RESEARCH OF AN ALGORITHM ABLE TO PREVENT THE STREET HARASSMENT IN MEDELLIN

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ABSTRACT

Sexual harassment is a problem women experience in their daily life, this can include verbal and non-verbal abuse, and can take place everywhere, in Medellin "over 61,5% of women for certain neighborhoods manifest that they felt insecure to move around the city after 7pm" (Gutierrez, 2019) [10]. The importance of this problem is that the fear women experienced of sexual harassment, make them take a certain behvaior to prevent walking and passing by those places they're more likely to be abuse, which affect their life opportunities and freedoms of mobility. Due to this, in order to make women feel more safe, this project and research is about using an algorithm that is able to calculate different paths depending on the distance and the sexual harassment of Medellin streets.

Key words

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

1. INTRODUCTION

Everyday sexism might not be noticed by perpetrators or bystanders, but it can wear women down and is linked to poorer physical and mental health. They often experience sexual objectification, such as street harassment and unwanted touching. Rules and laws against gender discrimination do not prevent people with sexist attitudes from treating others unfairly in everyday interactions, so we decided to help them raise their incentive and avoid being treated like that everyday. That is our motivation and what our program does. It helps people, especially women, to recognize their value and make the best decisions in their daily path, taking into account the distance and the risk of each street to provide the best path to womens, because this is our main reason in the project.

1.1. The problem

The problem is to find an algorithm that calculate the three different paths considering the distance and the sexual harasssment in Medellin streets, always trying to find paths that have a short distance and a small risk of sexual harassment, in order to produce a path safe for women in their daily mobility around the city. The impact this problem has on society is to create an algorithm that calculates and identifies safe routes to provide women security during their travel around the city, which makes women able to reach life opportunities they are missing because of their restricted mobility. It's useful to solve this problem to gather information about the most common places women are victims of sexual harassment, this helps to find more solutions to solve this global problematic.

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 How the fear of sexual harassment impacts on safety perceptions in transit environment

This research is the study of the fear of sexual harassment of female university students and how it impacts in the transit environment, which shows that women tend to prevent certain places and hours of the day that make them feel fear and insecure, causing them to have less life opportunities and be in a constant threat of their integrity during their travels. This research is based on samples of university students in different cities on six continents. [1]. (Ceccato and Loukaitou-Sideris, 2021).

2.2 Sexual harassment in Bogotá's public transport

This research is about the study of sexual harassment in public transport like buses, bus stops, etc. in Bogotá, and how it impacts women's behavior toward their mobility around the city, how they avoid certain paths and places in order to prevent being sexualize, which restrict their right of freedom of expression and mobility. In addition, this research presents information about the fear women have to complain about this problematic, because authorities and policies in Bogotá have many failures, and how places with a lower rate of authority presence increases those demonstrations of sexual harassment over women[2]. (Quiñones, 2019).

2.3 Empowering Women through a Privacy-Aware Location Based Application

A research made in Bangladesh by the Dept. of Computer Science and Engineering of Dhaka University [3], was created with the aim of empowering womens and also protecting their identities, preventing them from feeling shame or fear to inform these situations, taking into account all the social reality that this country lives related with the rights and perception of women. SafeStreet provides many tools that allow them to report in live time where they are suffering harassment, and also helping others to avoid those places where the harassment is high at determined hours.

In the same way, this provides the safest route that a woman can choose depending on all these factors and being friendly in their use with the users, making it easy to use all the tools that has. The research does not provide detailed information of how the algorithm works, however, they explained all the software processes followed to develop this App [3]. (Ali et al., 2015).

2.4 Safe street rangers: crowdsourcing approach for monitoring and reporting street safety

The faculty of engineering at the Chiang Mai University, allocated in Thailand; reports a mechanism that tries to monitor street safety. It allows the users around a certain zone to report different conditions about the streets and their status focusing on things like the brightness, traffic signs, solitariness and past accidents. The program system is based on a data server, a mobile and a web version of the app. Each report would be verified by the admin users to prove the value of the report.

This work could help us think outside our main goal and find more ways to deduce the factor that composes the problem we´re trying to solve. In fact, there are some limitations that we can attempt to expand with our own system and research [7]. (Sutigoolabud et al., 2019).

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 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] .

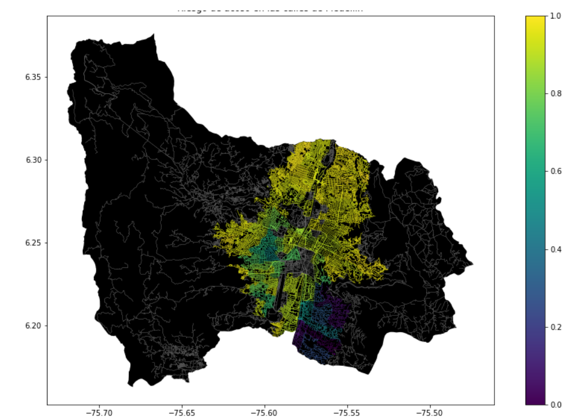

Figure 1. Risk of sexual harassment calculated as a linear combination of the fraction of households that feel unsafe and the fraction of households with income below one minimum wage, obtained from the 2017 Medellín Quality of Life Survey.

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.

3.2.1 Bresenham's Line Algorithm

"Bresenham Line Algorithm is an optimistic & incremental scan conversion Line Drawing Algorithm which calculates all intermediate points over the interval between start and end points, implemented entirely with integer numbers and the integer arithmetic. It only uses addition and subtraction and avoids heavy operations like multiplication and division." (Bresenham Line Drawing Algorithm, 2022). The complexity of this algorithm is O(n) in the worst, average, and best case time, and it's O(1) in the space complexity.

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

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

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

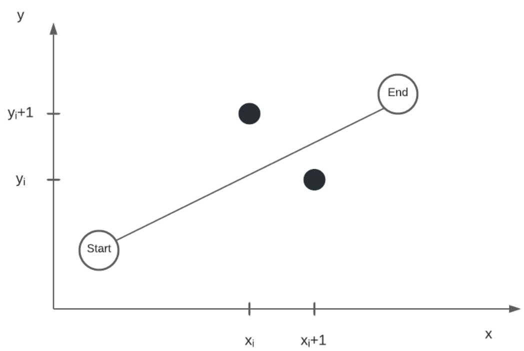

Figure 2. Representation of Bresenham's Line Algorithm [4].

3.2.2 Dijsktra's Algorithm

Dijkstra's Algorithm allows us to find the shortest path between any two vertices of a graph. The main base of this algorithm is that any subpath between two vertices A-D is also the shortest path between this subpath B-D. The algorithm searches for the next best solution hoping that in the end this will be the best solution of all possible solutions, because the algorithm overestimates the distance of each vertex from the start point [5].

All starts with a weighted graph, where you choose a starting vertex and an aim vertex, and the rest of vertices have infinity values. The algorithm starts to go to each vertex and updates its path length according to the shortest length between adjacent vertices.

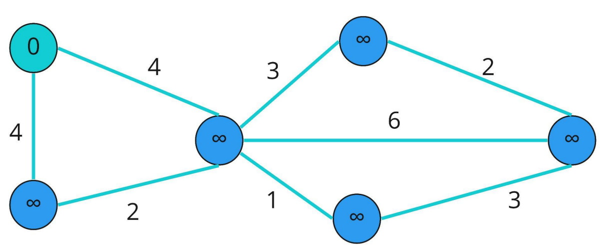

Figure 3. Representation of the starting phase of Dijkstra's Algorithm.

The algorithm avoids updating paths that were already visited. After each iteration, the algorithm picks the unvisited vertex with the least path length. All this process finishes when all the vertices have been visited.

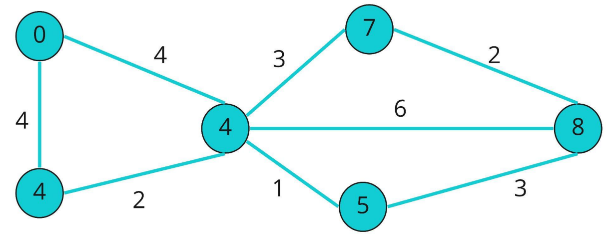

Figure 4. Representation of the final phase of Dijkstra's Algorithm where the shortest path is found.

The time complexity is O(E Log V), where E is the number of edges and V is the number of vertices. The space complexity is O(V) [6].

Dijkstra's Algorithm helps us to find the shortest path, the location in a map and is even used in social networking applications to create effective connections between users [6].

3.2.3 Floyd-Warshall Algorithm

Floyd-Warshall Algorithm is an algorithm that finds the shortest path between all the pairs of vertices in a weighted graph. This algorithm does not work where the sum of the edges in a cycle is negative (negative cycles). Only works with directed and undirected weighted cycles [8].

A weighted graph has in each edge a numerical value associated with it.

The algorithm starts with a matrix of $n * n$ dimensions, where n is the number of vertices. All the positions inside the matrix are indexed according to a row and a column position. The values in each position are the distances between i and j path, if they do not have a path, the cell is left as infinity.

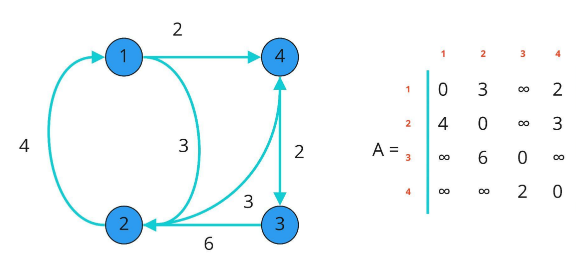

Figure 5. Representation of creation first matrix Floyd-Warshall Algorithm.

Then, we create a second matrix with this first matrix created. We update the solution matrix by considering all vertices as an intermediate vertex. Picking all vertices one by one and updating their value as an intermediate vertex in the shortest path. As doing this, we are considering vertices $0, 1, 2, \ldots, k - 1$ as intermediate vertices.

In each pair, there are two possible cases, 1) k is not an intermediate vertex in the path, so we keep the value as it was. 2) k is an intermediate vertex, so we update the value of A[i][j] as A[i][k] + A[k][j] if A[i][j] > A[i][k] + A[k][j].

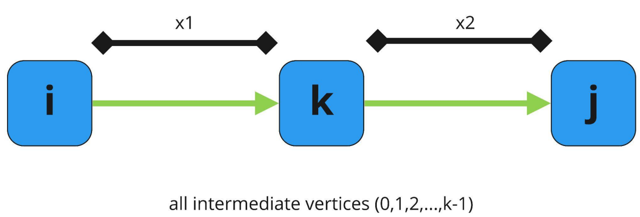

Figure 6. Representation of all the substructures created by the all-pairs shortest path.

The algorithm has three loops, each loop has a complexity constant. So, the time complexity is $O(n^3)$. The space complexity is $O(n^2)$[8][9].

3.2.4 Algorithm A*

This algorithm is a graph traversal and path search algorithm. What it does is help us find the quickest way to a goal overpassing some obstacles. Their mechanism consists in picking the node with the lowest "f" parameter, which is a value resultanting of the sum of other two parameters, 'g' and 'h'. 'g' is the movement cost from the starting point to a given cell, and 'h' is the movement cost from the current location to the destination point.

The complexity of this algorithm depends on the heuristic. In the worst case of an unbounded search space, the number of nodes expanded is exponential in the depth of the solution (the shortest path) d: O(bd), where b is the branching factor (the average number of successors per state) [11].

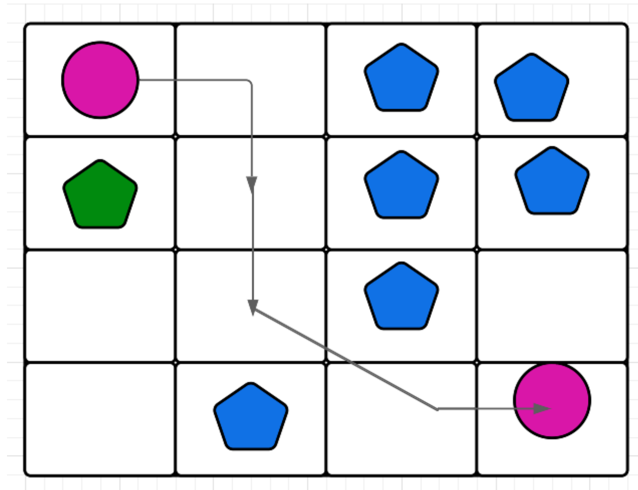

Figure 7. Visual description of the mechanic avoiding obstacles.

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