Traveling Salesperson Project

MATH 384 • Spring 2024
first draft due Thursday, April 11
revisions due Thursday, April 25

This project requires you to explore some aspect of the traveling salesperson problem (TSP). Choose one of the following options.

Project Options

1. Demonstrate how linear programming methods can be used to solve TSP tours with at least 40 sites. This builds on the linear programming we did in class on March 21. For this, you will need to use the "subtour inequalities" and "comb inequalities" as described in Chapter 3 of *The Traveling Salesman Problem* by Applegate et al., available on Moodle and via the St. Olaf Library. Exhibit a few minimal-distance tour and discuss how you know that they are optimal.
2. Explore how close you can get to an optimal TSP tour using simulated annealing. For this, you should improve your simulated annealing code from class on March 14 to use local distance updates rather than re-computing the entire tour distance for each iteration. Then use your algorithm to find near-optimal tours for various collections of sites. For each collection of sites, compare your tour length with that produced by Mathematica's FindShortestTour function, and provide a precise summary of your observations.
3. Explore connections between minimum spanning trees (MST) and TSP tours, using both random point sets and specific collections of sites that you specify. You may use built-in Mathematica functions such as FindShortestTour and FindSpanningTree. How precisely can you quantify the relationship between the lengths of the MST and the TSP tour? What best-case or worst-case examples can you find? What insight can you gain into the disparity that exists between the ease of computing the MST and the notorious difficulty of computing the TSP tour?
4. Come up with your own project idea related to the traveling salesperson problem. If you want to do this, discuss your idea with the professor.

Remember to be *creative*, *thorough*, and *precise*! *Communication* is at least as important as *computation*. You should turn in a well-organized notebook that clearly explains, using sentences and paragraphs, what you computed and what conclusions you can draw.

Grading

This project will be graded on the EMRN scale, as described in the syllabus. To receive a grade of *Meets Expectations*, your notebook should exhibit the following characteristics:

- You demonstrate thorough computational exploration the project option that you choose.
- You provide specific, precise answers to questions identified above for your project option.
- Your reasoning is explained using sentences, and your notebook is well-formatted and easy to read.
- No significant gaps or errors are present.

To receive a grade of *Excellent*, your notebook should meet the expectations above and further exhibit:

- Methodology that demonstrates mastery of concepts that we have studied in the course.
- Computation that is of high quality, demonstrating skillful and generalizable use of programming constructs.
- Exposition is clear and precise, thoroughly explaining your methodology and reasoning. Any assumptions necessary for the estimates are reasonable and clearly stated.
- The work extends beyond the project requirements in a creative or insightful direction.

Following the initial submission and grading, you will have the opportunity to revise and resubmit your project.