

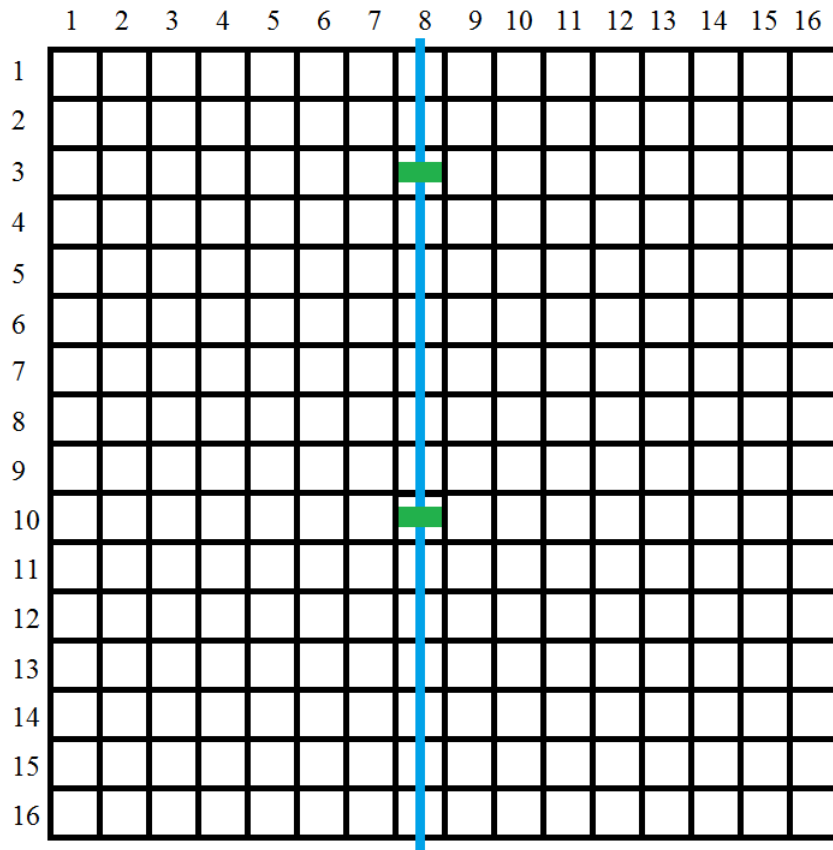
EAI 320
Practical Assignment 3

07 March 2016

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Problem

A new hospital is to be built within the city where you reside. The city council has asked you to help determine the optimal location of the new hospital. The objective is to place the hospital at a location such that the response time to any medical emergency is minimised. A medical emergency could occur anywhere in the city. The city is divided up into a 16×16 grid as illustrated below.



There is a river that flows through the city as indicated by the blue line. There are two bridges over the river at locations $[3,8]$ and $[10,8]$. These are illustrated by the green markers.

You have been provided with the results of a survey. The results include number of medical emergencies in each block over a period of a year. This data is provided in the following Numpy array:

```
w = np.array(
[[9, 7, 1, 9, 8, 8, 2, 8, 9, 9, 8, 5, 3, 6, 9, 5],
[9, 2, 4, 9, 9, 0, 3, 8, 9, 8, 5, 3, 7, 8, 4, 7],
[4, 7, 8, 9, 0, 6, 0, 3, 8, 7, 4, 4, 7, 1, 2, 7],
[2, 2, 4, 0, 1, 7, 1, 8, 7, 1, 9, 3, 0, 4, 1, 2],
[0, 9, 0, 3, 3, 8, 1, 8, 9, 7, 7, 7, 8, 2, 2, 1],
[1, 1, 2, 1, 9, 5, 9, 9, 8, 5, 2, 5, 0, 5, 4, 9],
[9, 1, 0, 7, 2, 1, 0, 5, 8, 7, 3, 6, 7, 6, 1, 2],
[4, 0, 3, 8, 0, 4, 2, 6, 3, 2, 0, 8, 6, 1, 7, 9],
[1, 0, 1, 3, 3, 6, 7, 0, 4, 4, 0, 3, 8, 3, 4, 7],
[1, 7, 7, 0, 5, 7, 0, 1, 1, 5, 8, 3, 5, 1, 1, 0],
[3, 1, 2, 6, 7, 1, 8, 1, 4, 5, 2, 1, 9, 8, 3, 8],
[1, 3, 2, 7, 7, 6, 3, 0, 1, 3, 2, 6, 6, 2, 0, 8],
[6, 9, 4, 8, 1, 2, 5, 5, 0, 9, 2, 8, 7, 9, 4, 9],
[0, 7, 4, 3, 4, 4, 5, 2, 8, 7, 4, 6, 9, 5, 5, 3],
[9, 1, 8, 0, 7, 2, 2, 5, 5, 8, 3, 8, 4, 3, 7, 6],
[6, 0, 0, 5, 6, 0, 8, 1, 7, 4, 5, 0, 8, 8, 8, 7]])
```

Furthermore, it is found that the average response time in minutes is $2.4 + 4.5d$, where d is the Euclidean distance from the hospital to the location of the emergency. With this information, a suitable cost function for a proposed location is given by

$$C_{loc} = \sum_i^{16} \sum_j^{16} w_{i,j} \sqrt{(x_i - x_{loc})^2 + (y_j - y_{loc})^2}, \quad (1)$$

where $w_{i,j}$ is the number of medical emergencies in block (i, j) , (x_i, y_j) are the coordinates of the block indexed by (i, j) and (x_{loc}, y_{loc}) is the proposed location of the hospital.

Question 1

Create a function in python to compute the distance between two blocks in the city, taking into account the river and bridges. Create a function in python that implements the cost function presented in equation 1. Plot the three dimensional cost surface for equation 1 over the grid space. Note where the global minimum is.

Question 2

Implement a genetic algorithm (GA) to search for the solution of the optimal hospital location. Please ensure that you indicate the following in your report:

1. How the chromosomes are represented.
2. The size of the population used.
3. How the selection step in the GA is performed.

4. How the crossover step in the GA is performed.
5. How the mutation step in the GA is performed.
6. The number of algorithm iterations required to find a solution.
7. The optimal location for the hospital.

Deliverables

- Write a technical report on your finding for this assignment.
- Include your code in the digital submission as an appendix, but leave it out for the hardcopy submission.

Instructions

- All reports must be in PDF format and be named report.pdf.
- Place the software in a folder called SOFTWARE and the report in a folder called REPORT.
- Add the folders to a zip-archive and name it EAI320_prac1_studnr.zip.
- All reports and simulation software must be e-mailed to *EAI320.UP@gmail.com* no later than 16:00 on 15 March 2016. No late submissions will be accepted.
- Place a hard copy of your report in the box in front of Eng 3 7-25 before the deadline.
- Submit your report online on ClickUP using the TurnItIn link.

Additional Instructions

- Do not copy! The copier and the copyee (of software and/or documentation) will receive zero for both the software and the documentation. Z-e-r-o.
- For any questions of appointments email me at *EAI320.UP@gmail.com*
- Make sure that you discuss the results that are obtained. This is a large part of writing a technical report.

Marking

Your report will be marked as follow:

- 60% will be awarded for the full implementation of the practical and the subsequent results in the report. For partially completed practicals, marks will be awarded as seen fit by the marker.
- 40% will be awarded for the overall report. This includes everything from the report structure, grammar and discussion of results. The discussion will be the bulk of the marks awarded.