Project SAFE: Safe path Approximation For Elementary schools

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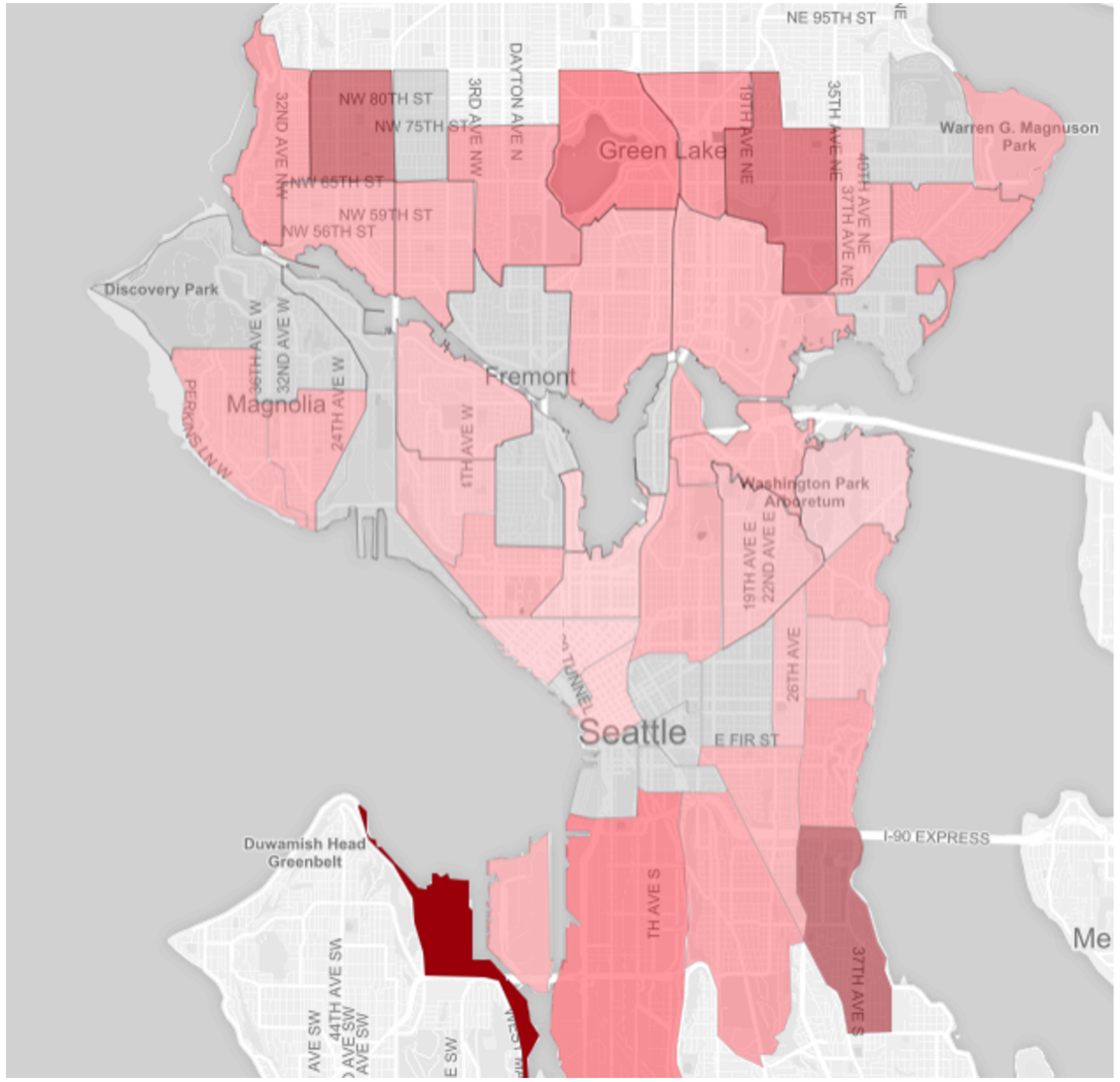
Inspired by Prof. Katie Siek

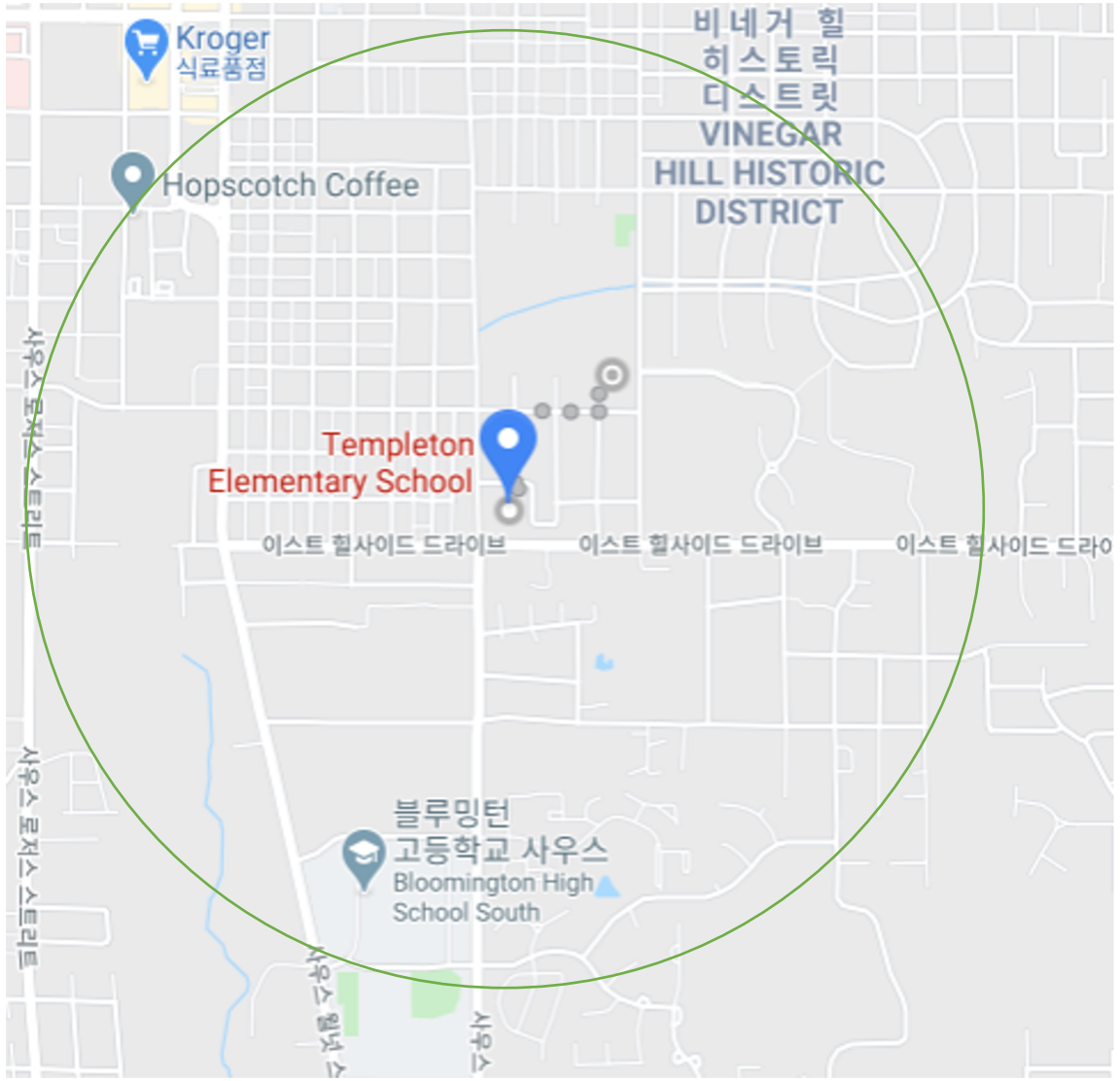
Project sidewalk

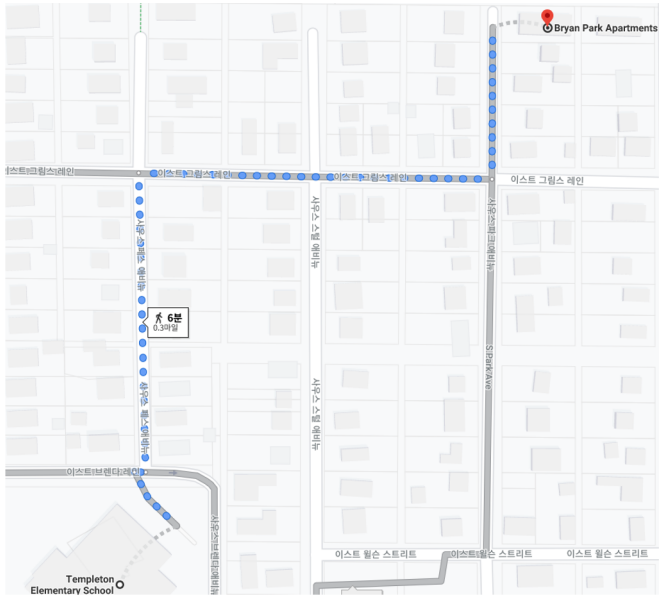
- https://sidewalk-sea.cs.washington.edu/
- Determines accessibility for physically challenged
- Crowd labels street images and trains on it

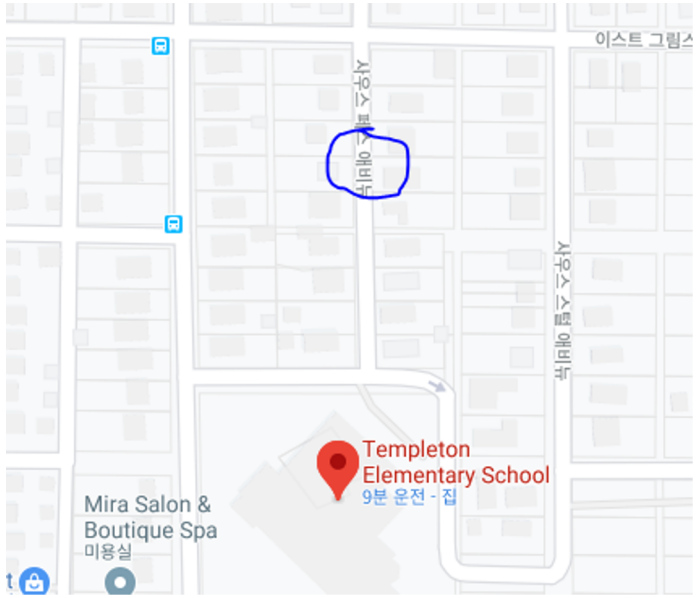


Expand the idea, but in a smaller region

- “Most Safe Routes to School practitioners agree that a half mile is as far as most kindergarteners will walk happily, a mile is a reasonable length for older elementary school kids, and that 1.5 miles is an acceptable distance for high schoolers.”
- https://www.saferoutespartnership.org/blog/too-far-walk





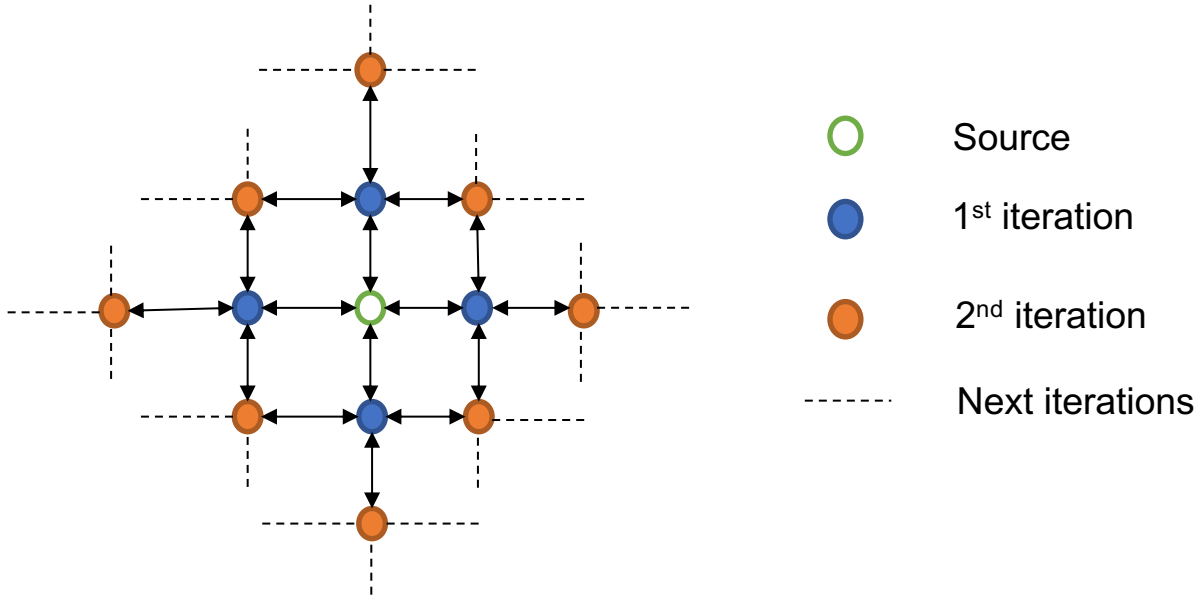


Current problem of paths

- The path recommended are not always the safest path
- When walking to school, there should a safe path, but also walkable(not going around the town searching for sidewalks)

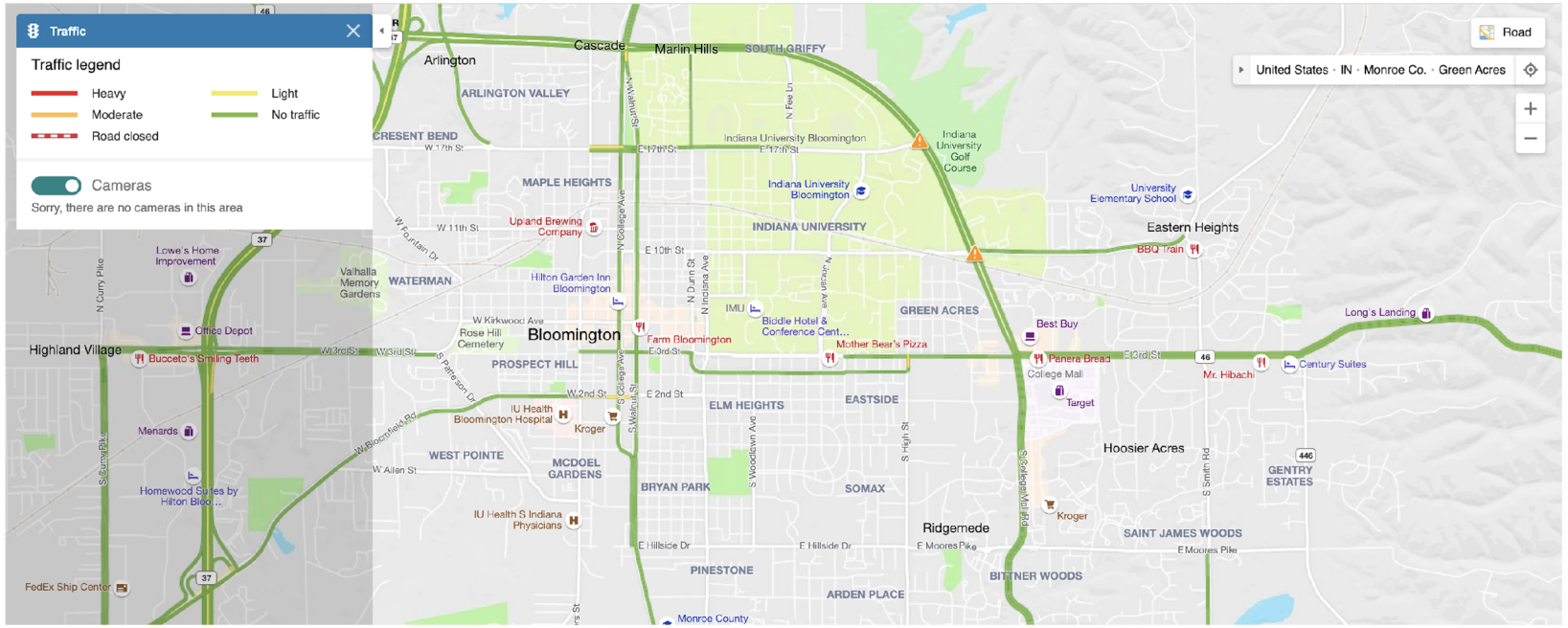
Connected graph creation

- From the source coordinate we get the next 4 coordinates with a 10m distance in 4 directions 0, 90, 180, and 270 and we add these coordinates onto queue
- The next 4 coordinates are determined using pygeodesy python package
- All the coordinates are generated in a Breadth-First Search (BFS) manner
- We get the distance between coordinates using Google Distance matrix API



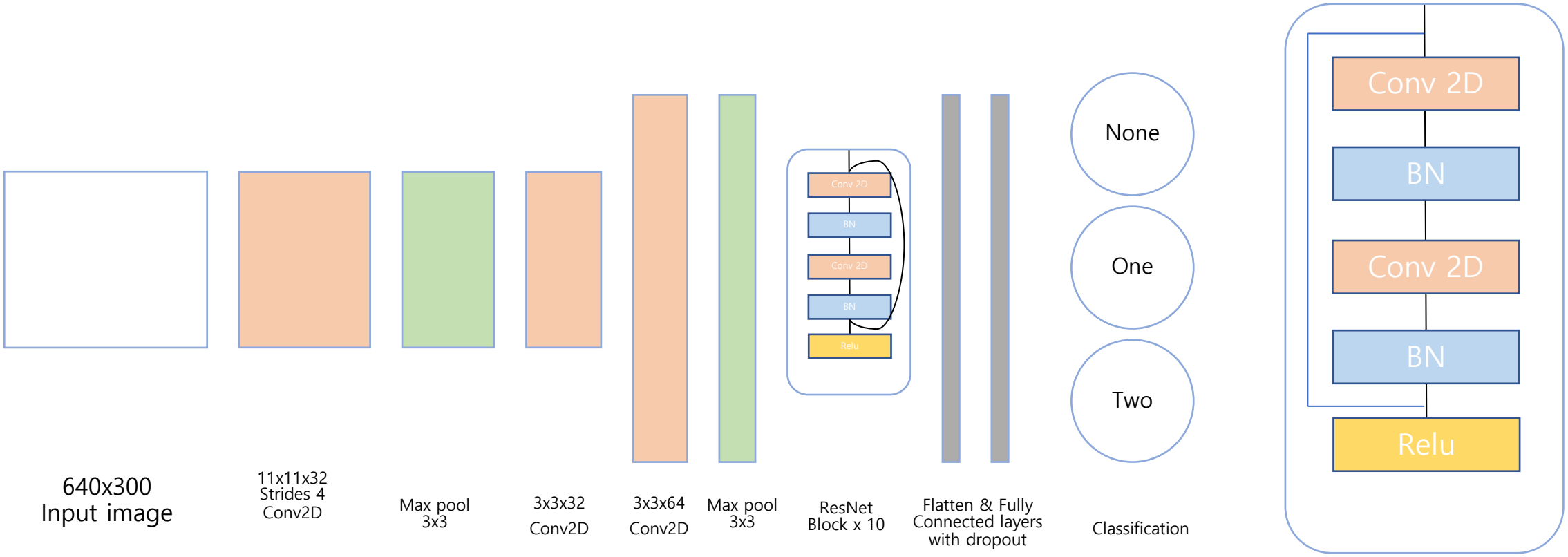
Traffic data

- Traffic data at any given source and destination coordinates are extracted using Bing routes API in driving mode
- API gives the categorical values as Heavy, Moderate, Light, No traffic and Unknown
- Given that we are taking coordinates around Bloomington, most of the coordinates had Unknown, No traffic, and Light values

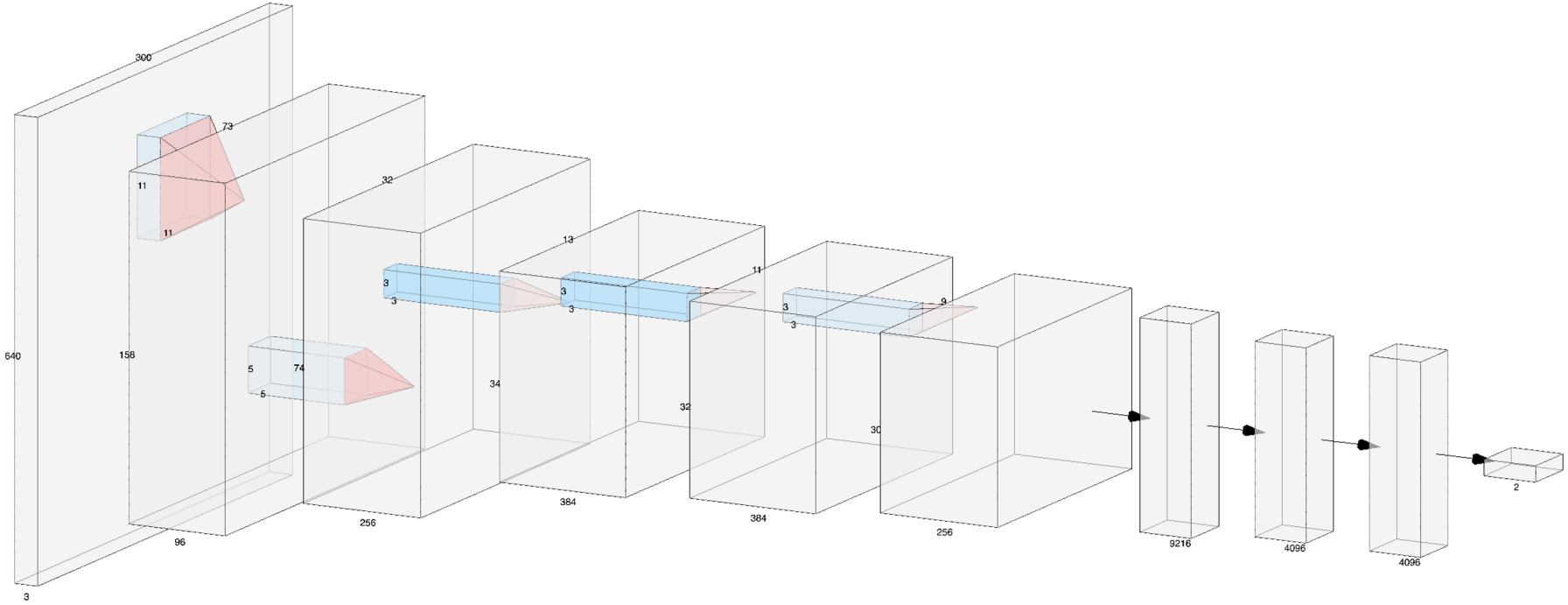


https://www.bing.com/maps

Sidewalk detection



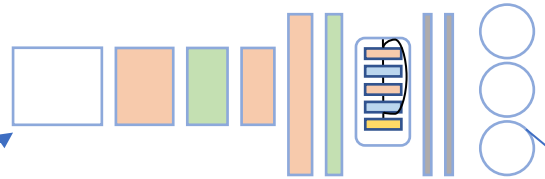
Crosswalk/sign and Stop sign/Traffic lights detection



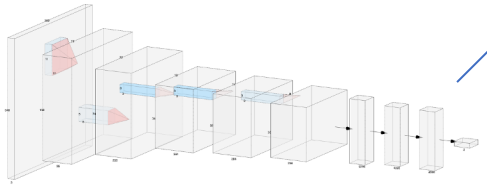
Safety score

- The safety score for the sidewalk was calculated to have weighted probabilities of having both sidewalks, sidewalks on one side and no sidewalks
- Each coordinate's safety score was calculated as a squared mean of these scores so that low probabilities will have a higher rate
- The overall safety score of a school was calculated again after taking the mean of the coordinate's scores

Street view image

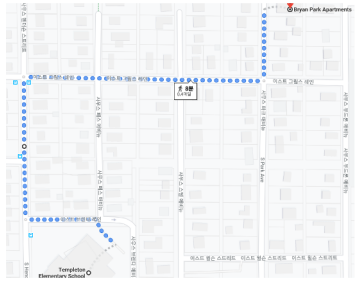


Sidewalk model



Cross walk, stop sign and traffic light models

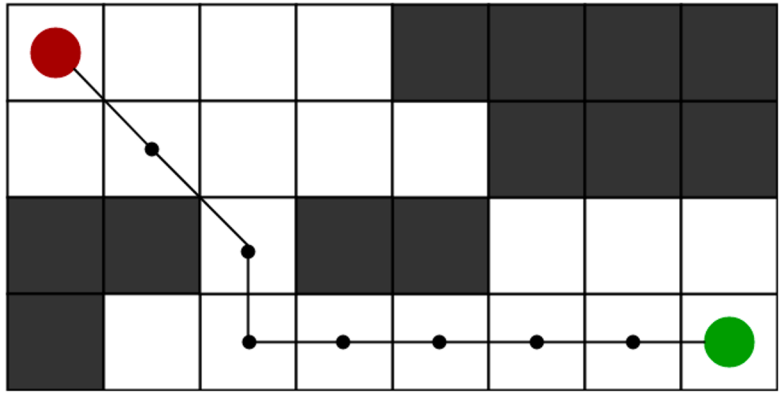
Safety score



Safe path recommendation

Search Algorithm

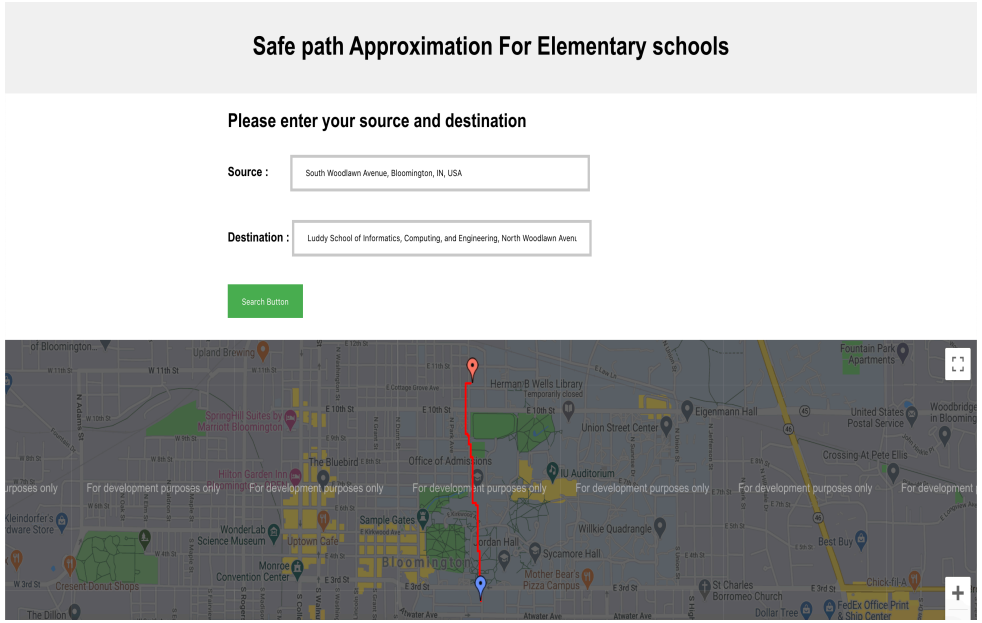
1. If GOAL?(initial-state) then return initial-state
2. INSERT(initial-node, FRINGE)
3. Repeat:
4. If empty(FRINGE) then return failure
5. s □ REMOVE(FRINGE)
6. If GOAL?(s) then return s and/or path
7. For every state s′ in SUCC(s):
8. INSERT(s′, FRINGE)



- Best First Search using above mentioned algorithm with f(s) = g(s) + h(s) + i(s), where:
  - g(s) = Distance from coordinates
  - h(s) = safety score
  - i(s) = Traffic score

Results

Model	Class	Precision	Recall	F1 score	Overall Accuracy
Crosswalk detection	Class 0	0.70	0.97	0.80	0.81
	Class 1	0.97	0.70	0.81	
Crosswalk sign detection	Class 0	0.98	0.70	0.81	0.85
	Class 1	0.77	0.98	0.87	
Sidewalk detection	Class 0	0.5	0.28	0.36	0.54
	Class 1	0.55	0.46	0.5	
	Class 2	0.55	0.91	0.69	
Stop sign detection	Class 0	0.84	0.94	0.89	0.89
	Class 1	0.94	0.85	0.89	
Traffic lights detection	Class 0	0.37	0.81	0.51	0.54
	Class 1	0.84	0.42	0.56	



Examples

Figure 3 : one of the images belonging to some coordinates and the safety scores. Top row are true positives, and the bottom row are incorrect examples. Starting from the left, cross walk, cross signs, sidewalks, traffic lights, stop signs examples.

Limitations

- We have created an approximated way of connected graph which considered all the coordinates. Hence the recommended path can include the coordinates where there is no path between them
- Since the data was self labeled and centered around Bloomington, models could not be generalized to match any given place
- Due to API constraints, we took the path along only 4 directions. But not all roads goes in only those directions, It can be improved to take different directions


DEMO