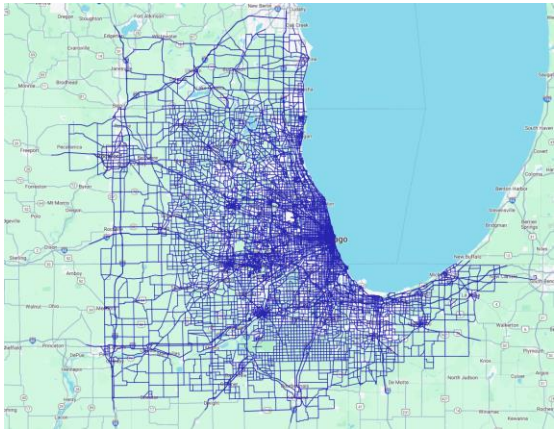
SUMMER ARGONNE STUDENT SYMPOSIUM, 07/26/2024

Argonne NATIONAL LABORATORY

PREDICTING AVERAGE ANNUAL DAILY TRAFFIC (AADT) WITH GRAPH NEURAL NETWORKS



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THE GOAL: PREDICT AADT OF ROADS

What is AADT?

$$\text{Average Annual Daily Traffic (AADT) of a road} = \frac{\text{Total Volume of Vehicle Traffic}}{\text{365 days}}$$

Why care about AADT?

- A crucial parameter that measures traffic flow patterns, which guides infrastructure design and planning
- Supports social benefit analysis, eg. traffic safety, environmental & economic impact

Why predict AADT?

- Informs policy making for potential construction projects

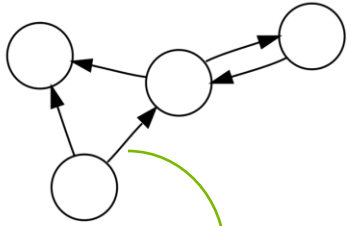
HOW IS AADT PREDICTED TRADITIONALLY?

1. Collect data on
   - Traffic network: road length, speed limit, capacity, current AADT ...
   - Demographic Info: # households, income ...
2. Run complicated stochastic optimization calculations
3. Wait a couple of months...

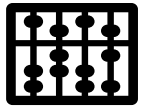
	
○ Accurate and reliable	○ Painstakingly slow
○ Allows delicate fine-tuning of input parameters	○ Difficult to scale up to a larger network

OUR IDEA: A GRAPH NEURAL NETWORK ALGORITHM

Consider the traffic network as a directed graph.

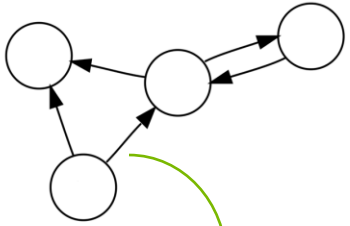


Input



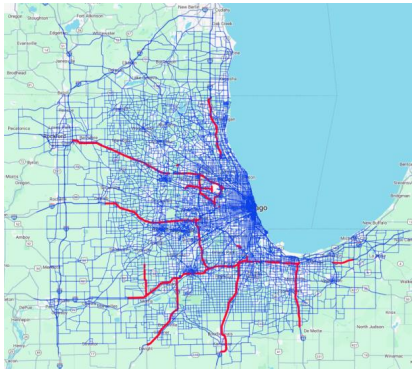
GNN Algorithm

Output



Edge Attributes (of all edges):
Length, # lanes, Traffic Capacity, Speed Limit
Edge Label (of selected edges):
AADT from simulation

Predicted Edge Label (of selected edges):
AADT



Compared to the traditional simulation method:

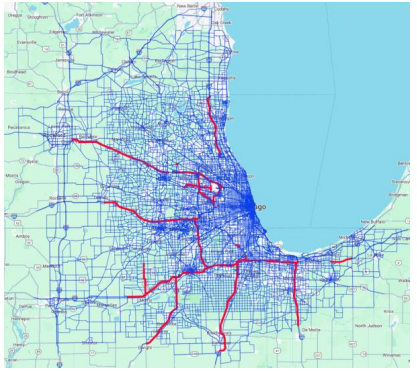
- Uses less input parameters to solve a simpler problem
- Runs faster and can be easily scaled up to a larger network

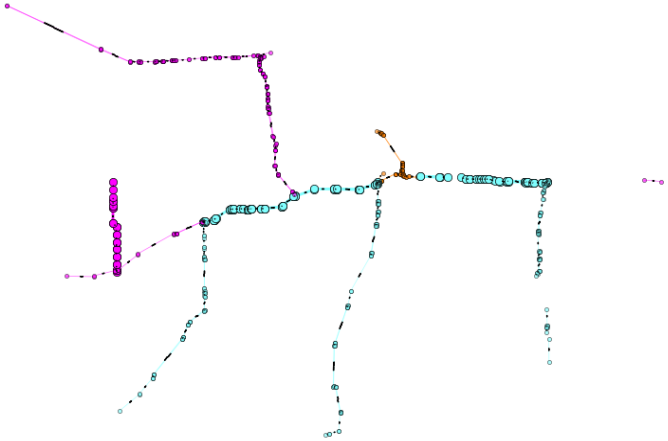
PROGRESS SO FAR

1. Baseline Method: Multilinear Regression
   - Relative Error of Predicted AADT = $O(10^{-3})$
2. GNN layers: EdgeConv, TransformerConv
   - EdgeConv:

     Relative Error of Predicted AADT = $O(10^{-3})$
   - TransformerEdge:

     Relative Error of Predicted AADT = $O(10^{-1})$



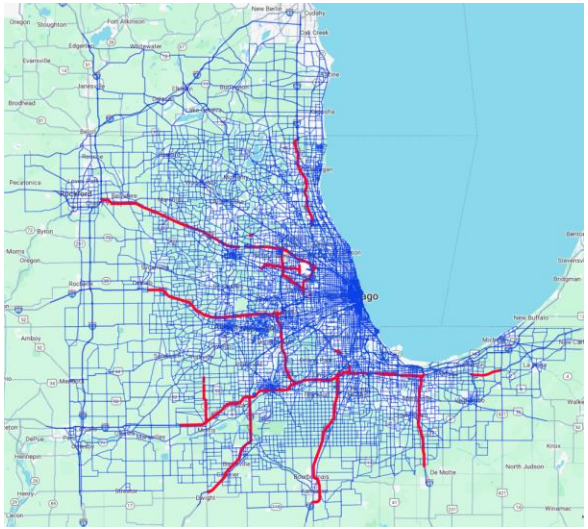


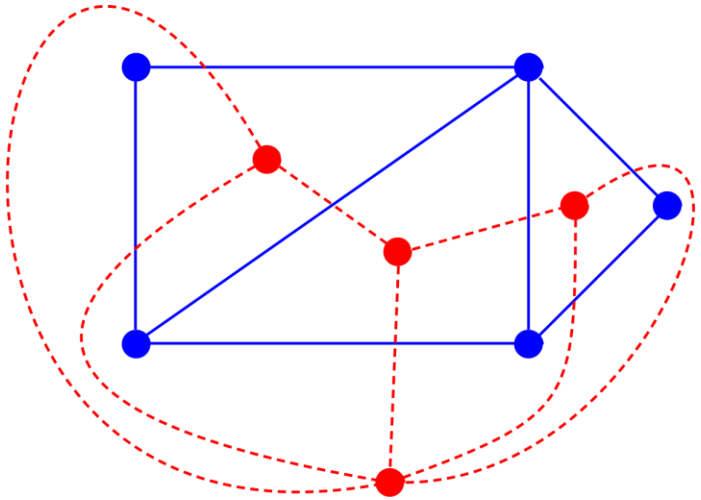
Limitations

- Data generation is slow
- Incomplete information about the entire traffic network

NEXT STEPS

- Use the general traffic network as the underlying **connected** graph
- Take the dual of the graph and use Graph Convolutional Network (CGN) layers, which avoids overly emphasizing on node attributes





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