

# CAP 5512 Evolutionary Computation

## Spring 2026

### Homework 3

## 1 Goal

In the first two homework assignments, you were asked to explore various elements of the GA, to better understand the algorithm and how it works. In this homework assignment, your goal will be to apply a GA to an optimization problem and obtain the best performance possible from your algorithm. Specifically, you will apply a genetic algorithm (GA) to the traveling salesman problem (TSP).

The TSP problem that you will address is to find the shortest path through all of the lower 48 state capitals plus Washington DC. You may start at any state capital and you must end back at that capital, so that the tour is a completed loop. The data file `tsp.dat` contains a list of 49 capital cities (from the lower 48 states plus Washington DC) and their latitude and longitude. (Note: The haversine formula may be used to calculate precise “as-the-crow-flies” distances between each pair of cities.) For your references, the optimal mileage to visit all capital cities is 10,637.36 miles.

As a group, please design and implement a GA that obtains the best possible solution that you can.

## 2 Note about assignments in this class

Please keep in mind that the assignments in this class typically will involve running and analyzing large amounts of data generated by GA runs. The time needed to run and analyze experiments will likely be significantly more than the time needed to code up your GAs. Make sure that you plan ahead and allow yourselves time to perform the analysis; don’t wait until the last minute to write your programs.

Even though this assignment is an application rather than an experimental study, you may want to try different GA implementations as you try to obtain optimal performance. As a result, make sure that you get started early enough to have time to optimize your algorithm design.

## 3 Code

Please use the Distributed Evolutionary Algorithms in Python (DEAP) code for this assignment (downloadable from the following website: <https://deap.readthedocs.io/>).

## Deliverables

Please upload the following deliverables for this assignment to webcourses.

- **Report:** A report of up to five pages that describes your final algorithm as well as the decisions that you made that led to the final design. Only one person from each group needs to upload

your report. If more than one person uploads, please email me and let me know which report to grade. This report should include:

- A description of the GA that you implemented to solve the TSP problem including details about:
  1. The problem representation that you use in your final algorithm. Why did you select the representation that you selected? What other representations were considered and why?
  2. A description of the fitness function in your GA.
  3. The genetic operators that your GA uses. Did you design new operators or use the traditional ones? Why?
  4. The selection method that your GA uses. Why did you select that method?
- The reasoning behind your major decisions about algorithm design.
- The length (in miles) of the shortest tour your GA learned.
- A description of your best solution (either a list of cities in the order visited or the tour drawn on a map).
- Any conclusions or insights that you gained about the GA or about the TSP problem as a result of this study.
- You may (but are not required to) include any plots, graphs, and graphics that you feel will help support your conclusions. Make sure your discussion is complete and that all plots and graphs are clearly labelled. If I cannot figure out what plot or graph you are referring to in your answers, if I cannot tell what data the plots describe, or if I cannot figure out what question you are answering, then I cannot give credit for that answer.
- **Code:** Your code for this assignment along with any extra instructions on how to run the code; for example, if an input file is required, please include the input file with your upload along with instructions on running your code using that input file.