

One-Day Assignment 10 – algorithmic solution

Human Cannonball Run

One Day Assignment 10 – General

- For this problem, it can be split into 2 parts:
 - Graph modelling
 - Running SSSP
- In this graph, vertices represent all points of interest in the conference (the starting point a, the ending point b, and all cannon)
- Edges represent the time taken to reach point v from point u directly (ie. not using any other cannon along the way, except for possibly the cannon at point u, if one exists)

One Day Assignment 10 – Graph Modelling

for vertex1 in vertices:

 for vertex2 in vertices:

 dist = sqrt(pow(vertex1.x – vertex2.x, 2) + pow(vertex1.y – vertex2.y, 2))¹

 time1 = dist / 5

 time2 = INF // some large number

 if vertex1 is cannon:

 time2 = 2 + (abs(dist – 50) / 5)

 // add edge (vertex1 -> vertex2) with weight (min(time1, time2)) to graph
 DS of your choice

1. Alternatively, Java provides a Math.hypot() method

One Day Assignment 10 – Bellman Ford

Initialise a distance array. Set everything except the starting point (a) to a large number

```
for i from 1 to num_vertices - 1:  
    for edge in graph:  
        if (dist[edge.u] + edge.w < dist[edge.v]):  
            dist[edge.v] = dist[edge.u] + edge.w  
return dist[b]
```

One Day Assignment 10 – M. Dijkstra's

Initialise a distance array. Set everything except the starting point (a) to a large number

add (0, a) to a PQ of IntegerPairs

while PQ is not empty:

 dequeue (dist_estimate, vertex) from PQ

 if dist[vertex] == dist_estimate:

 for each neighbour of vertex:

 if (dist[vertex] + edge.weight < dist[neighbour]):

 dist[neighbour] = dist[vertex] + edge.weight

 add (dist[neighbour], neighbour) to PQ

return dist[b]

One Day Assignment 10 – English Description

- Given two points (x_A, y_A) and (x_B, y_B) , the direct distance between the two of them is:
 - $\sqrt{(x_A - x_B)^2 + (y_A - y_B)^2}$
- After calculating the distance, we need to convert the distance into time required to cover the distance. Pick the minimum of the following two as the weight of edge (u, v)
 - 1. $\frac{dist}{5}$
 - 2. $2 + \frac{|dist - 50|}{5}$ (only if vertex u represents a point with a cannon)
 - $|x|$ means the absolute value (ie. if x is negative, change it to positive)

One Day Assignment 10 – English Description

- After modelling the graph as in the previous slide, just run any suitable SSSP algorithm from point a, and find the distance at point b.
- Note that $E = O(V^2)$ since this is a complete graph. The possible options are:
 - Bellman Ford: $O(V^3)$
 - Original/Modified Dijkstra's: $O(V^2 \log V)$ (no negative edges)