

Transportation Networks & Land Use:

GGR424 - Transportation Geography & Planning

Jeff Allen

University of Toronto

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Land Use

Urban Form

Built Environment

Urban Spatial Structure

In transportation geography and planning, we are usually working with **vector** data (rather than raster data)

Land Use Data

- ▶ What is located where
- ▶ Usually **Points or Polygons**

Network Data

- ▶ The spatial patterns of transportation networks
- ▶ Usually **Lines** (and nodes/intersections)

Travel Data (more on this next week)

- ▶ Travel Surveys (usually tables, linked to locations)
- ▶ GPS/Sensor Mobility Data (usually large N point data)

Land Use Data

- ▶ What is located where
- ▶ Usually Points or Polygons

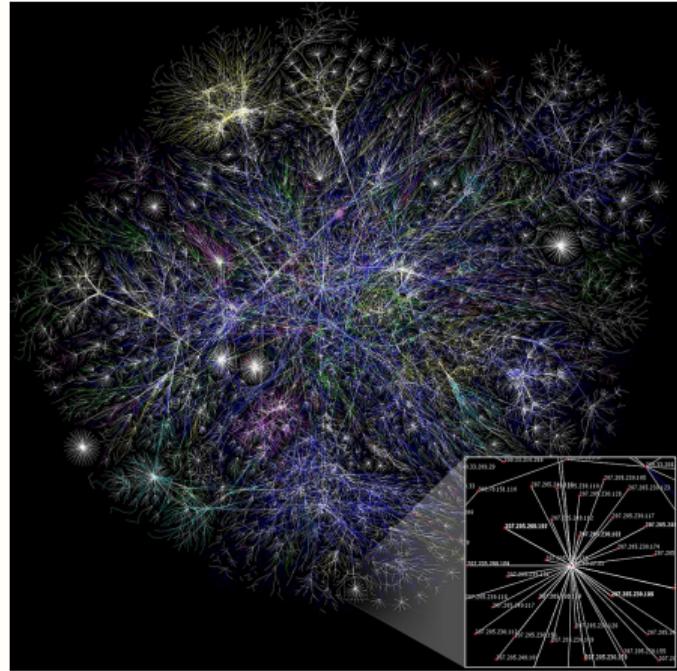
Network Data:

Network - an interconnected group or system

Examples

- ▶ Computer network
- ▶ Social network
- ▶ Transportation network
- ▶ Biological network

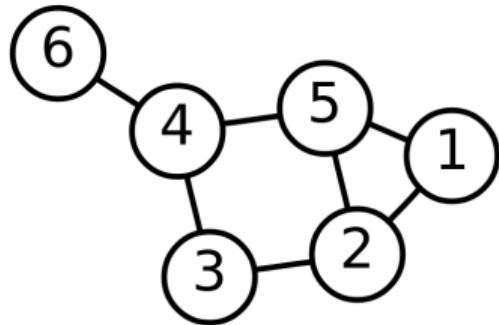
Often represented using **graphs**



Source: https://en.wikipedia.org/wiki/Network_science

Graph

- ▶ Set of *nodes* (also called points or vertices) and *edges* (also called lines or arcs)
- ▶ $G = (V, E)$
- ▶ If two nodes have a relationship, then there is an edge linking them
- ▶ Edges can have weights (e.g. travel time or speed, surface quality, elevation, etc.)
- ▶ Graphs can be directed or un-directed (e.g. can have one-way relationship)



Source: [https://en.wikipedia.org/wiki/Graph_\(discrete_mathematics\)](https://en.wikipedia.org/wiki/Graph_(discrete_mathematics))

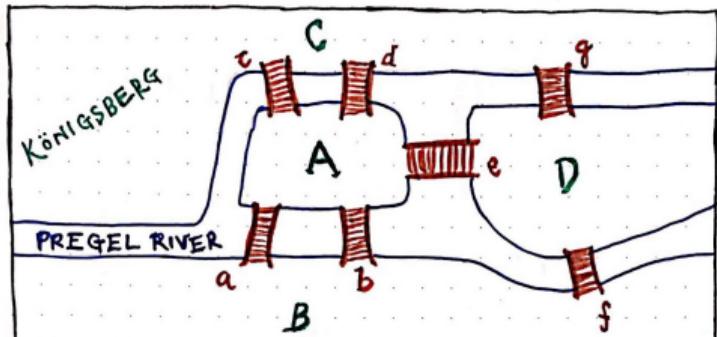
Can you walk across all of the seven bridges in Königsberg, without ever repeating a single bridge in the course of one's walk? (Leonhard Euler, 1736)



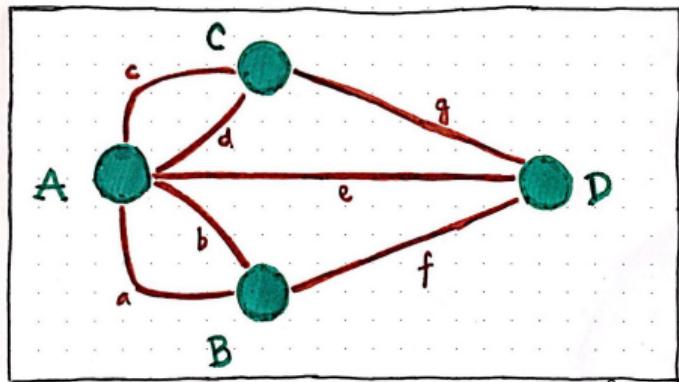
Source: <https://medium.com/basecs/konigsberg-seven-small-bridges-one-giant-graph-problem-2275d1670a12>

Can you walk across all of the seven bridges in Königsberg, without ever repeating a single bridge in the course of one's walk? (Leonhard Euler, 1736)

Representing Königsberg as a graph

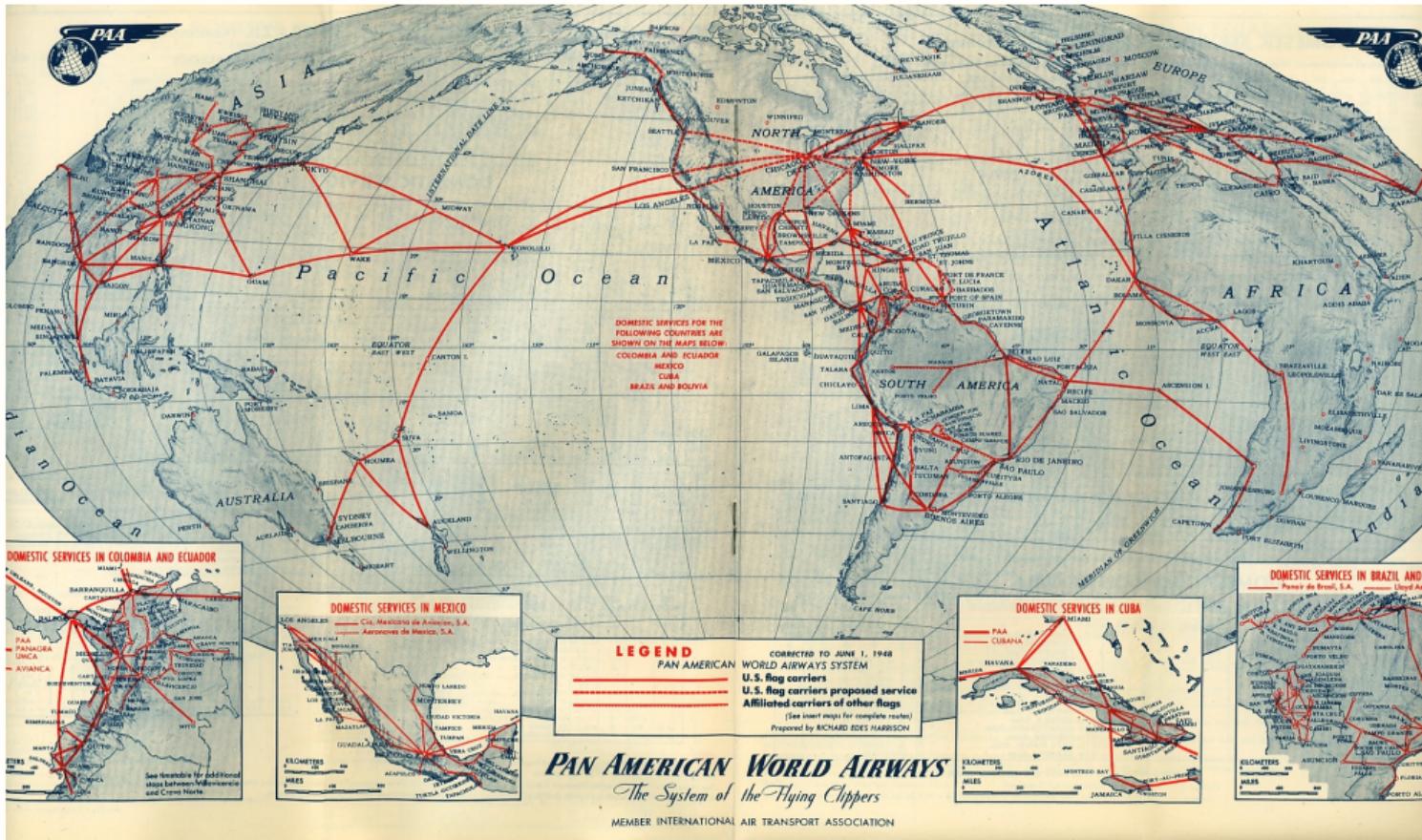


The Seven Bridges of Königsberg



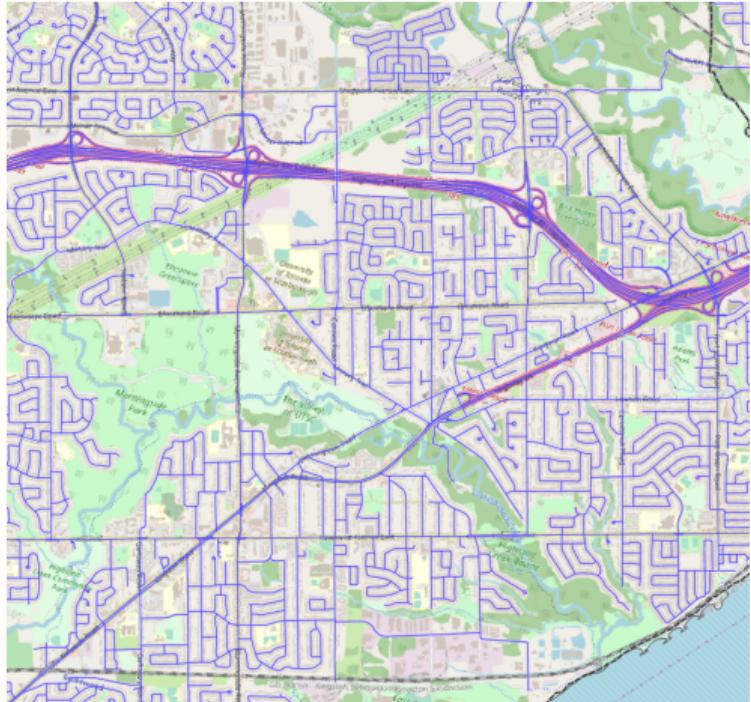
The Seven Bridges of Königsberg—Revisualized

Source: <https://medium.com/basecs/konigsberg-seven-small-bridges-one-giant-graph-problem-2275d1670a12>



In Transportation Geography & Planning, network analysis is used for measuring distances and travel times over *network* space.

Source: <https://www.openstreetmap.org>

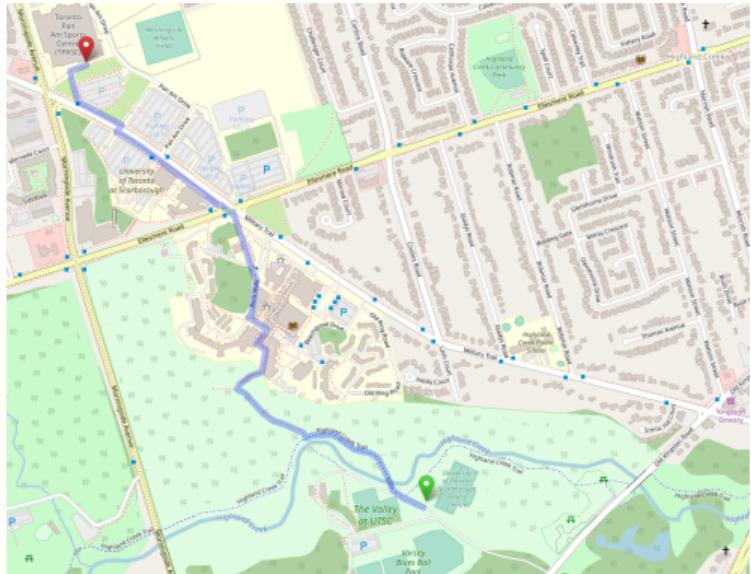


Network Distance

- ▶ The distance or travel time between two points, based on the *shortest-path* in a network graph.
- ▶ Included in many mapping applications and software (e.g. Google Maps, Uber, etc.)
- ▶ Different than straight-line (e.g. Euclidean) distance

Source: <https://www.openstreetmap.org>

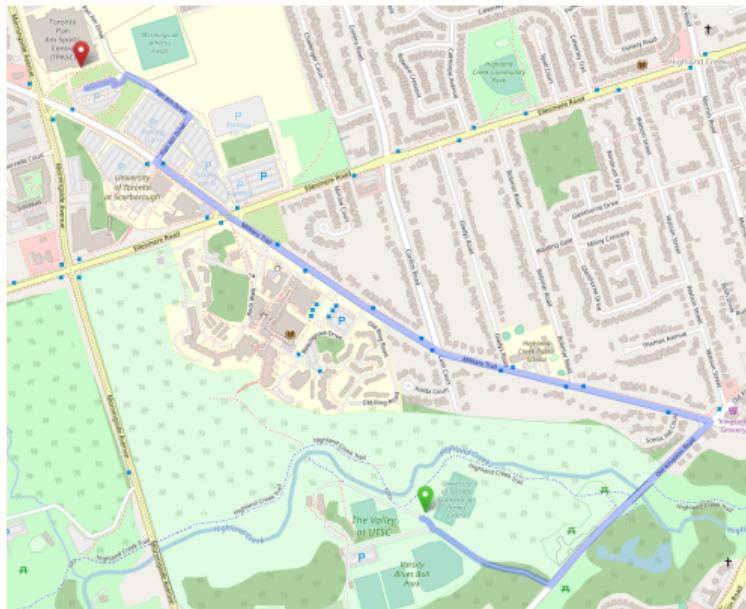
shortest-path by walking (22 min, 1.8 km)



shortest-path by bicycle (12 min, 2.5 km)

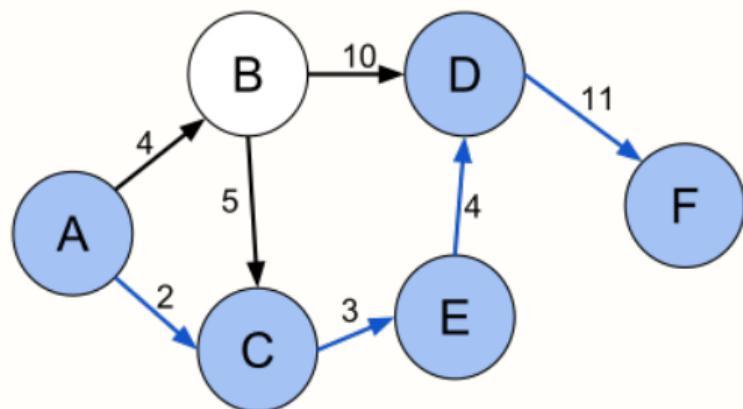


shortest-path by car (8 min, 3.0 km)



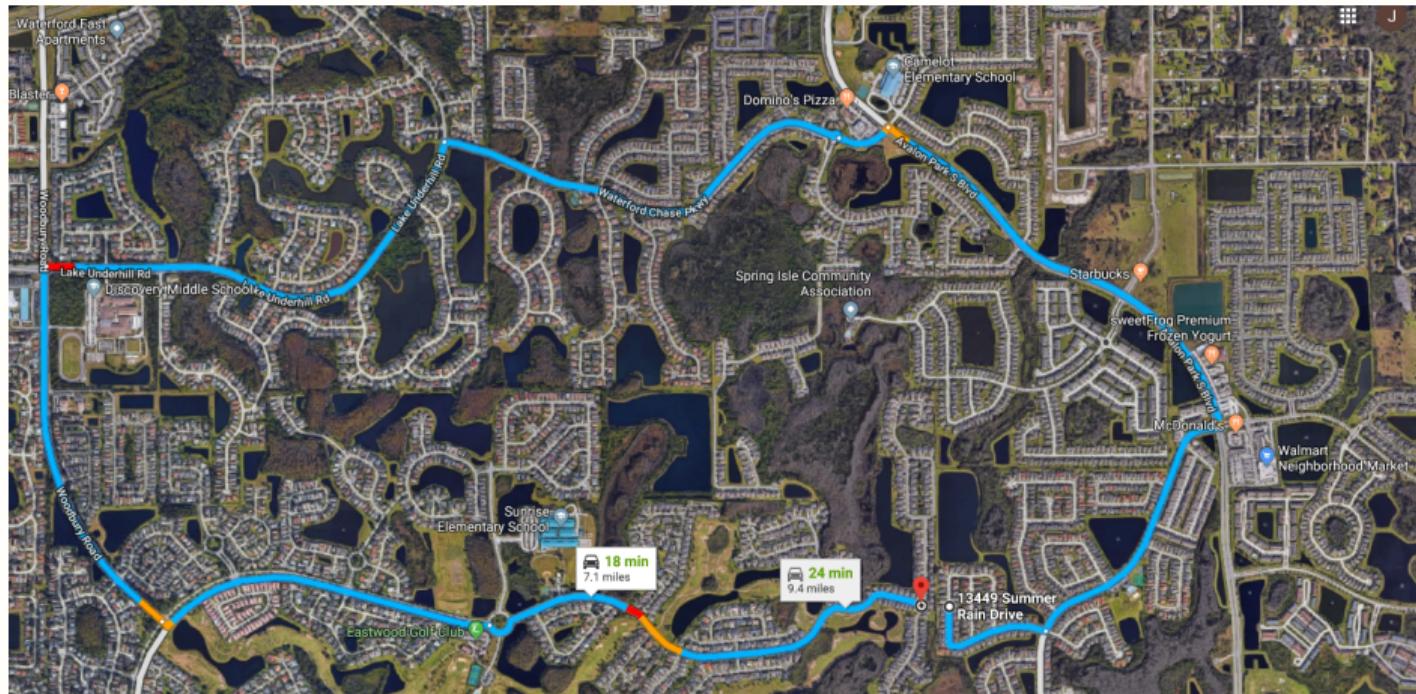
Shortest Path Analysis

- ▶ Finding the "shortest" path between A and B
- ▶ "shortest" can be in distance, time, other costs, or combination of costs
- ▶ Several different algorithms (e.g. Dijkstra)
- ▶ Widely used in mapping applications (Google Maps, Uber, etc.)



https://en.wikipedia.org/wiki/Dijkstras_algorithm

https://en.wikipedia.org/wiki/Shortest_path_problem



<https://www.google.ca/maps/dir/28.5327099,-81.1608841/28.5326847,-81.1618508/@28.5363151,-81.1840563,6816m/data=!3m1!1e3!4m3!4m2!3e0!5i1>

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13436 Summer Rain Dr, Orlando, FL 32824
14948 Golfway Blvd, Orlando, FL 32828, I

+ Add destination

Options

Send directions to your phone

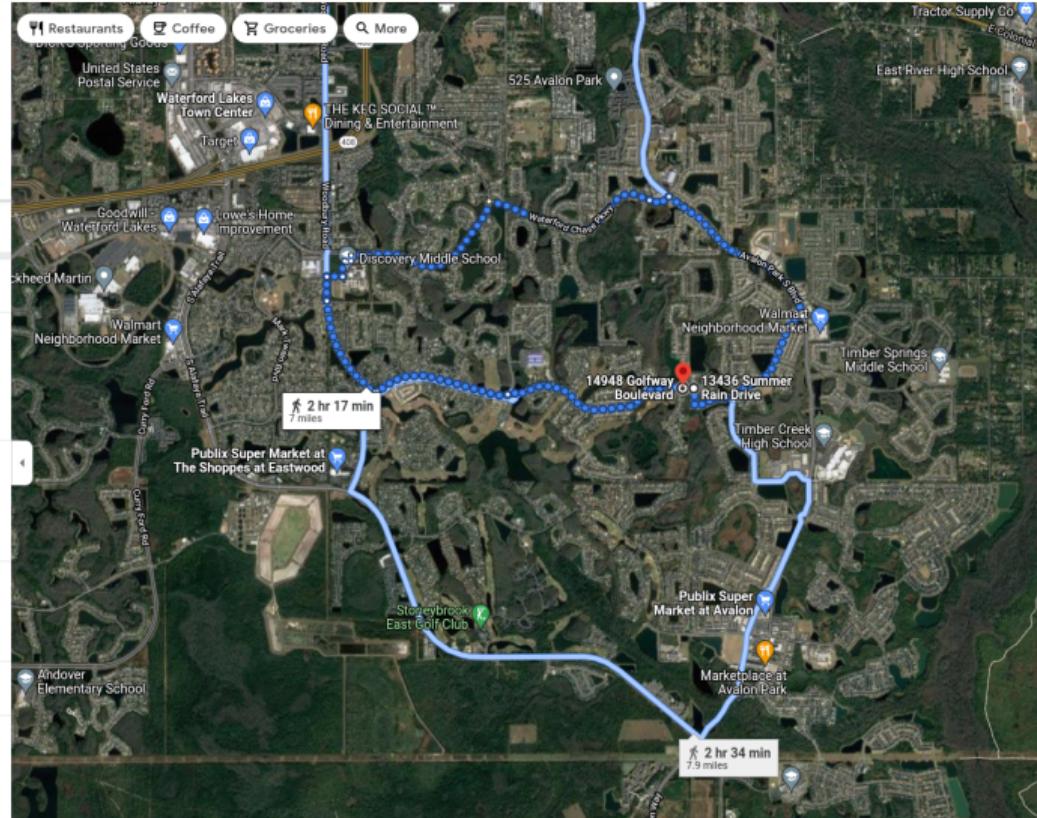
via Golfway Blvd 2 hr 17 min
⚠ This route has restricted usage or private roads.
7.0 miles

Details

via S Alafaya Trail/S R 434 and Golfway Blvd 2 hr 34 min
7.9 miles
⚠ This route has restricted usage or private roads.

via Woodbury Road 3 hr 4 min
⚠ This route has restricted usage or private roads.
9.3 miles

All routes are mostly flat



<https://www.google.ca/maps/dir/28.5327099,-81.1608841/28.5326847,-81.1618508/@28.5363151,-81.1840563,6816m/data=!3m1!1e3!4m3!4m2!3e0!5i1>

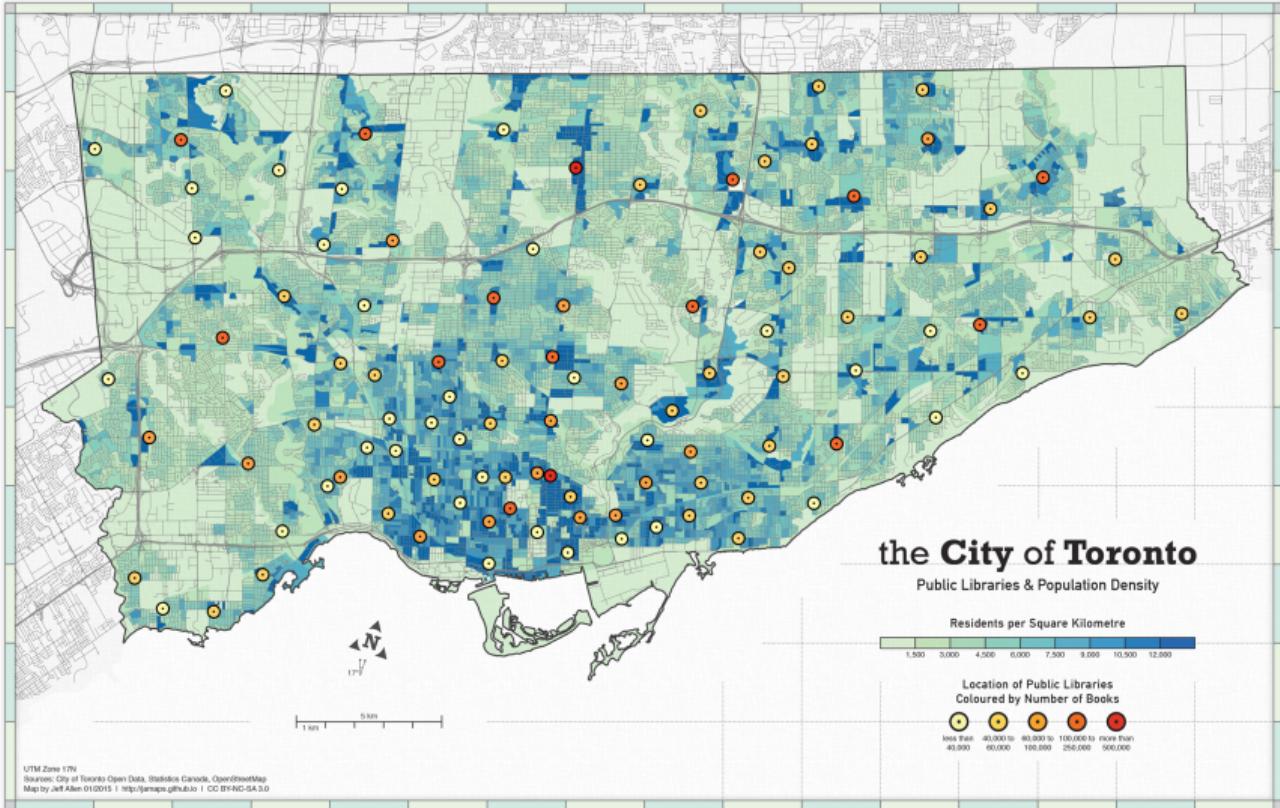
Closest Facility Analysis - finding the nearest location(s) from a set of locations distributed over space

Often used in medical and emergency services.

- ▶ e.g. which fire station is closest to a fire
- ▶ e.g. what is the nearest emergency room

Location Allocation

- ▶ Procedures for determining the optimal location for one or more facilities that will service demand from a given set of points across space
- ▶ Often used in planning new locations of retail, public facilities, distribution centres, etc.
- ▶ Often use network distances + other data (e.g distributions of population)



Source: https://commons.wikimedia.org/wiki/File:Toronto_Public_Libraries_and_Population_Density.png

Travelling Salesman

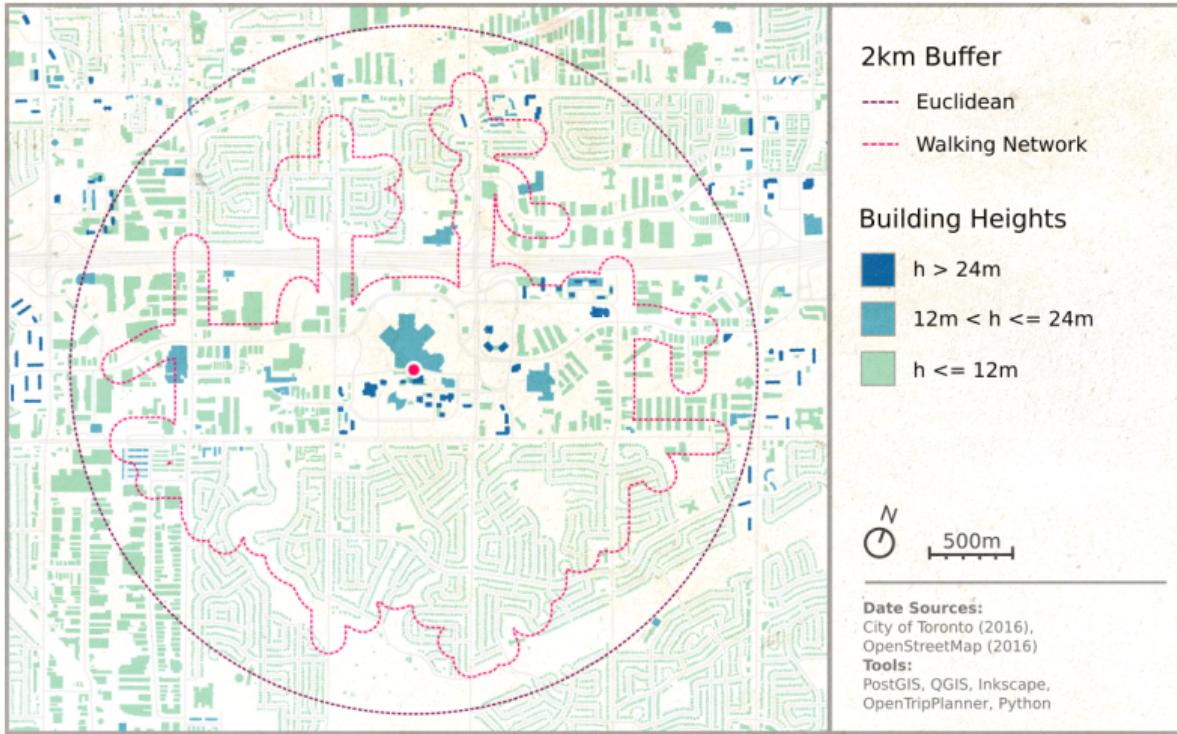
- ▶ Given a list of locations, and the (network) distances between each pair of locations, what is the shortest possible route that visits each location and returns to the origin point?
- ▶ e.g. what is the optimal route a salesman can take to visit potential clients in a region
- ▶ other applications include planning delivery routes or road trips

The optimal road trip visiting 50 cities in the USA



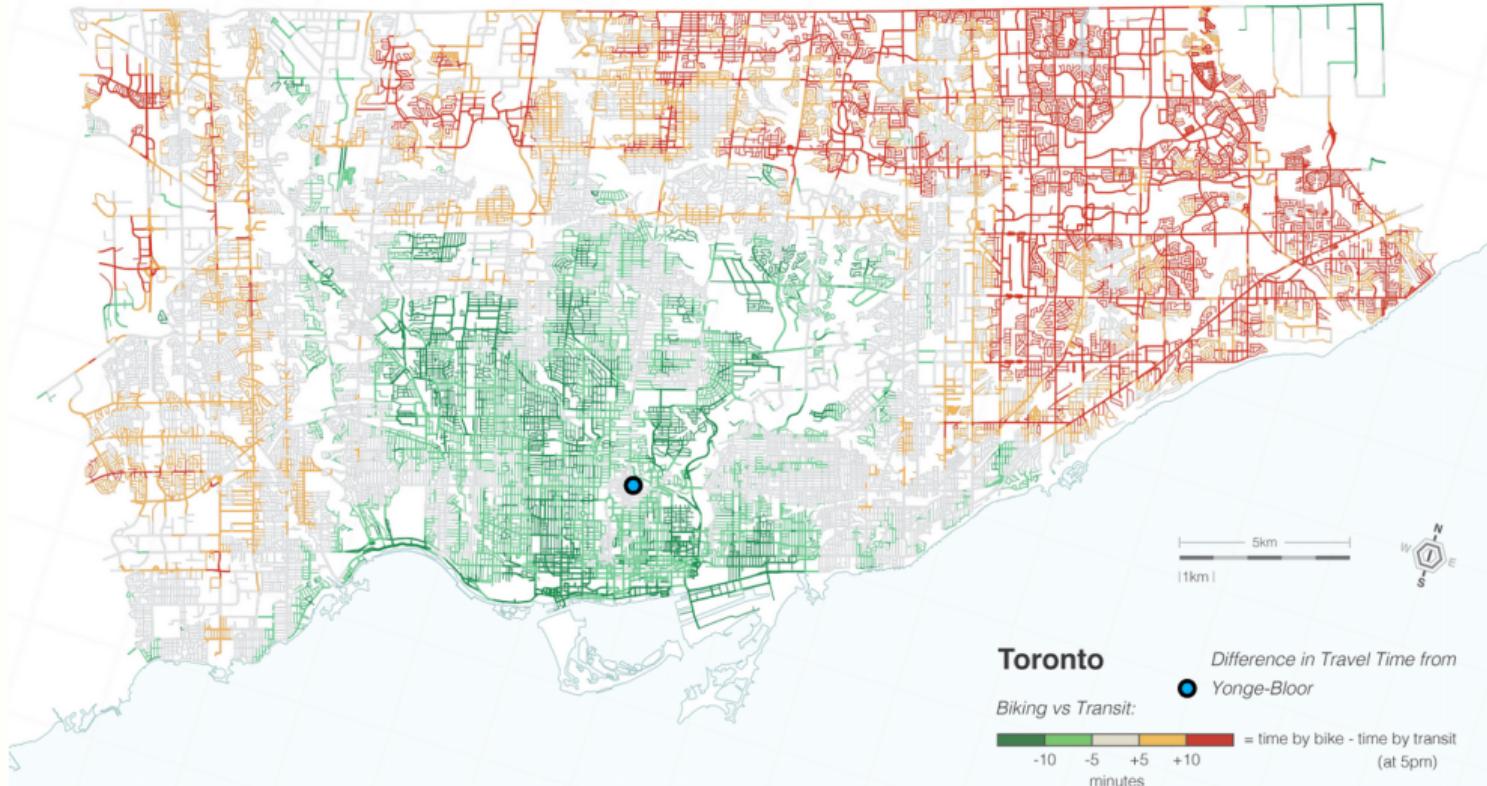
Source: Randy Olson (2015) <http://www.randalolson.com/2015/03/08/computing-the-optimal-road-trip-across-the-u-s/>

Isochrones (iso = equal, chrone = time) - A buffer based on *network* distances or travel times





Source: Galton, Francis. 1881. "On the Construction of Isochronic Passage-Charts." *Proceedings of the Royal Geographical Society and Monthly Record of Geography* 3: 657-658



Source: Allen, J. - *Using network segments in the visualization of urban isochrones* - Cartographica -
http://jamaps.github.io/docs/allen_2018_isochrones.pdf