Find the quickest and safest route to Medellin's streets

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ABSTRACT

Sexual harassment on the street includes all the different actions such as gestures, unwanted comments, and other acts that lack respect for someone, especially these days, are the women who suffer the most from this phenomenon. Medellín isn't the first one and neither the only one to suffer from this, other cities like Mumbai in India create a solution to reduce sexual harassment to find the safest route to a certain location. What is the algorithm you have proposed to solve the problem? What quantitative results have you obtained? What are the conclusions of this work? The abstract should be **at most 200 words**. (*In this semester, you should summarize here the execution times, and the results obtained with the three paths*).

Key words

Shortest route, street sexual harassment, identification of safe routes, crime prevention

1. INTRODUCTION

Sexual harassment on the street is one of many problems that humanity couldn't solve, so we are going to try to design a solution for this problem, in this case, an algorithm to find the safest and the shortest path to a certain location here on Medellín. A solution to this problem must be found if we are to improve ourselves as a society and as a country and if all citizens are to feel comfortable and secure.

1.1. The problem

In Medellín Colombia, 60% of the women population don't think the city is safe enough for them, so it is important to solve this problem to make them feel safer, also solving this problem would make the economy and the tourism growth even more and would make Medellin an incredible city.

1.2 Solution

Explain, briefly, your solution to the problem *(In this semester, the solution is a pedestrian algorithm to reduce both the distance and the risk of harassment. Which algorithms did you choose? Why?)*

1.3 Structure of the article

Next, in Section 2, we present work related to the problem. Then, in Section 3, we present the datasets and methods used in this research. In Section 4, we present the algorithm design. Then, in Section 5, we present the results. Finally, in Section 6, we discuss the results and propose some directions for future work.

2. RELATED WORK

Below, we explain four works related to finding ways to prevent street sexual harassment and crime in general.

2.1 Preventing Sexual Harassment Through a Path Finding Algorithm Using Nearby Search

This was a similar case in Mumbai, India, where they used thermal charts to predict high-risk locations for incidents of sexual harassment. The creation of this map and the use of Google maps API helped create the algorithm to find the safest places (the risk was 0 to 4, being 0 due safer). The main goal was to determine the shortest route and also the safest, they use the Euclidean equation of distance and to ensure that the line did not touch any grid point they used Bresenham’s line drawing method.

They give priority to the safest route, followed by the route closest to the destination.[1]

2.2 A Data Integration and Analysis System for Safe Route Planning

Aryan Guatpaa and Bhavye Khetan also made a research about finding the best route to reduce the cases of sexual harassment against women, find a route to be both safe, fast the present it appealingly. To determine the safety of a route they took into account the number of cases in the area and the people in it and other different aspects and the safety value is equivalent to the combination of all of the factors already mentioned (from negative infinity to 100). They use the 'Bottom Up' method to build functions from the bases using the aforementioned factors.

They used Dijkstra's algorithm (or Dijkstra's Shortest Path First algorithm, SPF algorithm) to find the shortest in the graph. They modified Dijkstra's algorithm to make it consistent with the route's safety value[2]

2.3 Safety-aware routing for motorised tourists based on open data and VGI

It was a work tested during the nights of Los Angles that consisted in present an application for finding routes avoiding relatively dangerous areas in this city. This work was based on taking the information of how dangerous some areas in the city are, with something called VGI, that means, volunteered geographic information and with this information create the safest and shortest routes for tourists and vehicle drivers.

For this work, they took into account 4 principal factors. First, the streetlights because they consider this is one of the indicators for more safty at night. Then, police stations, because they say people are not likely to commit a crime near a police station. The third factor was, where are located the highways in Los Angeles because these places have a high number of cars at high speeds, so these are dangerous places for robbers. Then, they extracted the crime data set for the last 30 days.

Finally, they used the IDW method with all the information they recollected before. This method consists in that each measured value has a weight that is inversely proportional to the distance to the estimated point values.[3]

2.4 A data integration and Analysis System for safe route planning

This article proposes a new model to identify the shortest and safest route with the lowest risk score. For this, they use updated crime and accident data available on DYC open data. Also uses machine learning algorithms to generate the risk score of a path. They also consider a lot of factors that affect the safety of a path that normally are not considered in the processes of creating a GPS with the safest routes. Finally, they use 3 algorithms: data processing mark algorithm, k-Mean, and k Nearest neighbor [4]

3. MATERIALS AND METHODS

In this section, we explain how the data were collected and processed, and then different alternative path algorithms that reduce both the distance and the risk of sexual street harassment.

3.1 Data collection and processing

The map of Medellín was obtained from *Open Street Maps* (OSM)[1] and downloaded using the Python API[2] OSMnx. The map includes (1) the length of each segment, in meters; (2) the indication of whether the segment is one-way or not, and (3) the known binary representations of the geometries obtained from the metadata provided by OSM.

For this project, a linear combination (LC) was calculated that captures the maximum variance between (i) the fraction of households that feel insecure and (ii) the fraction of households with incomes below one minimum wage. These data were obtained from the 2017 Medellín quality of life survey. The CL was normalized, using the maximum and minimum, to obtain values

[1] https://www.openstreetmap.org/

[2] https://osmnx.readthedocs.io/

between 0 and 1. The CL was obtained using principal components analysis. The risk of harassment is defined as one minus the normalized CL. Figure 1 presents the calculated risk of bullying. The map is available on GitHub[3]
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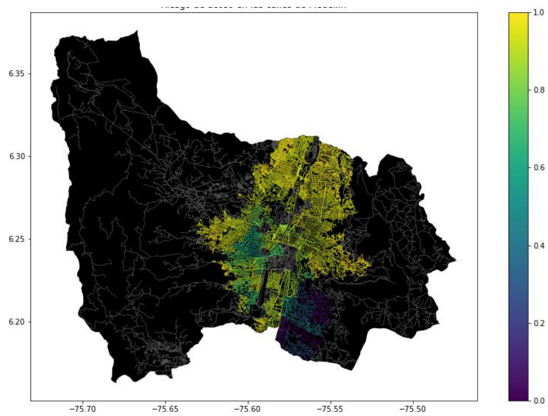


Figure 1. Risk of sexual harassment calculated as a linear combination of the fraction of households that feel unsafe and the fraction of households with income below one minimum wage, obtained from the 2017 Medellín Quality of Life Survey.

3.2 Algorithmic alternatives that reduce the risk of sexual street harassment and distance

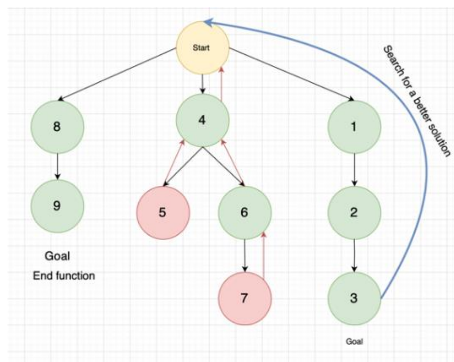
In the following, we present different algorithms used for a path that reduces both street sexual harassment and distance. *(In this semester, examples of such algorithms are DFS, BFS, Dijkstra, A*, Bellman, Floyd, among others).*

3.2.1 Backtracking algorithm

The first step is to validate every move. If we can't make any movement, we'll check the next one. To check this we follow the next order: if the upper cell is invalid, we check the lower cell. If the lower cell is also invalid we check for the right cell and if again this cell is invalid we finally check the left cell. In case all the moves are invalid, we backtrack to the last visited cell (This is done with a function that checks if the move is valid).

When we reach the end, we deliberately backtrack to explore any other possible path to reach the end.

Finally, after exhausting all possibilities, we output the best path to reach the end.
"The backtracking process of finding the shortest path in the maze is not efficient because it explores all possible paths to the destination, which may not be the final solution. " [Pencil Programmer, Anon] its complexity[5]



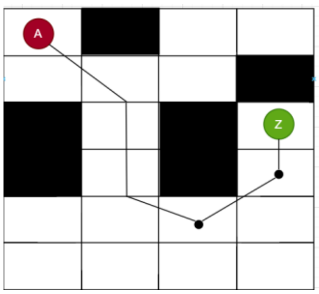
3.2.2 A* algorithm

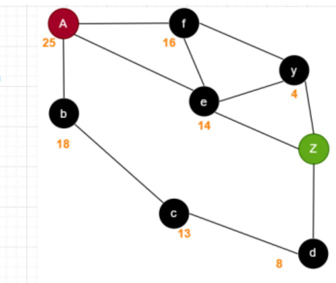
The A* algorithm is one of the best data structures to find a certain location on a maze, is using distance and heuristics to jump into different nodes and find the best path to the goal. Using heuristics can help to avoid different obstacles and plan ahead at each step to make a more optimal decision.

3

https://github.com/VillegasMich/Project_Datos1.git

The algorithm focuses on making a low-cost path tree from the start node to the goal, thanks to the function f (n) =g (n) +h (n) where f (n) = total estimated cost of the path through the node n, g (n) = cost so far to reach node n, h (n) = estimated cost from n, n to the goal. This is the heuristic portion of the cost function, so it's like an estimation. It is important to have allowable heuristic values and the cost of each node in order for the function to function correctly. its complexity [6]

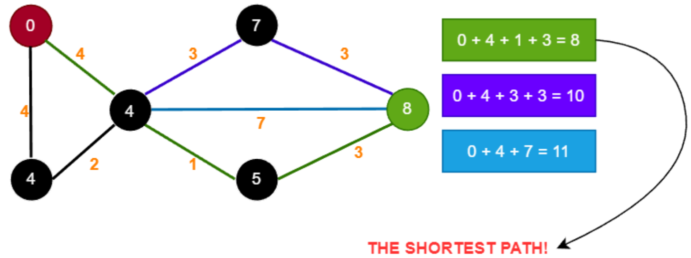




3.2.3 Dijkstra Algorithm

This algorithm is designed to find the shortest path between two points in a chart. "Dijkstra's Algorithm works on the basis that any subpath B -> D of the shortest path A -> D between vertices A and D is also the shortest path between vertices B and D." this means that Dijkstra will find the shortest subpath of the points of the principal path.

Dijkstra over-estimates the distance of each point from the starting point, then visits each point from the sides and moves towards the nearest point. The time complexity of this algorithm is $\boldsymbol{O = (E \log V)}$, E = number of edges & V = number of vertices.[7]

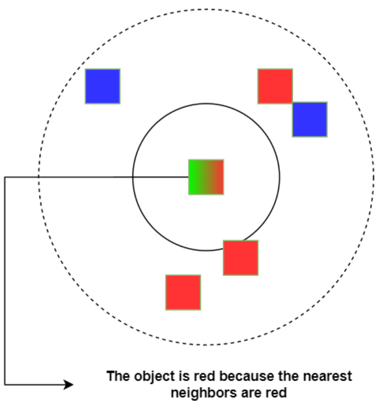


3.2.4 k-nearest neighbors algorithm

The KNN algorithm (k-nearest neighbors) is a simple machine learning algorithm useful to resolve classification and regression problems.

What it does is to work finding distances between a query and a specific number of examples(K) closest to the query.

We select the best K by trying several values of k and choosing the one that works better. [8]



4. ALGORITHM DESIGN AND IMPLEMENTATION

In the following, we explain the data structures and algorithms used in this work. The implementations of the data structures and algorithms are available on Github[4] .

4.1 Data Structures

Explain the data structure that was used to represent the map of the city of Medellín. Make a figure that explains it. Do not use figures from the Internet. *(In this semester, examples of data structures are adjacency matrix, adjacency list, adjacency list using a dictionary).* The data structure is presented in Figure 2.

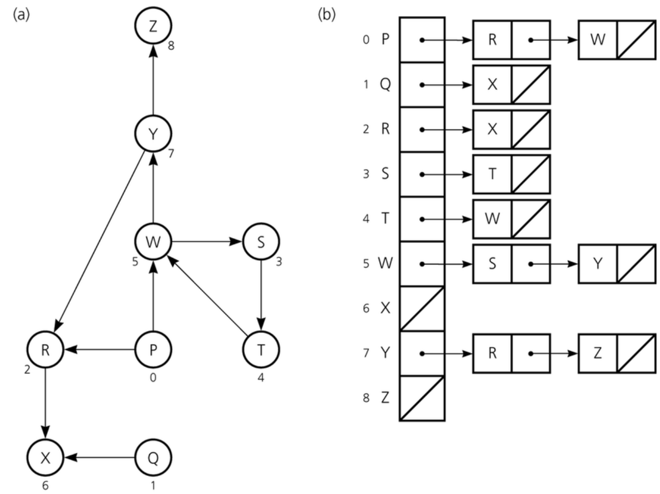


Figure 2: An example street map is presented in (a) and its representation as an adjacency list in (b). (*Please feel free to change this graph if you use a different data structure*).

4.2 Algorithms

In this paper, we propose an algorithm for a path that minimizes both the distance and the risk of street sexual harassment.

4.2.1 Algorithm for a pedestrian path that reduces both distance and risk of sexual street harassment

Explain the design of the algorithm for calculating a path that reduces both distance and risk of harassment and make your own graph. Do not use graphs from the Internet, make your own. *(In this semester, the algorithm could be DFS, BFS, Dijkstra, A*, Bellman, Floyd among others).* The algorithm is exemplified in Figure 3.

Figure 3: Calculation of a path that reduces both distance and risk of harassment (please feel free

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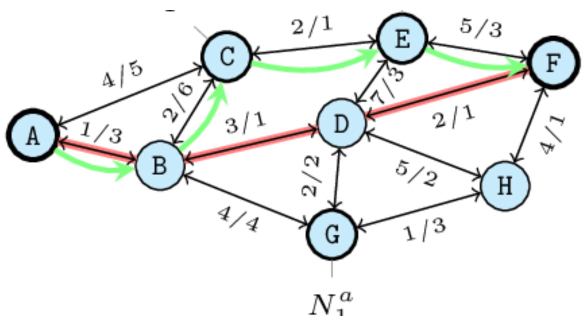
https://github.com/VillegasMich/Project_Datos1.git



to change this figure if you use a different algorithm).

4.2.2 Calculation of two other paths to reduce both the distance and the risk of sexual street harassment

Explain the other two paths that reduce both distance and risk of street sexual harassment and make your own graph. Do not use graphs from the Internet, make your own. *(In this semester, the algorithm could be DFS, BFS, Dijkstra, A*, among others).*) The algorithm is exemplified in Figure 4.

Figure 4: Map of the city of Medellín showing three pedestrian paths that reduce both the risk of sexual harassment and the distance in meters between the EAFIT University and the National University.

4.3 Algorithm complexity analysis

Explain, in your own words, the analysis, for the worst case, using the notation O. How did you calculate these complexities? Explain briefly.

Algorithm	Time complexity
Algorithm name	$O(V^2 * E^2)$
Name of the second algorithm (in case you have tried two)	$O(E^3 * V * 2^V)$

Table 1: Time complexity of the name of your algorithm, where V is.... E is... *(Please explain what V and E mean in this problem). No, do not use 'n'.*

Data Structure	Complexity of memory
Name of the data structure	$O(V*E*2^E)$
Name of the second data structure (in case you have tried two)	$O(2^{E*} 2^V)$

Table 2: Memory complexity of the data structure name used by your algorithm, where V is.... E is... *(Please explain what V and E mean in this problem). No, don't use 'n'. That is, don't use 'n'. Not 'n'.*

4.4 Algorithm design criteria

Explain why the algorithm was designed that way. Use objective criteria. Objective criteria are based on efficiency, which is measured in terms of time and memory. Examples of NON-objective criteria are: "I was sick", "it was the first data structure I found on the Internet", "I did it the last day before the deadline", "it's easier", etc. Remember: This is 40% of the project grade.

5. RESULTS

In this section, we present some quantitative results on the three pathways that reduce both the distance and the risk of sexual street harassment.

5.1 Results of the paths that reduces both distance and risk of sexual street harassment

Next, we present the results obtained from *three paths that reduce both distance and harassment,* in Table 3.

Origin	Destination	Distance	Risk
Eafit	Unal	??	??
Eafit	Unal	???	??
Eafit	Unal	??	??

Distance in meters and risk of sexual street harassment (between 0 and 1) to walk from EAFIT University to the National University.

5.2 Algorithm execution times

In Table 4, we explain the ratio of the average execution times of the queries presented in Table 3.
Calculate the execution time for the queries presented in Table 3.

Calculation of v	Average run times (s)
v = ??	100000.2 s
v = ??	800000.1 s
v = ??	8450000 s

Table 4: *Algorithm* name execution times *(Please write the name of the algorithm, e.g. DFS, BFS, A*)* for each of the three calculator paths between EAFIT and Universidad Nacional.

6. CONCLUSIONS

Explain the results obtained. Are the paths significantly different? How useful is this for the city? Are the runtimes reasonable to use this implementation in a real situation? Which path would you recommend for a mobile or web application?

6.1 Future work

Answer, what would you like to improve in the future? How would you like to improve your algorithm and its application? Will you continue this project working on optimization? Statistics? Web development? Machine learning? Virtual reality? How?

ACKNOWLEDGEMENTS

Identify the type of thank you you wish to write: to a person or to an institution. Keep the following guidelines in mind: 1. The professor's name is not mentioned because he or she is an author. 2. You should not mention the authors of articles that you have not contacted. 3. You should mention students, teachers of other courses who have helped you.
By way of example: This research has been supported/partially supported by [Name of Foundation, Donor].
We are grateful for help with [particular technique, methodology] to [First name Last name, position, name of institution] for comments that greatly improved this manuscript.
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