STATISTICAL STUDY WITH PLANNING ROUTES TO AVOID SEXUAL HARASSMENT IN MEDELLÍN.

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ABSTRACT

The following problem can be explained by showing the statistics and frequent cases in the social situation that resides on the constant and repeated sexual harassment given on streets, houses, schools, public transport, and places in general. The problem's relevance and importance can be seen on the fact that the kind of moments related to sexual harassment are way to usual or common in Medellín, along with the fact that not much attention is given to this problem. Now, if we talk about the related problems, it can be showed with systems like the ones to ride through streets and avenues avoiding traffic accidents and traffic in cities; or projects like the one in London that is used to calculate heat on the city and search for possible terrorist attacks.

Keywords

Constrained shortest path, street sexual harassment, secure-path identification, crime prevention.

1. INTRODUCTION

The motivation on this project resides on the fact that it was found very important to help people to search or have routes that can provides them with a path to wherever they may want to go, that doesn't make them handle with way too much sexual harassment but at the same time doesn´t make them go through way to long road.

If we're going to talk about history about this problem or passed things about this kind of problems, there´s an article named: 'The risk you run' talking about how those women suffered of verbal abuse, threats of sexual violence and discrimination during the wave of anti-government protests that has been spreading through Colombia since April 28.

1.1. Problem

The main problem it's based on an idea to calculate the risk to be sexual harassed and avoid that kind of situation the most while looking for the most short or fastest path to a place having in mind the most important thing: not exceeding certain amount of sexual harassment. This problem has a huge impact on the society because it´s important for people to understand that sexual harassment it's not normal and it doesn't have to happen to them; they must feel safe while they're going somewhere. We can conclude that is important the solution of this kind of problems, it's important to make people see that they can be secure and go safe to places.

1.2 Solution

In this semester we are using Dijkstra, along with a dictionary in pandas and polyline to graphic the path. We choose Dijkstra because it has shortest times, some of the other libraries we saw are slower. Also, because we already have used Dijkstra and finally because it uses recursion, something we have been seeing thought this semester so I´ll help us to keep learning.

1.3 Article structure

In what follows, in Section 2, we present related work to the problem. Later, in Section 3, we present the data sets and methods used in this research. In Section 4, we present the algorithm design. After, in Section 5, we present the results. Finally, in Section 6, we discuss the results, and we propose some future work directions.

2. RELATED WORK

In what follows, we explain four related works to path finding to prevent street sexual harassment and crime in general.

2.1 Path-finding Algorithm for Maximizing On-time Arrival Probability.

- The problem they found it's given by the fact that lots of people are usually traveling somewhere to another through routes; but those people don´t know which path maximizes the probability of on-time arrival.
- The results of the study were given through a two-stage solution algorithm that: 1. Finds the upper and lower bound of on-time arrival estimated time. And 2. Tries to find the results to a the most reliable path through a multi-criteria label-setting approaching.
- They found an algorithm that has a remarkable computational advantage over others and efficiently determines the most reliable path to go from a place to other.

2.2 Finding Lonely Routes for Runners and Bikers.

- There´s problems with conservating personal health with COVID-19 going around the world and at the same time maintaining good physical and mental health through exercising.

- This problem was solved with the creation of an algorithm that allows the user to choose a start and some end point, and considerate the distance and popularity of paths and finds the most optimal one.
- They reached the conclusion that the things proposed by them provides the user to get a nice workout and at the same time minimize the probability to be exposed to others.

2.3 Real-Time Pathfinding in Multirobot Systems Including Obstacle Avoidance.

- The problem base resides in the idea of trying to approach to the solution of the path problem to make the robot get to the end, including obstacle avoidance in multirobot systems.
- It’s a multirobot system based on a few algorithms that have a real method for real-time pathfinding itself that uses a systematic design procedure for multirobot systems which includes the hierarchical coordinator and is based on the nonlinear con troll approach.
- They approached to demonstrate the efficiency of their real-time pathfinding by showing several cases of practical interest, like the interaction of stationary robots, a collision avoidance between three robots and the movement of robots avoiding obstacles of variable size.

2.4 Increase the Safety of Road Traffic Accidents by Applying Clustering.

- It was found as a problem the increase in the number of traffic accidents and an even more alarming trend the increasing of those accidents with catastrophic consequences of human life health.
- They used the implementation of advanced information systems in existing traffic environment, along with accident clusters, databases of traffic accident, modern ICT technologies, etc.
- The results they obtained were: the increase of road safety thanks to the development of intelligent transport systems as well as the application of information and communication technologies.

3. MATERIALS AND METHODS

In this section, we explain how data was collected and processed and, after, different constrained shortest-path algorithm alternatives to tackle street sexual-harassment.

3.1 Data Collection and Processing

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

For this project, we calculated the linear combination that captures the maximum variance between (i) the fraction of households that feel insecure and (ii) the fraction of households with income below one minimum wage. These data were obtained from the quality-of-life survey, Medellín, 2017. The linear combination was normalized, using the maximum and minimum, to obtain values between 0 to 1. The linear combination was obtained using principal components analysis. The risk of harassment is defined as one minus the normalized linear combination. Figure 1 presents the risk of harassment calculated. Map is available at GitHub[3].

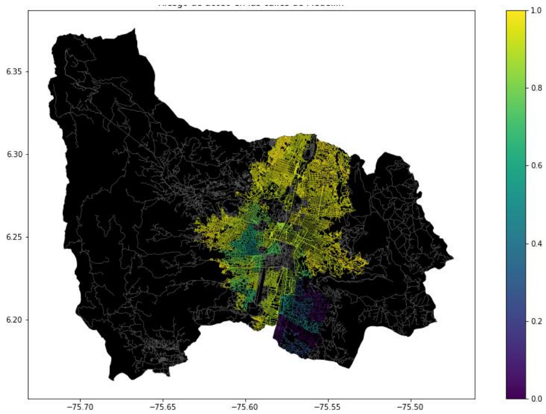


Figure 1. Risk of sexual harassment calculated as a lineal combination of the fraction of households that feel insecure and the fraction of households with income below one minimum wage, obtained from Life Quality Survey of Medellín, in 2017.

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

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

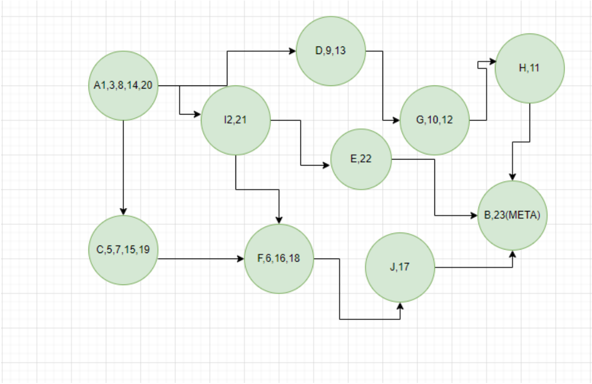
[3] https://github.com/mauriciotoro/ST0245Eafit/tree/master/proyecto/Datasets/

3.2 Constrained Shortest-Path Alternatives

In what follows, we present different algorithms used for constrained shortest path. *(In this semester, examples of such algorithms are DFS, BFS, a modified version of Dijkstra, a modified version of A*, among others).*

3.2.1 Depth first search

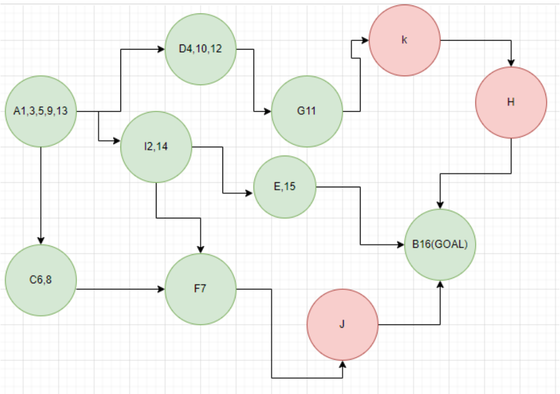
The way this algorithm works can be explained as if it were a blind man touching walls in a large room until he finds what he needs after walking so much. With this algorithm, you start with a random node and then randomly choose a neighbor and travel to it until you reach the desired node.



The letter means the name of the node and the numbers separated by commas are the steps that have been taken and indicate the order of the path that the algorithm would take.

3.2.2 Breadth first search

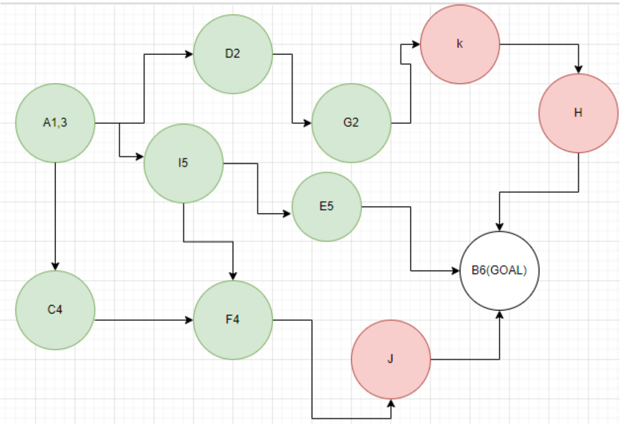
We can use the analogy of the previous algorithm to explain this algorithm as well. Now the blind man has consciousness and a walking stick which means that he can identify in a very short distance where he is standing, and he can remember where he has been and try to remember where he should go until he arrives thanks to his consciousness. This means that this algorithm first evaluates the nearest neighbors and then covers the neighbors of those nodes until reaching the destination one step at a time.



The letter means the name of the node and the numbers separated by commas are the steps that have been taken and indicate the order of the path that the algorithm would take. In addition, the red nodes are those that the algorithm has avoided.

3.2.3 Dijkstra

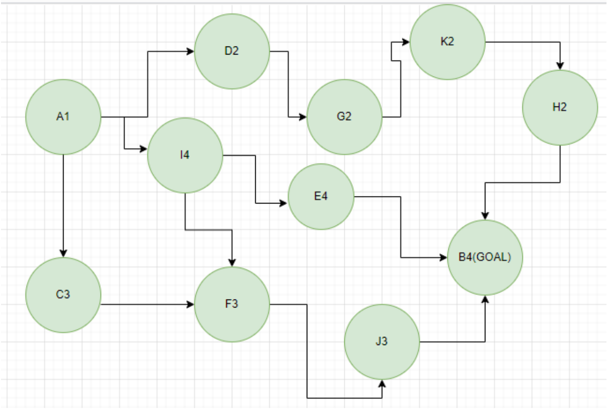
This algorithm can be seen as a completely healthy person with the mind of a curious child trying to explore the shortest paths. This means that what the algorithm does is investigate the shortest paths and then try them until it finds which one guides it to the goal. of the fourth algorithm



The letter means the name of the node and the numbers separated by commas are the steps that have been taken and indicate the order of the path that the algorithm would take. In addition, the nodes are those that the algorithm has avoided. And it can be added that the number of steps has been greatly reduced because the algorithm can evaluate more distance nodes.

3.2.4 A*

The operation of this algorithm it’s like the previous one with the only difference that the algorithm decides which path to expand based on both the length of the path and how far from the goal each path would be.



The algorithm goes through all the nodes and in one step per path and was able to successfully choose the shortest path.

4. ALGORITHM DESIGN AND IMPLEMENTATION

In what follows, we explain the data structures and the algorithms used in this work. The implementations of the data structures and algorithms are available at GitHub[4].

4.1 Data Structures

We are using a panda’s dictionary. We have a couple of keys or information (name, origin, destination, length, oneway, harassmentRisk, geometry) on files to organize, it has this data among with the organization of this data on maps to graphic it. Besides the teacher gave us some keys for coding that work well.

Keys	Values
Name	Calle 10
Origin	(-75.5728593, 6.2115169)
Destination Linepoint	(-75.5739582, 6.2081811)
Length	18.479
One Way	True
Harassment Risk	0.5265393126661695
Geometry	LINESTRING (-75.5660756 6.2089072, -75.56591880000001 6.2088496)

Data structure is presented in Figure 2.

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

4.2 Algorithms

In this work, we propose algorithms for the constrained shortest-path problem. The first algorithm calculates the shortest path without exceeding a weighted-average risk of harassment *r*. The second algorithm calculates the path with the lowest weighted-average risk of harassment without exceeding a distance *d*.

4.2.1 First algorithm

Dijkstra's algorithm starts with a node and analyzes the graph to find the shortest path between that node and all other nodes in the graph.

The algorithm keeps track of the currently known shortest distance from each node to the source node and updates these values when a shorter path is found.

The process continues until all nodes in the graph have been added to the path. This way, we have a path connecting the source node to all other nodes and following the shortest path to each node. We use a library call network x to implement dijkstra´s algorithm. The root code is here (https://networkx.guide/algorithms/shortest-path/dijkstra/)Algorithm is exemplified in Figure 3.

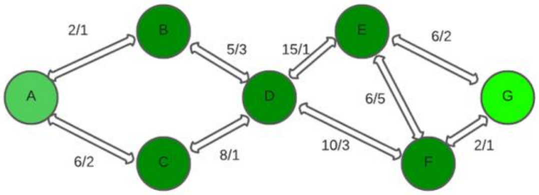


Figure 3: Solving the constrained shortest-path problem with Dijkstra.

4.2.2 Second algorithm

The only difference is that we considered the multiplication of two weights (shortest distance and risk of harassment) so that the algorithm could identify the necessary parameters to find the ideal path as in the previous case.

[4] http://www.github.com/ LauZar12/proyecto/

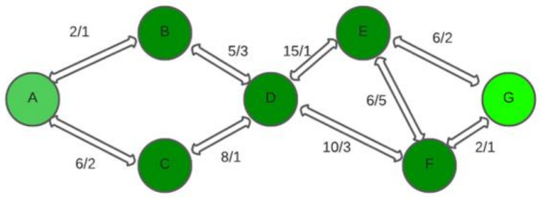


Figure 4: Solving the constrained shortest-path problem with Dijkstra.

4.4 Complexity analysis of the algorithms

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

Algorithm	Time Complexity
DIJKSTRA WITH MODIFIED WEIGHTS	O(V^2)

Table 1: *This is the time complexity of our algorithm in this case dijkstra . The number of vertex on the graph is V*

Data Structure	Memory Complexity
PANDA’S DICTIONARY	O(n)

Table 2: Complexity defined in the dictionary. Where n are the keys of the related values*)*.

4.5 Design criteria of the algorithm

Dijkstra’s algorithm was designed to be more efficient in all respects than other algorithms such as dfs and bfs. We implement it because this algorithm allows us to work with the data in a less complicated and faster way .For example, to find the distances in the shortest paths edge weight attributes must be numerical so the distances are calculated as sums of weighted edges traversed .In addition, its complexity in the worst case seemed better to us than the other algorithms since its composition makes it handle simplicity and optimization of resources.

5. RESULTS

In this section, we present some quantitative results on the shortest path and the path with lowest risk.

5.1.1 Shortest-Path Results

In what follows, we present the results obtained for the shortest path due to new directions given in class harassment is not taken into account in Table 3.

Origin	Destination	Shortest Distance
Universidad EAFIT	Universidad de Medellín	6142 m
Universidad de Antioquia	Universidad Nacional	815 m
Universidad Nacional	Universidad Luis Amigó	1469 m

Table 3. Shortest distances

5.1.2 Lowest Harassment-Risk Results

In what follows, we present the results obtained for the path with lowest weighted-average harassment risk due to new directions given in class shortest path is not taken into account

Origin	Destination	Lowest Harassment
Universidad EAFIT	Universidad de Medellín	0.642
Universidad de Antioquia	Universidad Nacional	0.605
Universidad Nacional	Universidad Luis Amigó	0.599

Table 4. Lowest weighted-average harassment risk.

5.2 Algorithm Execution-Time

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

Compute execution time for the queries presented in Table 3. Report average execution times.

	Average execution times (s)
Universidad EAFIT to Universidad de Medellín	13,5 s
Universidad de Antioquia to Universidad Nacional	11.5 s
Universidad Nacional to Universidad Luis Amigó	12.49 s

Table 5: Execution times of Dijkstra for the queries presented in Table 3.

6. CONCLUSIONS:

- The program is very useful, due to its execution times of maximum 15 seconds it can be perfectly used in everyday life.
- During the development of the project we found in the csv NaNs that incurred in the harassment map giving extraordinarily incoherent routes and very late we realized that. Which leaves us as a conclusion that preferably for this type of project you should have resources to carry out your own measurement or before starting to work do an optimization of the .csv
- This project is very useful for the city since it allows people to choose which routes to take to avoid insecurity and harassment.

6.1 Future work

We would love to continue with this project in the future, clearly the first thing we would do would be to transfer it to the web environment, then we would turn it into something bigger, multi-platform type that not only allows for paths that take harassment into account, but also construction works, marginal places, places with violence and also draw paths for all passers-by, from cyclists to pedestrians

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