# SAFEST PATH FINDING ALGORITHMS ON STREET HARASSMENT PREVENTION

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## ABSTRACT

Street harassment is one of the main reasons why not everyone feels comfortable going out on the street, it is a form of intimidation by a stranger that occurs in public spaces. The way it has become normalized is frightening once you realize that it is expected when going out, especially by women. Causing fear of using public transportation or being alone outside, in addition to anxiety and stress affecting their lives.

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

## 1. INTRODUCTION

The present work aims to generate an alternative solution to the current problem of street harassment, a form of sexual harassment that generally occurs in a public space and in which women are mainly affected. According to Billi [1] (2015), "street sexual harassment corresponds to any practice with an explicit or implicit sexual connotation, which comes from a stranger [...] and has the potential to cause discomfort in the harassed person". In Medellín, it is a situation that puts the lives of the victims at risk and that threatens their dignity as people. In addition, it is an issue that also mentally affects the victims and makes them go to the streets in fear or feel vulnerable [2] to harassers. From the foregoing lies the importance of understanding this problem as a systematic issue that must be studied and addressed rigorously, seeking to reduce the cases of street sexual harassment that occur so frequently.

According to Daniela Maturana [3], former councilor of Medellín, currently there are not enough tools or ways of attention to report street harassment, that is why the following report seeks to generate a resource that allows promoting the safety and protection of affected people through the implementation of a safe path algorithm.

### 1.1. Problem

The main problem around the development of this work is to find an efficient way to develop an algorithm that shows the user the safest route and at the same time the most comfortable to arrive, that is, the route that offers a path with the least amount of harassment and at the same time, in terms of distance, it is not so long for the person who wants to get from one place to another. Therefore, the real challenge is to offer a balance between both needs in three different ways and, likewise, to determine the calculation of the risk of harassment in a coherent manner according to the map of the city of Medellín.

### 1.3 Article structure

In what follows, in Section 2, we present relatedwork 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

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

### 2.1 Siempre Seguras: diagnóstico y prevención del acoso callejero

“Siempre Seguras” es una iniciativa de diagnóstico y prevención del acoso callejero [4] que busca generar un mapeo del acoso sexual callejero en México, por medio de una app cuya funcionalidad se basa en identificar las zonas donde más se concentra el acoso. Este mapa, creado en la ciudad de Querétaro, recoge datos estadísticos del acoso callejero y los despliega en un mapa de focos rojos [5] . Los datos son reportados por usuarios desde la plataforma de Twitter por medio de la cuenta @siempre_seguras y son procesados mediante algoritmos apoyados en inteligencia artificial que reconocen el lenguaje natural para identificar ubicaciones, percepciones, horarios, etc. Uno de los hallazgos que se pudo obtener gracias a este proyecto fue el hecho de que las mujeres padecen más acoso en el transporte público [5].

### 2.2 Safecity: una app que busca crear espacios más seguros

Safecity es una plataforma cuyo objetivo es empoderar a las personas, comunidades, policía y las gobernaciones municipales/departamentales a crear espacios públicos y privados más seguros para todos. Por medio de un algoritmo que recolecta reportes anónimos de violencia sexual [8], Safecity analiza estos testimonios identificando patrones y perspectivas clave, generando un mapa de focos de calor con predicciones sobre las estadísticas de crimen cercanas a la ubicación del usuario [7]. Dentro de los hallazgos más importantes se pudo reconocer que los usuarios, como es el caso de los policías, se sintieron cómodos al usar esta aplicación y poder reportar casos de delincuencia. Esta iniciativa ha ganado gran variedad de premios desde su lanzamiento como el "Winner of the World Justice Forum's Equal Rights and Non-Discrimination Award" en 2022 [6].

### 2.3 Harrasmap: Uso de datos colaborativos para mapear el acoso sexual en Egipto

Harrasmap es una plataforma digital y en línea que propone el uso de las tecnologías de la información espacial para cartografiar lugares donde se han presentado incidentes de acoso callejero, para tal propósito la plataforma se basa en el "crowdmapping", una forma de mapeo donde los datos que entran provienen de las multitudes. Las víctimas pueden reportar anónimamente lo que ocurrió y dónde ocurrió, Posteriormente a través de un algoritmo estos reportes son categorizados según el tipo de acoso que tratan, para después poder ser visualizados en un mapa en línea. esta plataforma ha dejado un impacto positivo en Egipto, país donde opera actualmente gracias a la atención que atrajo está provocando un cambio en la actitud de la sociedad hacia este problema, tal ha sido este impacto, que antes de su existencia el acoso callejero no era considerado ilegal, actualmente en Egipto ya es considerado ilegal e implica consecuencias.[18]

### 2.4 "Safe and the City": una empresa social que busca diseñar ciudades más inteligentes y seguras

"Safe & the City" es una aplicación móvil que muestra las peores zonas de Londres en cuanto a acoso callejero, para que hombres y mujeres puedan planificar sus rutas en torno a él. El algoritmo utilizado por la plataforma está diseñado para crear rutas personalizadas para caminar evitando las zonas y lugares con elevado número de incidentes de acoso callejero denunciados también se basan en datos sobre delincuencia, la cantidad de alumbrado de una calle, el número de comercios abiertos y las denuncias de acoso sexual en la calle realizadas por el público. Las personas pueden denunciar de forma anónima si han sufrido acoso y luego el mapa se actualiza para que otras personas lo vean. Además de contar con la opción de alertar a las autoridades en caso de encontrarse en una situación peligrosa. La plataforma ha ayudado a sensibilizar a la población acerca de esta problemática además de darles a sus usuarios una herramienta que les brinde seguridad y mayor confianza al momento de salir a la calle.[16]

## 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. Thisdata wasobtained 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 com-ponents 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 on Github[3].

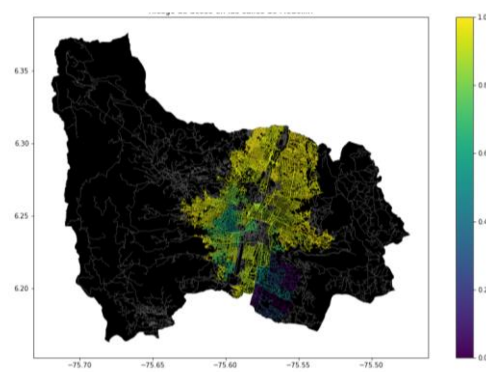


**Figure 1.** Risk of sexual harassment calculated as a linear combination of thefraction of households that feel insecure and the fraction of households with income below one minimum wage, obtained from Medellin's 2017 Life Quality Survey.

### 3.2 Constrained Shortest-Path Alternatives

In what follows, we present different algorithms used for constrained shortest path.

#### 3.2.1 Dijkstra's algorithm

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

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

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

Dijkstra's algorithm was conceived in 1956 and first published in 1959 by Edsger Dijkstra, a computer scientist from the Netherlands. The main component of this algorithm is that its goal is to find the shortest distances from a source vertex to any other node of a specific network [9]. This network is known as a graph, and refers to the unit made up of objects called nodes or vertices that are linked by edges or arcs and represent binary relationships between the elements of a certain set [10]. The edges of the graph must express positive values since this algorithm does not work for negative values.

The operation of this algorithm is based on iterations, so as the size of the network increases, its development could be difficult compared to other optimization methods within mathematical computational sciences. To start working with the algorithm, it is necessary to indicate the graph to be implemented with its source or initial node joined by subnodes whose links contain "weights" or values [11] that allow calculating the shortest path, as shown in the following graphic :

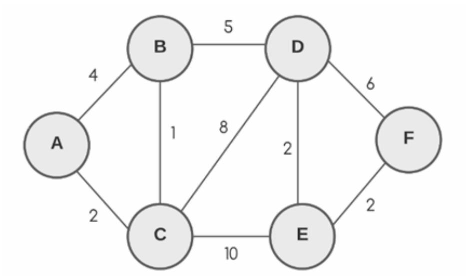


**Figure 1.** Graph example of Dijkstra's algorithm

In this case, the origin node will be symbolized as "A". Starting from this initial node, the vertices adjacent to the origin, the closest ones, which in this case would be "B" and "C", will be evaluated. Successively, the other subnodes continue to be evaluated in order in a way that in each evaluation the differences in weights of the edges that link the nodes are taken into account and following the assignment of labels that correspond to the accumulated value of the size of the arches or edges and the closest origin of the route. These tags can be temporary or permanent/definitive and vary according to the complexity of finding the shortest path [17]. For the cited case, the ideal is to calculate the shortest path between "A" and "F".

In each step of the algorithm, as previously mentioned, the vertex closest to the origin, which has not yet been visited, is taken into account. That it has not been visited means that it has not been evaluated, and, therefore, this node has the smallest distance calculated from the initial node. Taking into account the above, all the minimum paths are recalculated, taking the node that has not been visited as the intermediate path, until reaching "F" [17].

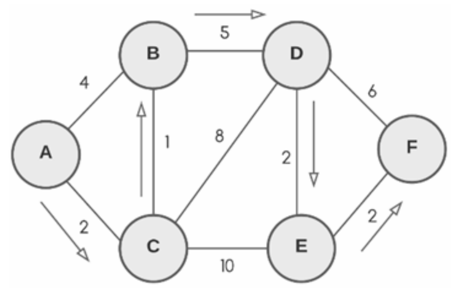


**Figure 2.** Representation of the search for the shortest path from "A" to "F" using Dijkstra's algorithm.

### 3.2.2 A* Algorithm (A Star)

The A search algorithm, also called A asterisk or A star, dates back to 1968 and was proposed by Peter E. Hart, Bertram Raphael and Nils John Nilsson. This algorithm is born according to the heuristic model proposed by Nilsson with the purpose of improving Dijkstra's algorithm so that this new version generates greater performance optimization within its operation, taking into account that it seeks to find the path of lowest cost between an initial point (as is the case of the nodes or vertices within the Dijkstra method) and a goal or objective [19]. Within the search parameters, there is a better understanding when deciding which path to follow since certain possibilities to go through are ignored and emphasis is placed on those that can be taken more effectively to go through the graph. It is a simple algorithm that is usually used in video games, which does not require much processing or memory consumption. The following graph shows an example of a first moment that occurs in the algorithm:

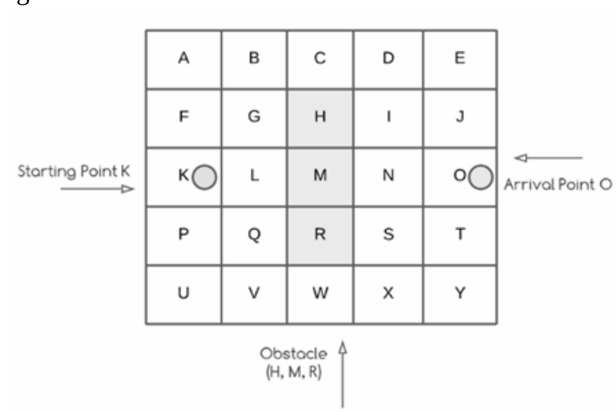

**Figure 3.** Example of a first moment of algorithm A*

Where K will be the initial point, simulating, for example, an individual who wants to reach O, his point of arrival, and H, M and R being an obstacle between both points. The algorithm consists of a series of steps that start with a chosen node (in this case K). The cost the initial node will have will generally be 0. After having carried out a heuristic evaluation in which the estimated cost from the beginning to the final goal is calculated, the algorithm begins to evaluate the cost of its neighboring nodes from position K and determines what position to follow [15]. Consecutively, when finding the ideal position, the current position that was previously defined by K will become the ideal position and now from this new position, the following best position is evaluated to continue evaluating the neighboring nodes until reaching the goal O.

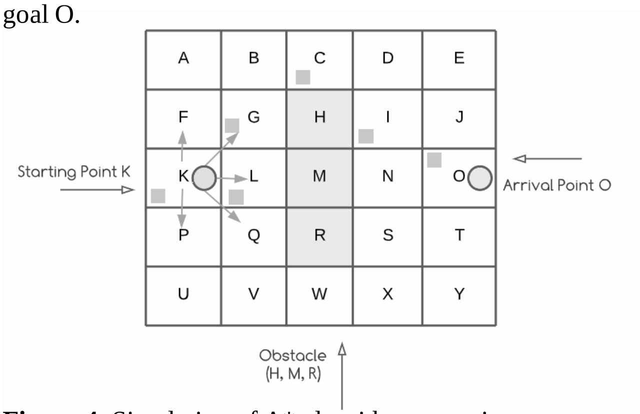


**Figure 4.** Simulation of A* algorithm operation

### 3.2.3 Floyd-Warshall Algorithm

The Floyd-Warshall, is an algorithm designed to find the shortest path between the pairs of vertices in a graph that has a numerical value associated with each edge in it.[13] The logarithm works by combining the solutions to the smaller subproblems allowing it to solve the larger starting problem. Therefore to find the quickest route between A and C it compares the quickest route between A and C ever discovered or the quickest route between A and B and B to C[14]. As a first step, we initialize the solution matrix same as the input graph matrix. The solution matrix is then updated by treating each vertex as an intermediate vertex. The plan is to select each vertex one at a time and update any shortest paths that use the selected vertex as an intermediate vertex. Vertices 0, 1, 2,.., k-1 are already taken into consideration when vertex number k is chosen as an intermediate vertex. There are two potential outcomes for every pair of source and destination vertices (i, j). 1) In the shortest path from I to j, k is not an intermediate vertex. We maintain the current dist[i][j] value. 2) The shortest path from I to j passes through the intermediate vertex k. If dist[i][j] > dist[i][k] + dist[k][j], we update the value of dist[i][j] as dist[i][k] + dist[k][j].[12]

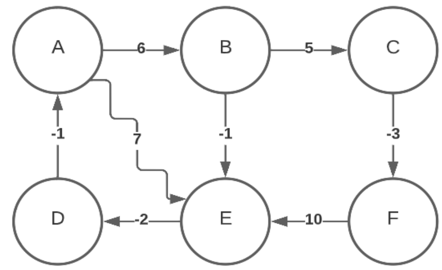


**Figure 5.** Graph example of Floyd-Warshall algorithm

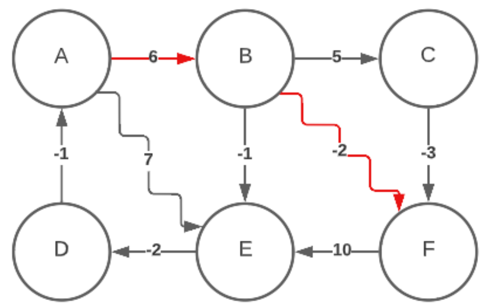


**Figure 6.** Representation of the search for the shortest path from "A" to "F" using Floyd-Warshall algorithm.

### 3.2.4 DFS

The algorithm known as "depth-first search" is used to navigate through tree or graph data structures. The algorithm begins at the root node and proceeds to examine each branch as far as it can go before backtracking. it does so by marking the node and moving to the adjacent unmarked node, repeating this process until there is no unmarked adjacent node, then it backtracks while looking for other unmarked node, and if it finds one it explores along the found branch, and ends by printing the nodes along the path. [20]

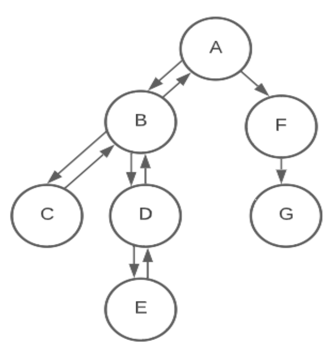

**Figure 7.** Representation of the search for path from “A” to “G” using Floyd-Warshall algorithm.

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