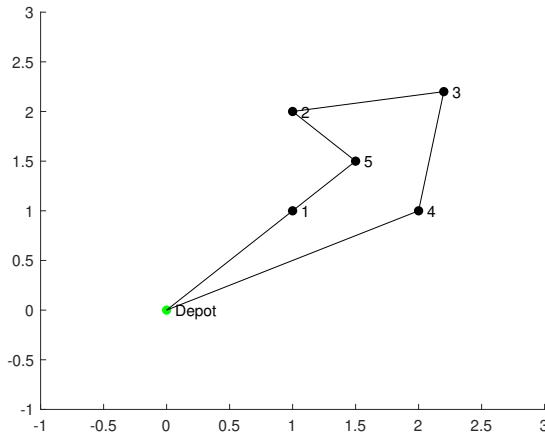


The solution Matlab codes for all exercises can be found on Moodle. The answers to the questions can be found below.

a) The tour according to the nearest neighbor heuristic is given in Figure 1. The corresponding length of the tour is 7.5, leading to a cost of \$35.



**Figure 1:** TSP tour according to NN heuristic

b) The central node out of the five customer nodes is number 5. This can already be explored visually from the plot, but is obtained formally by summing the distances to all other nodes.

c) The best node in terms of cost is node number 1. To find this, we took every node as a candidate and evaluated the served and unserved parcels for every node. This allowed us to calculate the cost.

d) The best node performs 43% better. The reason for this is that the number of crowd-shippers leaving node 5 is very low. Potentially, the location of node 5 is not well accessible by bikers due to water or elevation. Thereby, the cost for line-haul is lower between the depot and node 1.

e) For a cost of 4: crowd-shipping performs better  
For a cost of 2: traditional delivery performs better  
The difference can be explained by the relatively low service level. In the best node, 20% of the parcels need to be outsourced for a cost that is significantly higher than that of traditional delivery.