

Open House Route Planner

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Inspiration

I have been looking for houses. When I add open houses to my Google Calendar, I am able to request direction to whatever house is open next in time, but I was thinking, *“What if two houses are significantly far apart, open at similar times, and there are other houses in each of their respective neighborhoods that open at different times? Is there a way I can plan my day of house hunting so that I can attend all of the open houses?”*

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The answer to this question is, “yes, within reason.”

Objective

Given a series of open houses the application should find routes that will allow the user to visit the maximum number of open houses given the constraints of *travel time* and *when the open houses are open*.

After stating the problem, it was divided up into several part:

- where the houses were with respect to each other,
- when the open houses were,
- and try to determine the path I needed to take to visit as many open houses as possible.

I will describe how each of these tasks were accomplished and what other work needed to be done to facilitate that work.

Requirements

As with any project, it is difficult to just dive right into working on the solution.

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Data needed to be

- gathered,
- parsed,
- geocoded,
- transformed for repeatable use,
- and cached.

ETL

Extract - ICS files [2] was manually gathered from Trulia.com [7].

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Transform -

- The ICSParser (see slide 10) parsed ICS files to JSONs that python could handle.
- The directions matrix (see slide 8) were used to manipulate the data into a form that would be useful for the OpenHouseGraph.
- And the Esri Flask App (see slide 10) gathered data from the Esri Developer API to geocode addresses to locations and fetched directions between two points so we could see how long it would take to travel between houses.

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Load - MongoOps (see slide 10) performed several roles:

- querying for existence of geocoded addresses and directions,
- storing data in a MongoDB instance,
- fetching data from a MongoDB instance,
- and requesting information from the Esri Flask App if the data did not exists in its database.

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For this, I used docker-compose [6].

My docker-compose network consisted of three containers:

- esri [1],
- mongo [4],
- and routefinder [3],

The docker-compose.yml can found [here](#).

Definitions

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- geocoding - the process or converting addresses to coordinates on the globe.

Definitions

- *directions matrix* - an array of JSONs containing vertex and edge information. While not strictly a matrix, it supplies the information to populate a matrix of travel times. While a matrix is no longer used, it is a good mental image to have when thinking about the OpenHouseGraph.

```
[{'_id': ObjectId('5cad42f3671c850b358ab86b'), 'url': REDACTED, 'dtstart':
  ↳ '20190414T153000Z', 'dtend': '20190414T170000Z', 'summary': REDACTED,
  ↳ 'description': REDACTED, 'location': {'geometry': {'x': x_0, 'y': y_0,
  ↳ 'spatialReference': {'wkid': 4326, 'latestWkid': 4326}}, 'attributes':
  ↳ {'Loc_name': 'World', 'Status': 'M', 'Score': 100, ... 'X': x_0, 'Y':
  ↳ y_0, 'DisplayX': x_{d0}, 'DisplayY': y_{d0}, 'Xmin': x_{min0}, 'Xmax':
  ↳ x_{max0}, 'Ymin': y_{min0}, 'Ymax': y_{max0}, 'ExInfo': '', 'OBJECTID':
  ↳ 1}, 'address': REDACTED}, 'address_hash': sha1(location0), 'durations':
  ↳ [[1, 13.85]]}]

{'_id': ObjectId('5cac003a671c85002d41afb9'), 'url': REDACTED, 'dtstart':
  ↳ '20190413T150000Z', 'dtend': '20190413T170000Z', 'summary': REDACTED
  ↳ 'description': REDACTED, 'location': {'geometry': {'x': x_1, 'y': y_1,
  ↳ 'spatialReference': {'wkid': 4326, 'latestWkid': 4326}}, 'attributes':
  ↳ {'Loc_name': 'World', 'Status': 'M', 'Score': 100, ... 'X': x_1, 'Y': y_1,
  ↳ 'DisplayX': x_{d1}, 'DisplayY': y_{d1}, 'Xmin': x_{min1}, 'Xmax': x_{max1},
  ↳ 'Ymin': y_{min1}, 'Ymax': y_{max1}, 'ExInfo': '', 'OBJECTID': 1},
  ↳ 'address': REDACTED},, 'address_hash': sha1(location1), 'durations': [[0,
  ↳ 14.15]]}]
```

Figure 1: Simplified Directions Array (Matrix)

Definitions

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- Figure 2 is an implied matrix of travel times between locations from Figure 1. $t_{i,j}$ is the travel time between house i and house j . The travel time from house i to house i is given the value -1 as a guard against reflexive traveling.

$$\begin{pmatrix} -1 & t_{0,1} & \cdots & t_{0,n-1} \\ t_{1,0} & -1 & \cdots & t_{1,n-1} \\ \vdots & \ddots & \ddots & \vdots \\ t_{n-1,0} & \cdots & \cdots & -1 \end{pmatrix}$$

Figure 2: Matrix of travel times between locations.

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 - and querying the ArcGIS Developer API for directions.
- OpenHouseGraph - A graph data structure used for computing routes one might take while visiting open houses.
 - Inspired by: Data Scientists, The one Graph Algorithm you need to know [5] - Basis for the OpenHouseGraph class.

ICS files contain more information than is provided. Some information has been omitted for brevity and privacy.

DTSTART:20190428T160000Z
DTEND:20190428T183000Z
LOCATION: location2
→ (New Hartford)

Figure 3: Shortend ICS files.

```
[{'ID': 0, 'address': location0 (Clinton),
  'edges': [[1, 14.88], [2, 7.42], [3, 8.51], [4, 21.55], [5, 31.54], [6, 25.19]],
  'end': 810, 'start': 720},
{'ID': 1, 'address': location1 (Utica),
  'edges': [[0, 15.47], [2, 8.54], [3, 7.85], [4, 31.88], [5, 42.08], [6, 35.73]],
  'end': 900, 'start': 810},
{'ID': 2, 'address': location2 (New Hartford),
  'edges': [[0, 8.15], [1, 8.34], [3, 2.05], [4, 24.24], [5, 33.74], [6, 27.41]],
  'end': 870, 'start': 720},
{'ID': 3, 'address': location3 (New Hartford),
  'edges': [[0, 10.03], [1, 8.88], [2, 3.36], [4, 26.72], [5, 36.22], [6, 29.85]],
  'end': 780, 'start': 690},
{'ID': 4, 'address': location4 (Sherrill),
  'edges': [[0, 21.93], [1, 31.39], [2, 23.43], [3, 25.09], [5, 15.65], [6, 9.24]],
  'end': 1080, 'start': 960},
{'ID': 5, 'address': location5 (Morrisville),
  'edges': [[0, 32.63], [1, 42.56], [2, 34.11], [3, 35.71], [4, 16.2], [6, 14.71]],
  'end': 720, 'start': 600},
{'ID': 6, 'address': location6 (Oneida),
  'edges': [[0, 25.42], [1, 35.35], [2, 26.93], [3, 28.53], [4, 8.9], [5, 15.26]],
  'end': 720, 'start': 600}]
```

Walkthrough

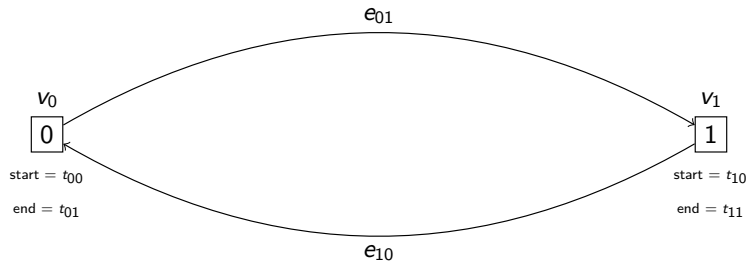


Figure 5: A trivial case of the Open House Graph.

Walkthrough

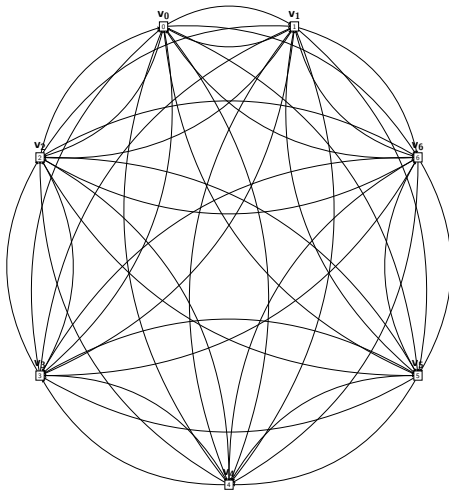


Figure 6: Open House Graph containing seven houses.

Walkthrough

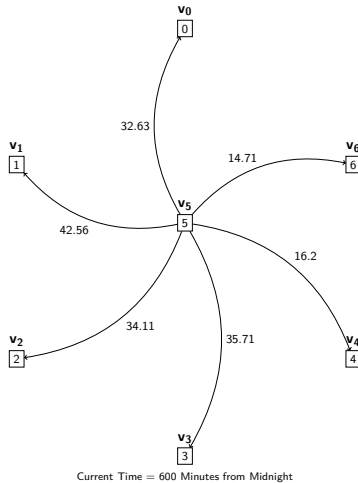
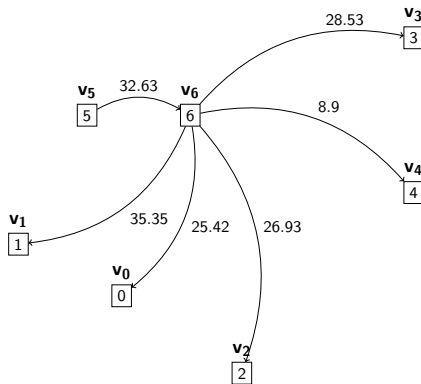


Figure 7: Step 1 - 'ID': 5, 'end': 720, 'start': 600.

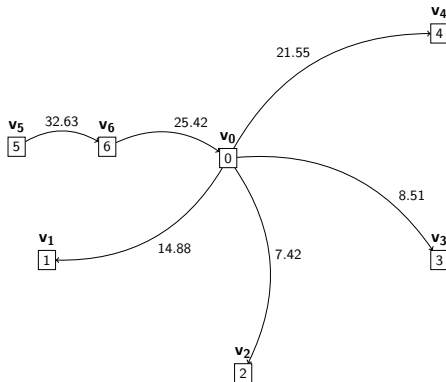
Walkthrough



Current Time = 662.63 Minutes from Midnight ($600 + 30 + 32.63$)

Figure 8: Step 2 - 'ID': 6, 'end': 720, 'start': 600.

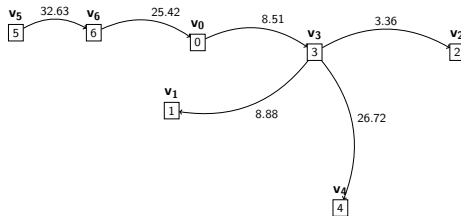
Walkthrough



Current Time = 720 (718.05) Minutes from Midnight (662.63 + 30 + 25.42)

Figure 9: Step 3 - 'ID': 0, 'end': 810, 'start': 720.

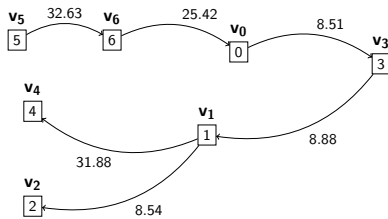
Walkthrough



Current Time = 758.51 Minutes from Midnight ($720 + 30 + 8.51$)

Figure 10: Step 4 - 'ID': 3, end': 780, 'start': 690.

Walkthrough



Current Time = 810 (797.39) Minutes from Midnight (758.51 + 30 + 8.88)

Figure 11: Step 5 - 'ID': 1, 'end': 900, 'start': 810.

Walkthrough

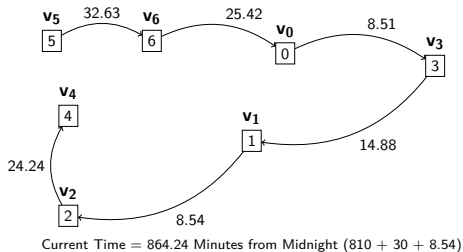
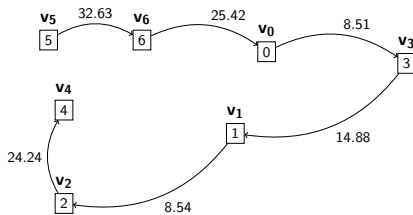


Figure 12: **Close** Step 6 - 'ID': 2, 'end': 870, 'start': 720.

Walkthrough



Current Time = 960 (918.48) Minutes from Midnight (864.24 + 30 + 24.24)

Figure 13: Step 7 - 'ID': 4, 'end': 1080, 'start': 960

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