Enhancing Food Access Through AI-Guided Infrastructure Improvement

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Purpose of the Project

- Provide an overview of transportation routing approaches
- Guide trainees in integrating realistic routing tools into the FEAST workflow
- Enable participants to independently run analyses and customize model inputs for food-access research
- Support the development of FEAST to better account for infrastructure conditions

Problem Statement

Food Accessibility

Source: Walmart Foundation

Source: World Economic Forum

Source: ABC News

Food Access

Who are low food access populations? How do governments support food entrepreneurs? ...

Civil Infrastructure

How to improve the infrastructure to enhance food security?

Extreme Weather

Where are food deserts under different weather conditions?

Existing vs. New Methods

ICICLE's FEAST Model

Census

Open Street Map

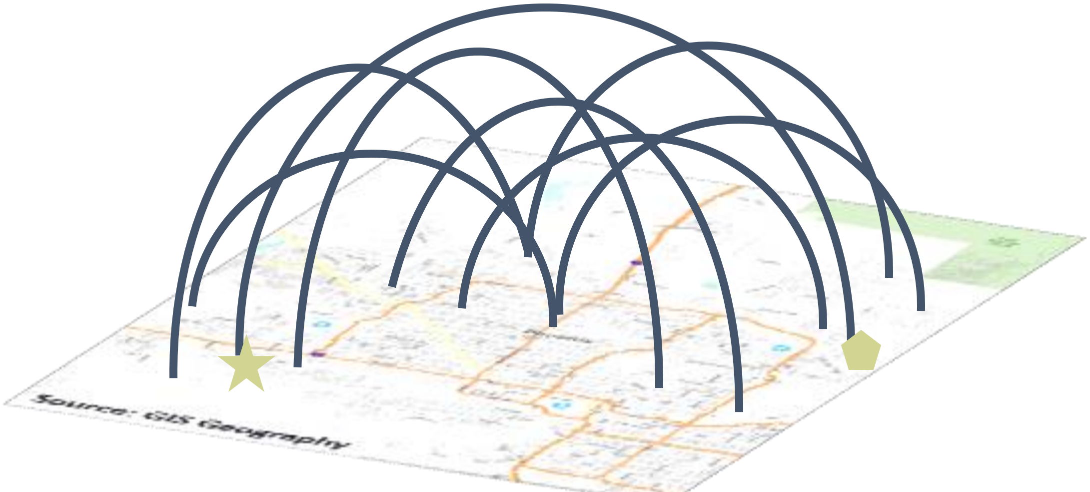
Google API

(1). Pre-processing

- Query and download data
- Household location from OSM
- Household features from census
- Store location and types
- Travel time as Euclidian distance
- Store data in PostgreSQL

(2). Initialization (Agent Generation)

- Load data from PostgreSQL
- Create store (location, type) and household (location, features) agents
- Set up spatial environments
- Set up scheduler



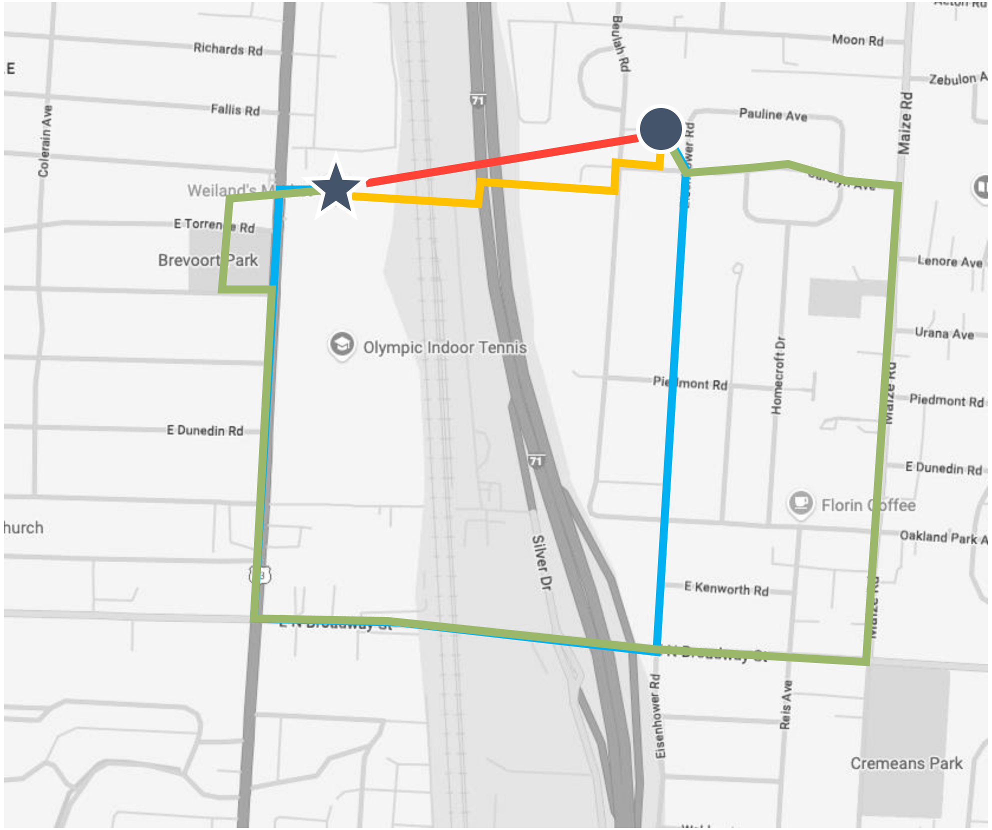
(3). Simulation

- Activate household agents
- Evaluate food access using MFAI
- Update agent states

(4). API Interaction

- Add/remove store
- Advance simulation step
- Get data

Trip Modelling 101



Euclidean Distance

$$d_E = \sqrt{(\Delta x)^2 + (\Delta y)^2}$$

Straight-line distance between two locations. but Ignores roads, buildings, rivers, and other barriers; not realistic for actual travel.

Manhattan Distance

$$d_M = |\Delta x| + |\Delta y|$$

The sum of horizontal and vertical distances, mimicking travel along a city grid. More realistic than Euclidean distance, but still not realistic in accounting for real-world infrastructure.

Shortest Travel Time

Calculates the fastest route using actual roads (for cars) and sidewalks (for walking)

Impedance-based Travel Time

Calculates the fastest route considering time and other factors (e.g., health, weather, etc.)

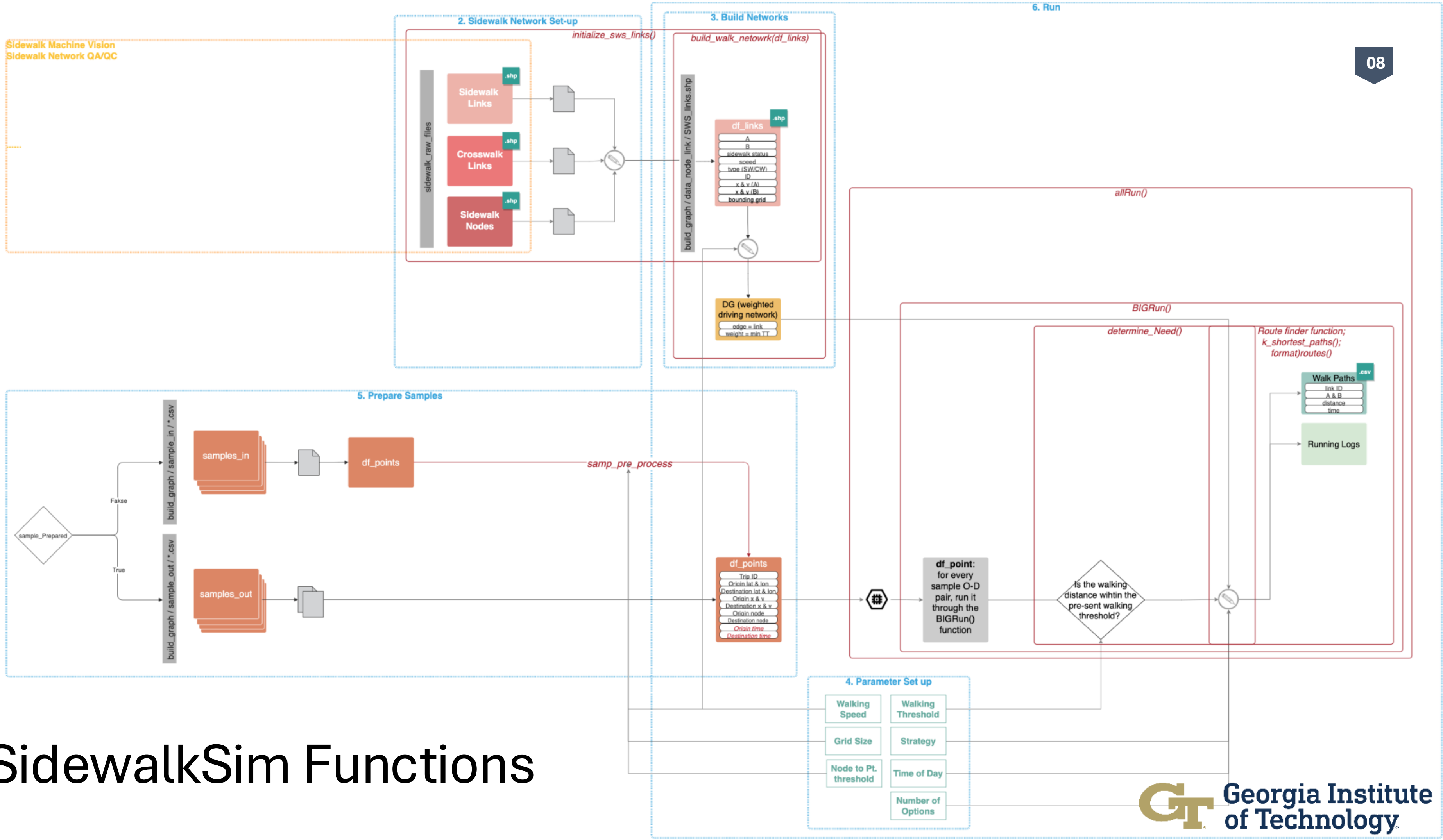
Sidewalk Simulator (SidewalkSim)

SidewalkSim is a pedestrian path routing tool within Georgia Tech's TransportationSim suite.

Shortest-path routing
Computes realistic travel times based on detailed pedestrian networks

Open & flexible
Fully open-source and easily modified for new applications

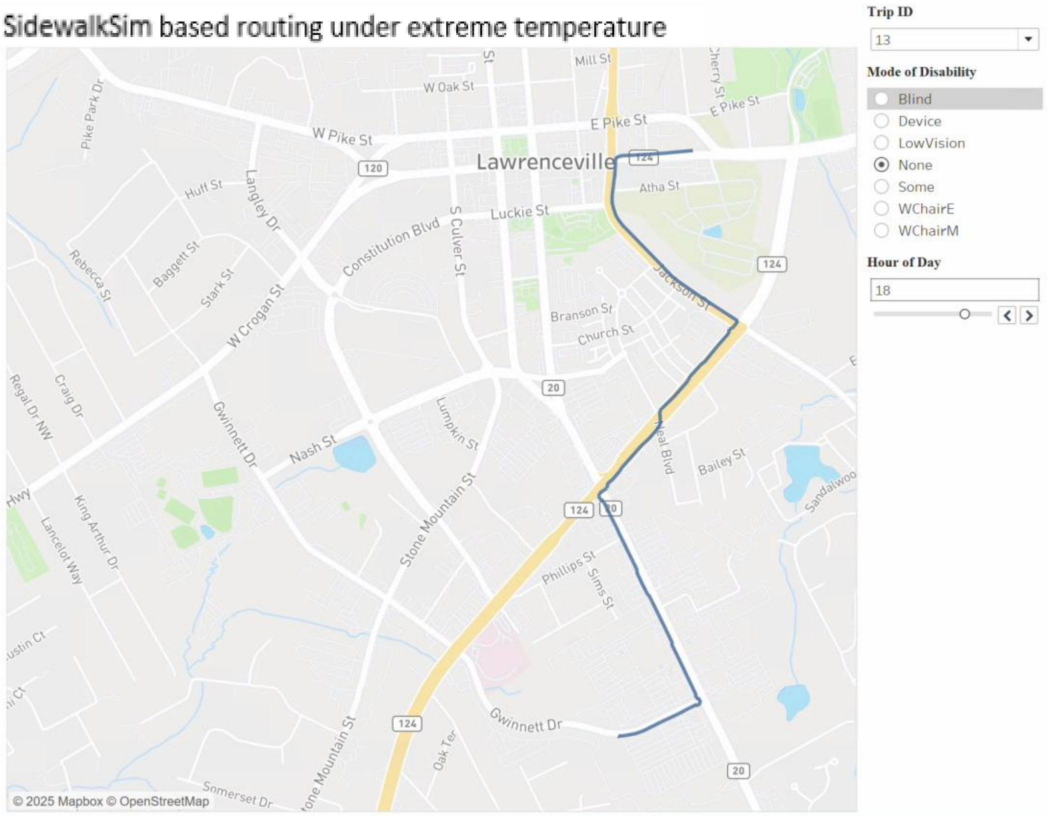
Custom cost functions
Integrates factors like health, heat, and safety into routing

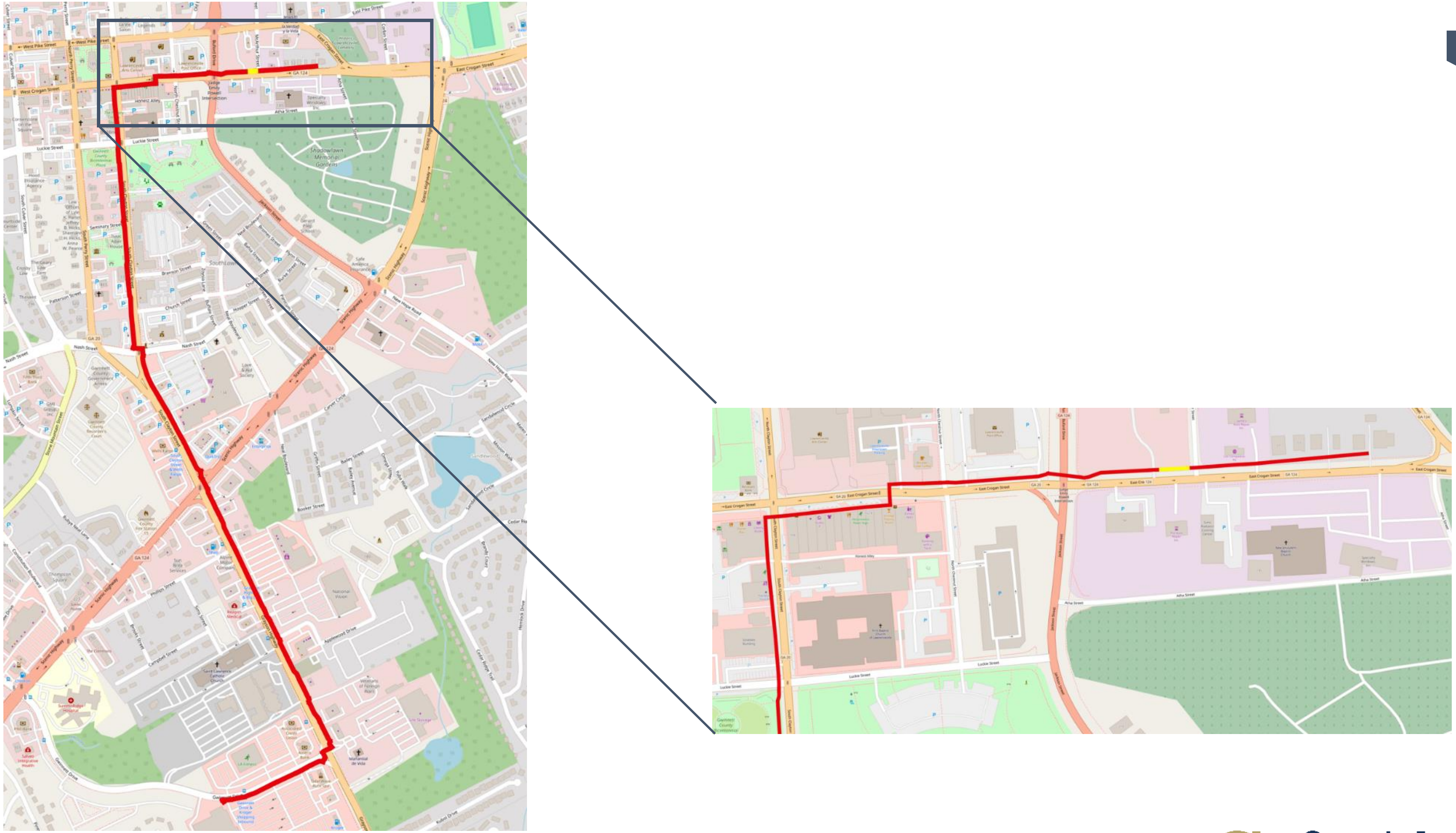


SidewalkSim Functions

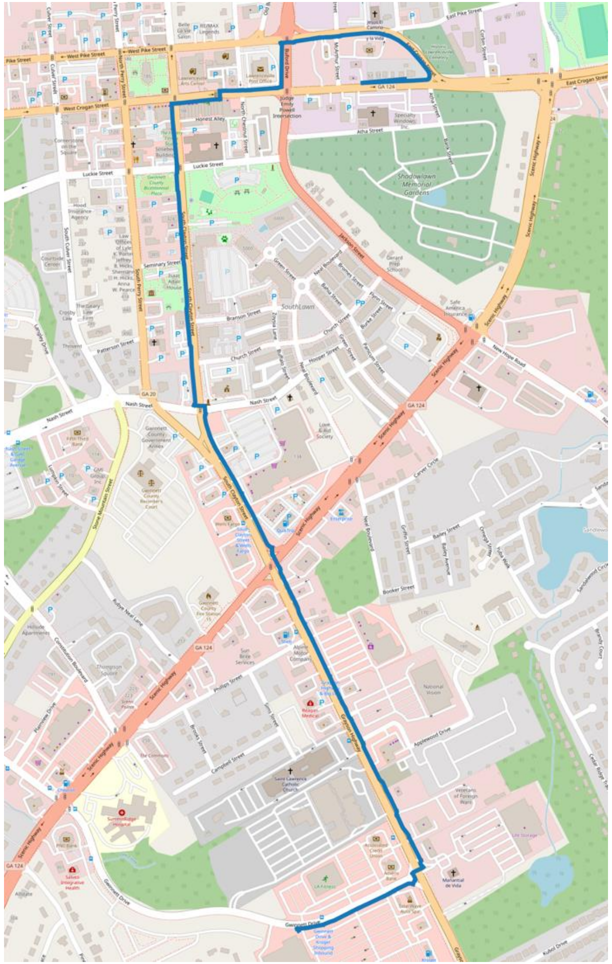
SidewalkSim Routing Functionality

- Allows users to use different impedance factors based on population group and mobility constraints
- Models different safety scenarios at different times of the day (when temperatures are different)

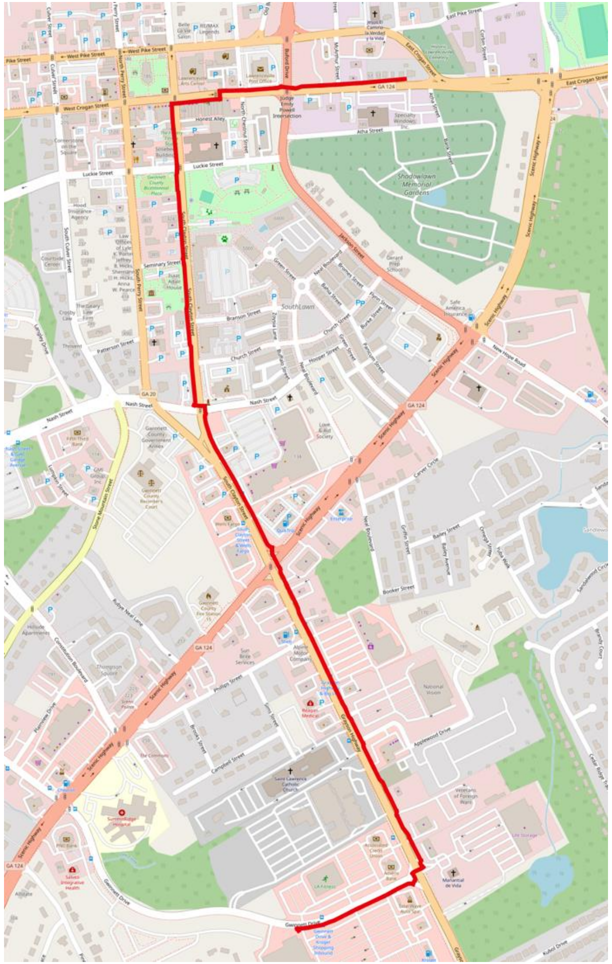




West Crogan Street
East Crogan Street
Luckie Street
Nash Street
Shadowlawn Memorial Gardens
Scenic Highway



Before



After

Using SidewalkSim

Input Format

Columns:

- origin_to_destination: a code denoting the pair of household and grocery stores (e.g., fassApartment_to_wholeFoods)
- ori_lat: latitude of household
- ori_lon: longitude of household
- dest_lat: latitude of grocery store
- dest_lon: latitude of grocery store
- trip_id: assigned trip ID

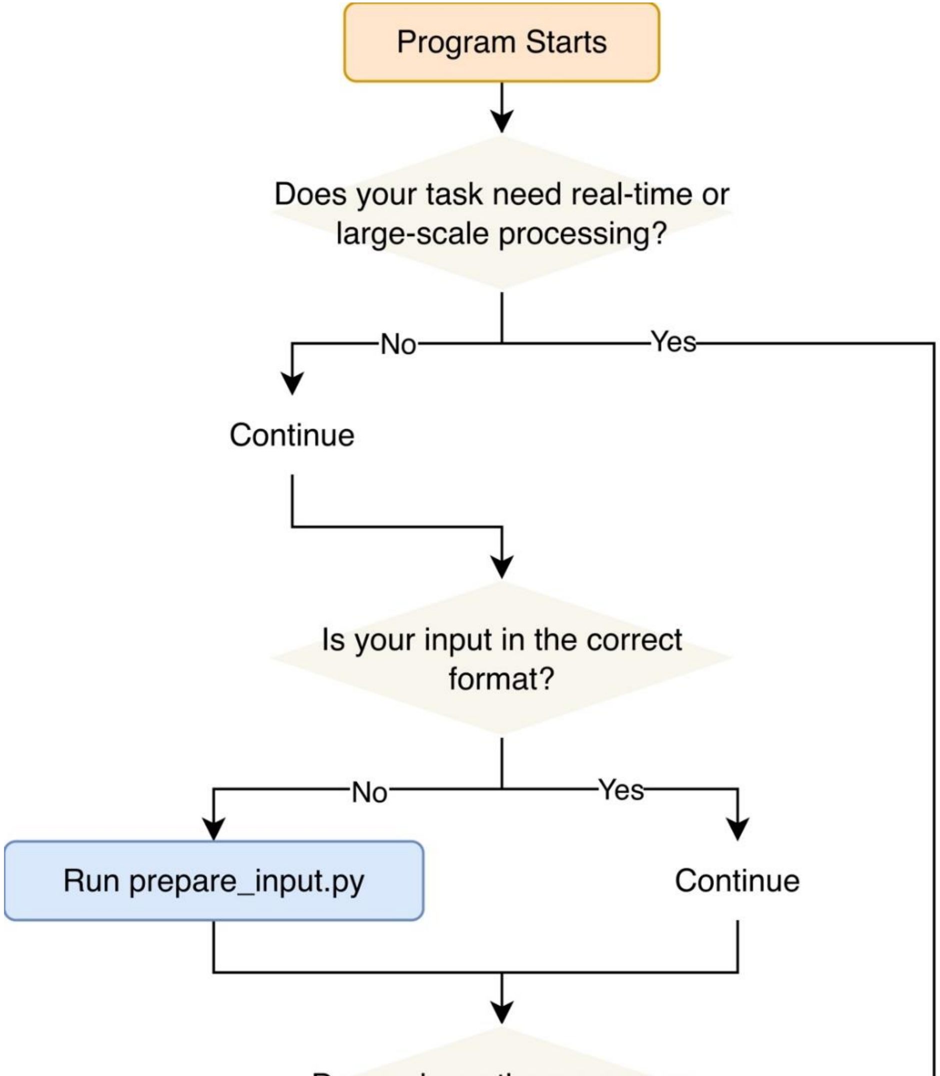
origin_to_destination	ori_lat	ori_lon	dest_lat	dest_lon	trip_id
household1_to_store1	39.94327	-82.97743	39.94608	-82.98234	0
household2_to_store2	40.03799	-82.99340	40.03719	-82.99970	1
household3_to_store3	40.10568	-83.06891	40.11683	-83.06801	2

Output Format

Columns:

- trip_id: assigned trip ID
- tt_min: travel time in minutes

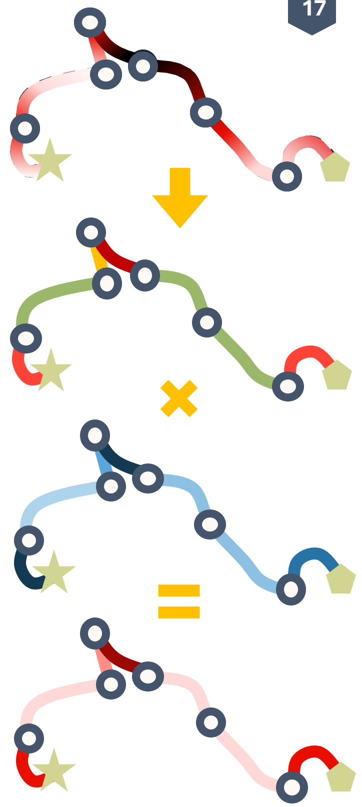
trip_id	tt_min
0	23.2
1	21.2
2	20.2


Program Starts
Does your task need real-time or large-scale processing?
No
Yes
Continue
Is your input in the correct format?
No
Yes
Run prepare_input.py
Continue

Optional Modules

Travelers' Cumulative Heat Exposure

- Risk-constrained Route Optimization or Transit Riders under Cumulative Heat Strain
  - $\min_{\mathcal{R}} \sum_{(i,j)\in\mathcal{R}}(t_{ij,t_i} + e_{ij}) : R_i = 0, \forall i \in \mathcal{R}$
    - $e_{ij} = \frac{t_{ij,t_i}}{\rho_{ij}}\eta_{ij}, (\rho_{ij}, \eta_{ij}) = \mathrm{H}(T_{mrt}, P_{d,m_{ij}})$
    - $E_j = [E_i + 1_{\{P_{d,m_{ij}}>0\}} e_{ij} - 1_{\{P_{d,m_{ij}}=0\}} t_{ij,t_i}]^+$
    - $R_j = 1_{\{P_{d,m_{ij}}>0\}\cup\{e_{ij}>0\}} \cdot (R_i + t_{ij,t_i}/\rho_{ij})$



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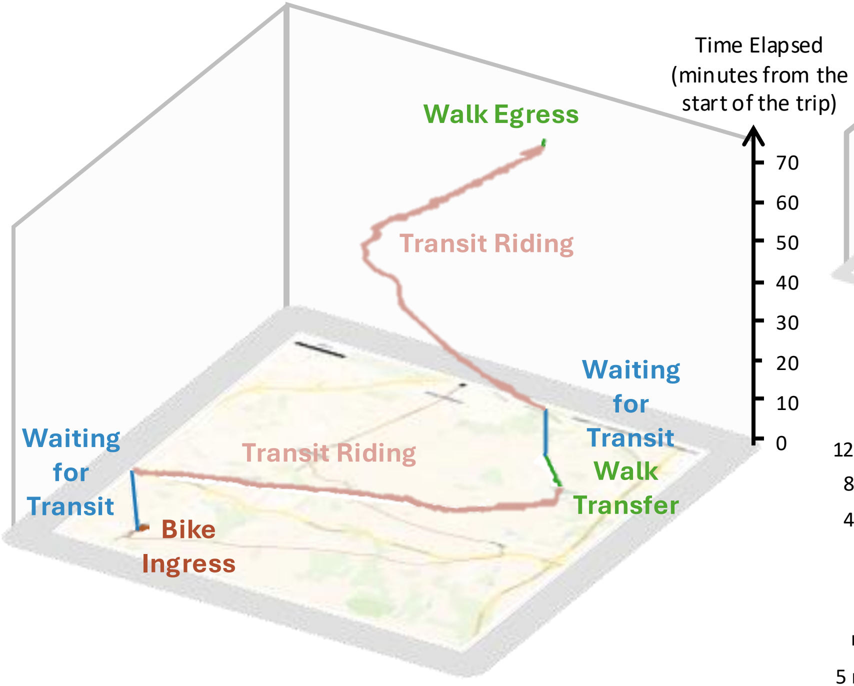
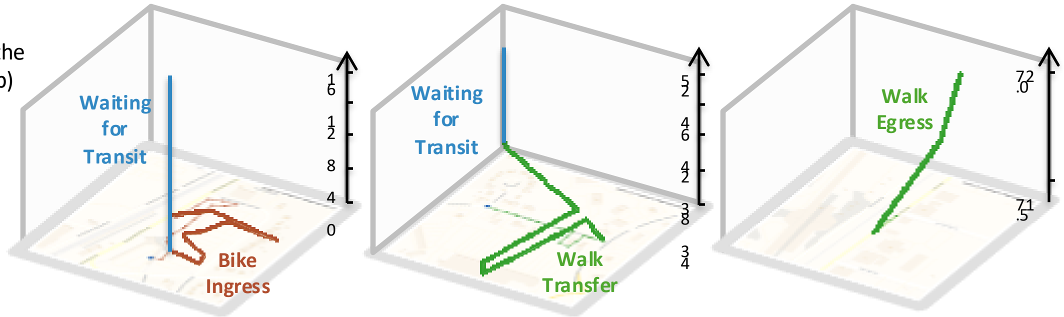
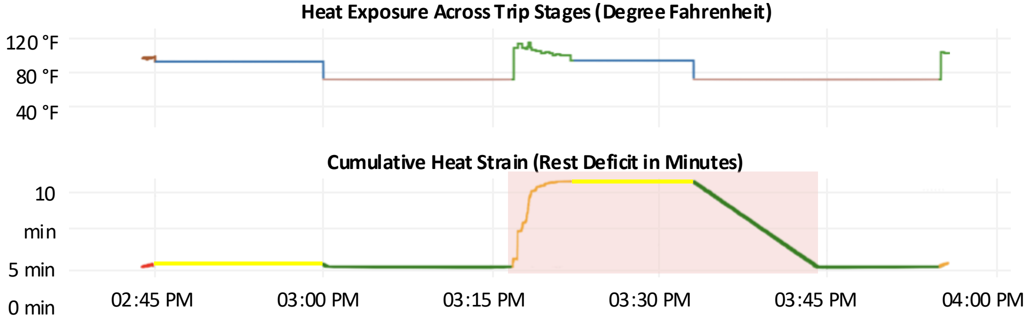
Travelers' Cumulative Heat Exposure







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Thank you!