15.076 Homework 3

Due: March 14, 11:59 pm

Problem 1: The Ocean Cleanup

Figure 1: The Ocean Cleanup proof of "System 002" technology. October, 2021

The Ocean Cleanup is a Dutch nonprofit organization founded in 2013 with the goal of cleaning 90% of floating ocean plastic pollution from the ocean. One of the technologies they have developed is named "System 002". It is essentially a large net dragged between two ships and is pictured above. In this assignment, you will use a prediction of plastic in the ocean to develop an algorithm that plans a navigational course for System 002 that collects as much plastic as possible.

A mission is being planned to travel within a square 100 nautical mile region of the pacific ocean. A physics model predicted plastic in the region down to the nearest tenth of a nautical mile and is displayed in figure 2. The file `plastic_map.jld2` contains a 1001x1001 array named `plastic_map` representing the amount of plastic in kg located by increasing row 0,.1,.2,...,100 nautical miles north of the home port and by increasing column 0,.1,.2,...,100 nautical miles east of the home port. Here is a plot of the field of plastic:

1. Suppose the ship will move from the bottom left (0,0) nm to the top right of the region (100,100) nm. For simplicity, assume from any node the ship can only move to the node

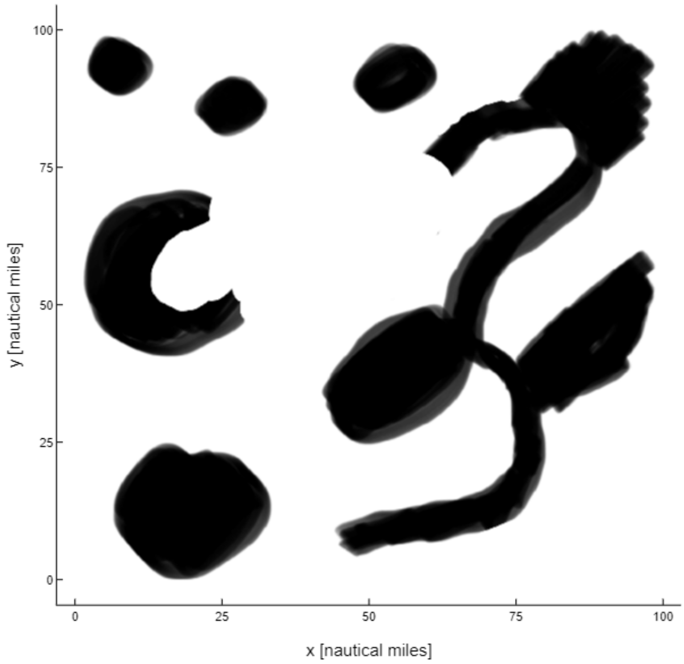

Figure 2: Map of predicted plastic in a certain square region of the pacific ocean.

directly above or the 5 nodes in the column just to the right of the original node (see figure 3). Implement code in Julia following the Dike Height Optimization method to find the course that collects as much plastic as possible. Turn in your code as a .ipynb file. Create and print a variable called "course" that is an array in the format [(0,0), (x1,y1), ...,(100,100)]. The elements of the array are "tuple" type. Report the amount of plastic collected.

2. Now suppose the ship can only carry 45,000 gallons of fuel and the ship requires 150 gallons per nautical mile. How might this change the optimal course and amount of plastic collected? Can you use the same algorithm? Write (but don't implement) a MIP formulation that solves the problem with a fuel constraint.

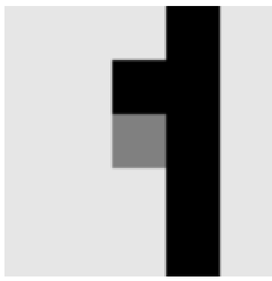

Figure 3: The black cells are nodes the ship can move to when starting from the central node.

Problem 2

The Netherlands is planning to locate blood distribution centers for hospitals at some of the hospitals in the country. The hospitals are described in ziekenhuizen.csv (hospital in dutch) and the driving times reistijden.csv (drive time in dutch). They wish to minimize the largest drive time between a hospital and its blood distribution center.

1. Write (but don't implement) a MIP formulation that solves this problem for 10 hospitals.
2. Suppose the MIP formulation is too slow to solve so we must use a heuristic method. Implement Julia code to solve the problem for 10 hospitals using the greedy "change one" heuristic approach described in the Hospital Location Optimization in Timor-Leste lecture. Start with a feasible solution and replace one hospital with another one that most improves your objective and repeat until you stop seeing improvement. Break ties by prioritizing hospitals higher in the csv file. Submit your code (as a .ipynb) and report the ten best hospitals you find if you initialize your algorithm with the first ten hospitals in the ziekenhuizen csv file.