

# Stride Smart - Promoting Sustainable and Accessible Urban Mobility

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## Abstract

This paper presents the development of *Stride Smart*, a web-based navigation system that provides optimized walking routes based on multiple criteria, such as thermal comfort, accessibility for wheelchair users, air quality, green spaces, safety, and touristic attractions.

## CCS Concepts

• **Information systems** → **Location based services**; **Geographic information systems**; • **Theory of computation** → *Shortest paths*; *Dynamic graph algorithms*; • **Computing methodologies** → *Heuristic function construction*; • **Human-centered computing** → *Accessibility systems and tools*; **Geographic visualization**; *Information visualization*; • **Mathematics of computing** → **Graph algorithms**.

## Keywords

Route planning, Urban mobility, Accessibility, Personalized navigation, Location services, Multi-criteria decision-making

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## 1 Introduction

Stride Smart was created during the *M100 Cities hackathon: InnovateTech for Climate* with the objective to encourage pedestrian mobility as an alternative to vehicular transport by offering personalized routes.

In order to identify key community needs, we made a survey that revealed that clean air, more green spaces, and the avoidance of excessive heat would enhance walking experiences. Respondents also noted the limitations of existing navigation apps, such as lack of real-time data, pollution information, and diverse route options. Consequently, Stride Smart allows users to customize routes based on *Clean Air*, *Nature Path*, *Thermal Comfort*, *Discover and Explore* and *Safety Trail* preferences.

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Recognizing the importance of universal access, Stride Smart includes *Accessible Adventure* to provide routes suitable for wheelchair users, addressing issues like steep slopes and narrow sidewalks. Furthermore, the *Navigator's Reports* feature enables users to share real-time accessibility updates and other encountered issues.

## 2 Data Collection

The data based on which our routes are calculated were collected by a team of students from Geography and Urban Planning. It was provided in different formats, such as raster maps representing thermal comfort insolation maps and accessible region delimitation and GeoJSON files contouring tree-covered areas.

These different data types were converted into numerical values that could be manipulated within the program. This was possible using Python scripts that enabled the analysis and classification of the rasters' pixel values, and the computation of the areas of different geometrical types representing green spaces. Database storage was granted by the PostGIS extension and geometric data types available for PostgreSQL.

Furthermore, the system incorporates dynamic, real-time updated data facilitated by 32 air quality sensors in Cluj-Napoca. These sensors provide hourly updates, with data sourced from *Strop de Aer*, an air quality monitoring platform.

Data visualization on the map is possible through overlays.

## 3 Methodology

### 3.1 Algorithms

In order to provide the best directions, Stride Smart uses two AI-based algorithms that are also efficient in terms of time and space complexity: A\* search algorithm and Ant Colony Optimization.

For most of the route options (*Clean Air*, *Nature Path*, *Thermal Comfort*, *Safety Trail* and *Accessible Adventure*) and for combining criteria, a customized version of the A\* algorithm was employed, due to its efficiency compared to other algorithms. Although many competent path-finding algorithms can identify a solution, A\* often achieves this using less time, fewer computational resources, or both [3]. Studies indicate that A\* can demonstrate a general efficiency advantage of over 40% [1]. The edge weights of the underlying graph were modified to incorporate the attributes relevant to each criterion. Adjustable weighting coefficients were introduced to balance these factors against the overall distance to the destination.

Ant Colony Optimization was used for the *Discover& Explore* feature, in order to suggest a path between locations that the users adds to a bucket list. The algorithm uses 200 virtual ants that find the most optimal walking route in 10 iterations. The main advantages of this technique are self-organization, proficiency in solving optimization problems, and flexibility [2].

### 3.2 Implementation and Technologies

The programming languages used for developing the web system are Python for the backend, along with JavaScript, HTML and CSS for the frontend. By using Tailwind CSS, the design of Stride Smart was also made responsive for mobile devices.

In order to apply the path finding algorithms, the program uses a graph of the walking routes in Cluj-Napoca provided by *Open Street Map* through the *osmnx* Python library, where every intersection point is a node and every street is an edge.

The custom costs for the A\* algorithm are calculated differently for each route option. *Clean Air* considers PM2.5 and PM10 values from sensors, with each sensor's measurement applied to a 1-kilometer radius area. The *Nature Path* index takes into consideration the area of the green space traversed by the edge. This ensures that the algorithm will prefer roads located in big parks or tree-covered areas over streets that only have some trees on the sides. The value for *Accessible Adventure* states whether an edge is accessible or not based on the slope inclination, while the one for *Thermal Comfort* is computed based on insolation levels, taking into account the current season and time of the day.

For *Combined Routes*, the data were normalized using min-max scaling.

### 4 Testing

Stride Smart was tested by groups of individuals who interacted with the application and provided valuable feedback about the user experience, features and points of improvement. The favorite routes were *Nature Path* (22,5%), *Discover & Explore* (20,6%), and *Clean Air* (19,1%), indicating user interest in eco-friendly and exploratory walking options. Participants also highlighted the usefulness of data visualization through overlays. Suggestions included improving map legend readability and improving the map interaction experience.

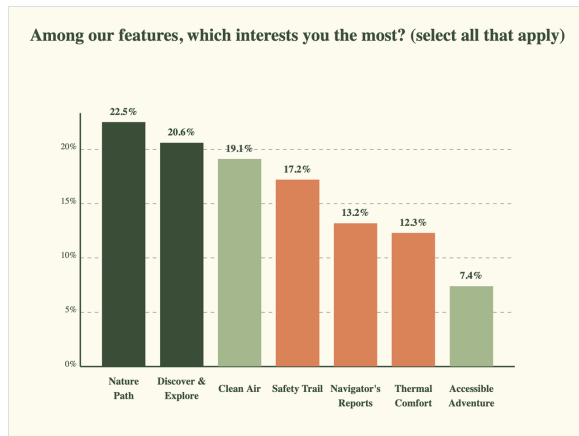


Figure 1: Survey Responses: Most Interesting Routes

### 5 Future development

The next improvements of Stride Smart will regard adding new functionalities, adapting the system for more cities, and refining

existent features for improving the user experience. The new functionalities should focus more on sustainability, for example adding information about the saved amount of CO2 after choosing walking over driving. Moreover, we aim to turn our responsive website into a mobile application available on Android and iOS and take into consideration the feedback received from the community.

### 6 Conclusions

This research presents a personalized, multi-criteria routing system designed to enhance pedestrian mobility by integrating diverse data into route planning. The integration of green indices, thermal comfort, and accessibility information promotes more sustainable and inclusive urban navigation.

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