)
- use other people's code (other than that of your group members)

Input specification A problem *instance* (a particular input) will always be given to you as a text file. Each line defines a city and each line has three numbers separated by a white space. The first number is the city identifier, the second number is the city's x-coordinate and the third number is the city's y-coordinate.

Output specification You must output your solution into another text file with $n + 1$ lines where n is the number of cities. The first line is to be the length of your tour you find. The next n lines should contain the city identifiers in the order they are visited by your tour. Each city must be listed exactly once in this list. This is the *certificate* for your solution and your solutions will be checked. If they are not valid, you will not receive credit for them.

Example instances We have provided you with three example instances. They are available in the directory `http://eecs.orst.edu/~glencora/cs325/tsp`. `example-input-*` are provided according to the input specifications. `example-output-*` are example outputs corresponding to these three example cases. You should use the output instances to test that you are computing distances correctly. The **optimal** tour lengths for test cases 1, 2 and 3 are 108159, 2579, and 1573084, respectively. You should use these values to judge how good your algorithm is.

108,159, 2579, and 1,573,084

Test instances

On **November 26 at 10 AM**, we will make available 3 test instances. The location will be emailed to the class email list. By **November 27 at 10 AM**, you will be required to submit 3 separate text files according to the output specification and corresponding to each of these test instances. These files should be called `test1`, `test2`, `test3` and will be submitted to the TEACH subdirectory of **one** team member.

The deadline for this portion of the project is hard. No exceptions will be made without prior approval from Prof. Borradaile.

Project report

You will submit a project report on November 27 at 10 AM. You may submit this up to 24hrs late without penalty. The project report may only be up to **2 pages in length** in no less than **11pt font**. In this report you must describe the ideas behind your algorithm as completely as is possible.

In-class competition

On November 29, we will hold an in class competition. In order to compete, your code must be ready to run out of your ENGR home directory. We will have several, virtual machines (as close to identical as Todd Shechter can make them) set up for this purpose. The virtual machines will be just like flip, so you can test out your final version on that. The competition will require your program to find the best solution possible to one or more instances within a fixed amount of time (on the order of 4 minutes). Your program will be terminated after this amount of time, so your code should write out the best solution found so far prior to termination (with some frequency).

Any further details will be made available closer to the competition.

Grading rubric

30% of your project grade will be determined by your solutions to the test instances. You will be judged on how close your tour length is to that of the best possible solution. However, you will not be told what the optimal tour length is for the test instances.

50% of your project grade will be determined by your project report. You will be judged on clarity and creativity.

20% of your project grade will be determined by your participation in the competition. **10/20** will be awarded for full participation (finding a working, but not necessarily very short, solution), regardless of performance. Remaining points will be awarded based on performance.

Check list

1. **Does your program correctly compute tour lengths?**
2. **Does your program meet the output specification?**
3. **Did you submit your solutions to the test instances by November 27 at 10 AM?**
4. **Does your code run out of your home directory on flip?**
5. **Have you checked the discussion forum on Blackboard for any updates?**