Transportation Networks & Land Use:
GGR424 - Transportation Geography & Planning

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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

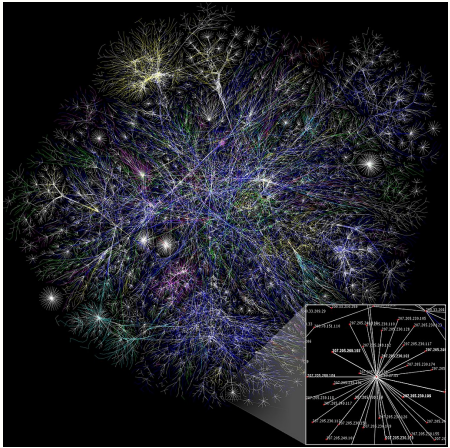
- The spatial patterns of transportation networks
- Usually **Lines** (and nodes/intersections)

Network - an interconnected group or system

Examples

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

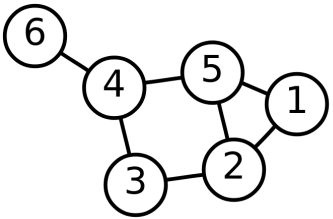
Often represented using **graphs**



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

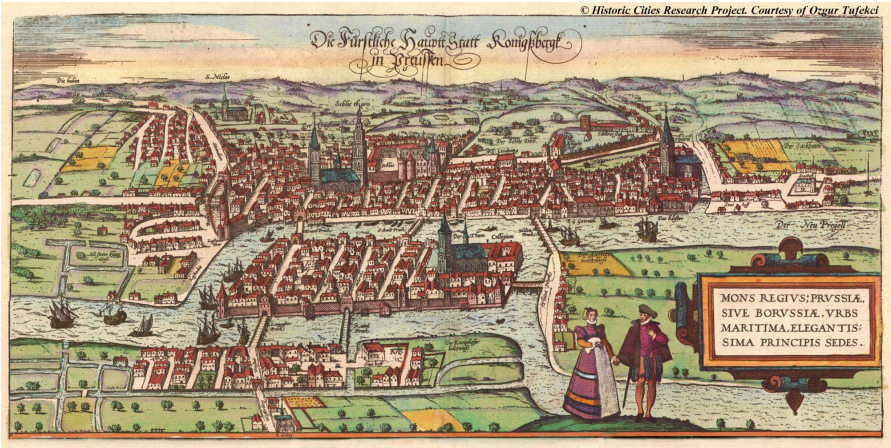
Graph

- 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)



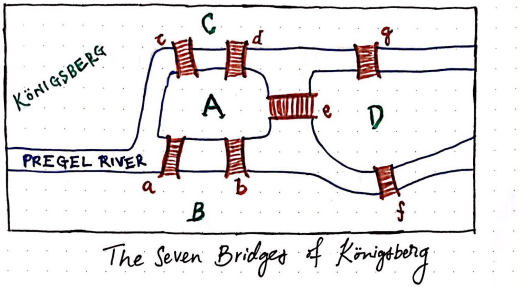
Source: https://en.wikipedia.org/wiki/Graph_(discrete_mathematics)

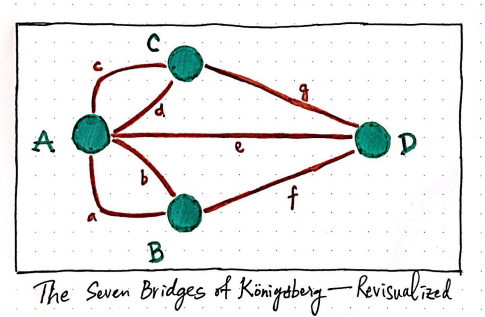
Can you walk across all of the seven bridges in Königsberg, without ever repeating a single bridge in the course of one's walk? (Leonhard Euler, 1736)



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

Representing Königsberg as a graph





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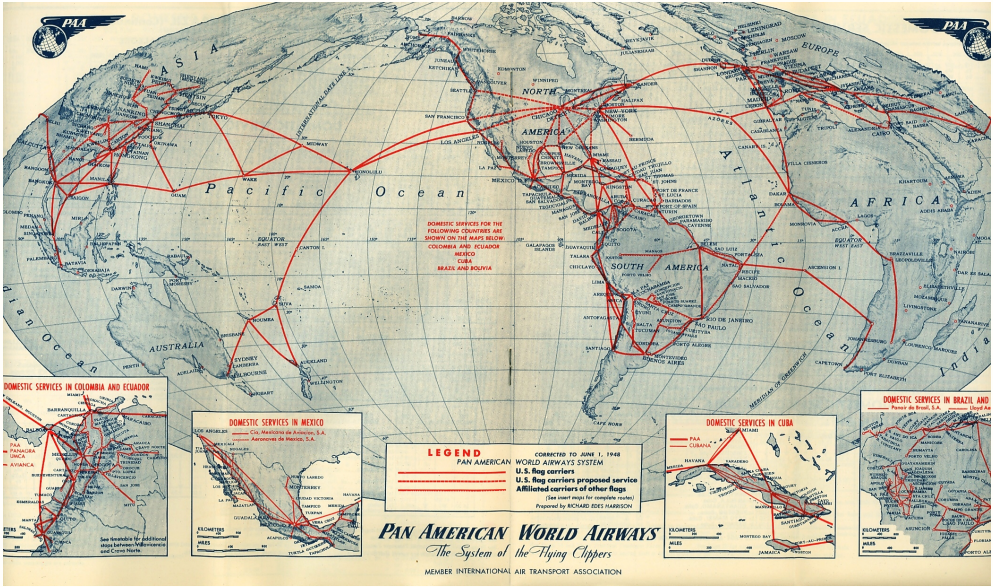
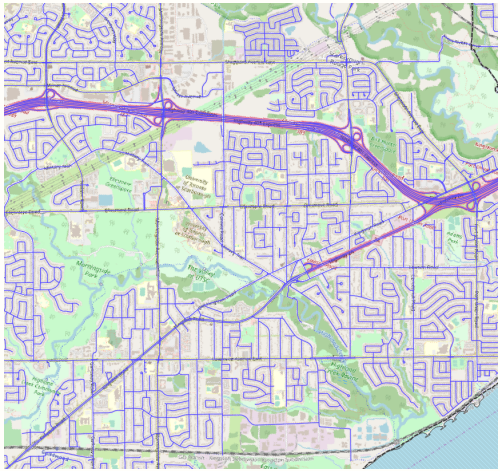

PAA
PAA
ASIA
EUROPE
NORTH AMERICA
Pacific Ocean
Atlantic Ocean
AFRICA
SOUTH AMERICA
AUSTRALIA
Indian Ocean
DOMESTIC SERVICES FOR THE FOLLOWING COUNTRIES ARE SHOWN ON THE MAPS BELOW:
COLOMBIA AND ECUADOR
MEXICO
CUBA
BRAZIL AND BOLIVIA
DOMESTIC SERVICES IN COLOMBIA AND ECUADOR
DOMESTIC SERVICES IN MEXICO
Cía. Mexicana de Aviación, S.A.
Aeronaves de Mexico, S.A.
DOMESTIC SERVICES IN CUBA
PAA
CUBANA
DOMESTIC SERVICES IN BRAZIL AND
Panair do Brasil, S.A.
Lloyd Aé
KILOMETERS
MILES
LEGEND
PAN AMERICAN WORLD AIRWAYS SYSTEM
CORRECTED TO JUNE 1, 1948
U.S. flag carriers
U.S. flag carriers proposed service
Affiliated carriers of other flags
(See insert maps for complete routes)
Prepared by RICHARD EDES HARRISON
PAN AMERICAN WORLD AIRWAYS
The System of the Flying Clippers
MEMBER INTERNATIONAL AIR TRANSPORT ASSOCIATION

GIS applications of network analysis usually pertain to transportation networks.

Analyzing distances and travel times over *network* space.

Source: https://www.openstreetmap.org

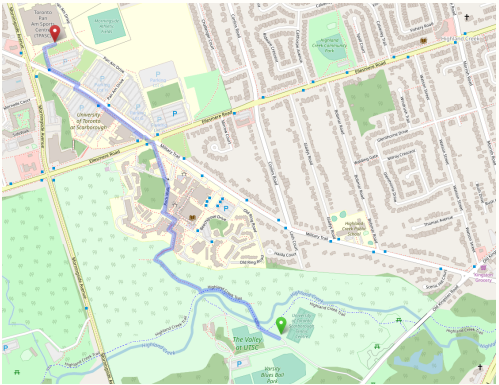


Network Distance

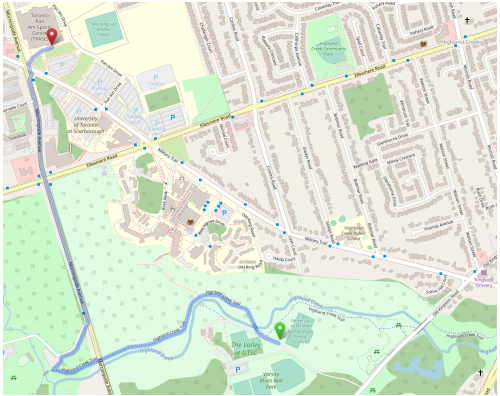
- The distance or travel time between two points, based on the *shortest-path* in a network graph.
- Included in many mapping applications and software (e.g. Google Maps, Uber, etc.)
- Different than straight-line (e.g. Euclidean) distance

Source: https://www.openstreetmap.org

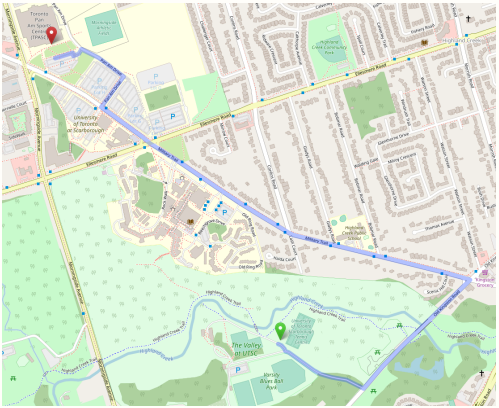
shortest-path by walking (22 min, 1.8 km)

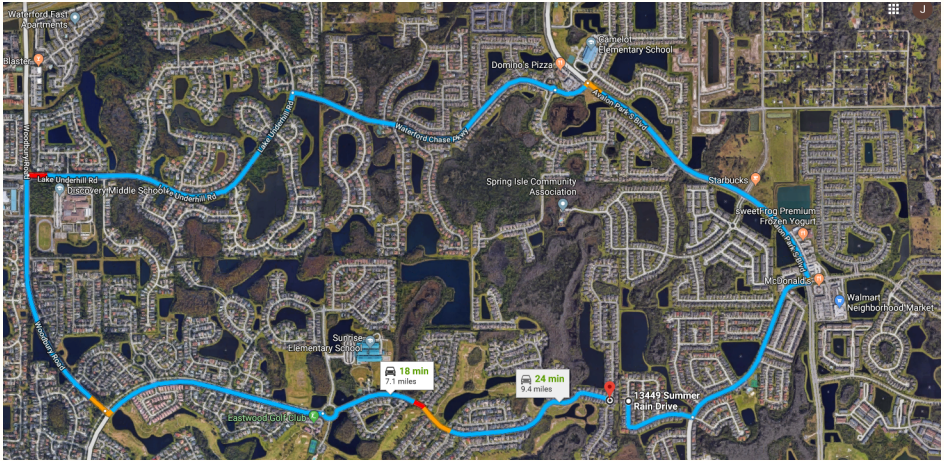


shortest-path by bicycle (12 min, 2.5 km)



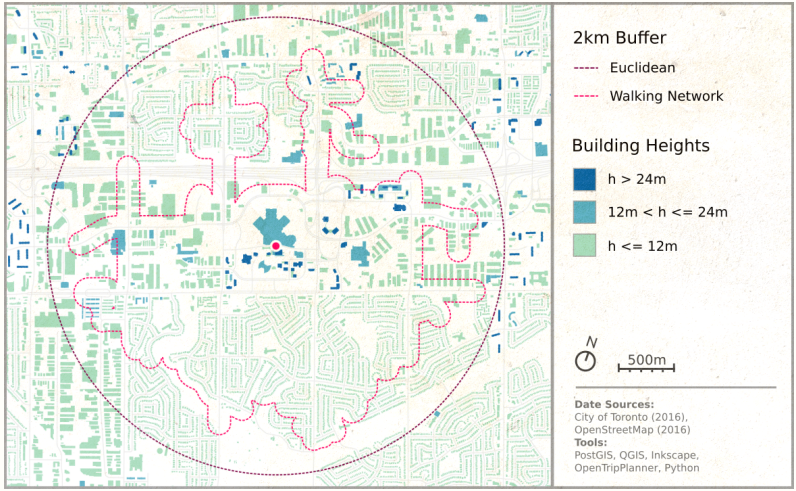
shortest-path by car (8 min, 3.0 km)



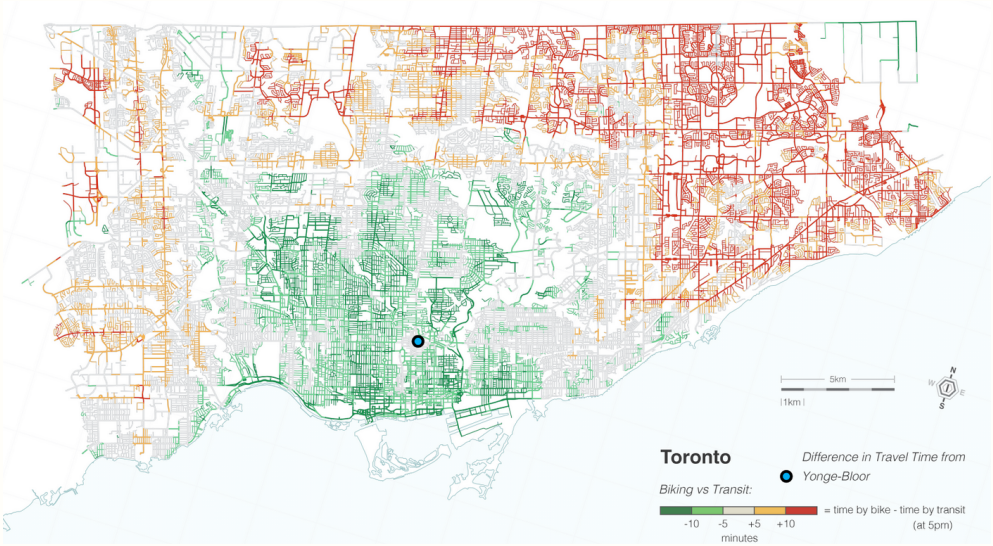


Source: Google Maps (2019)

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

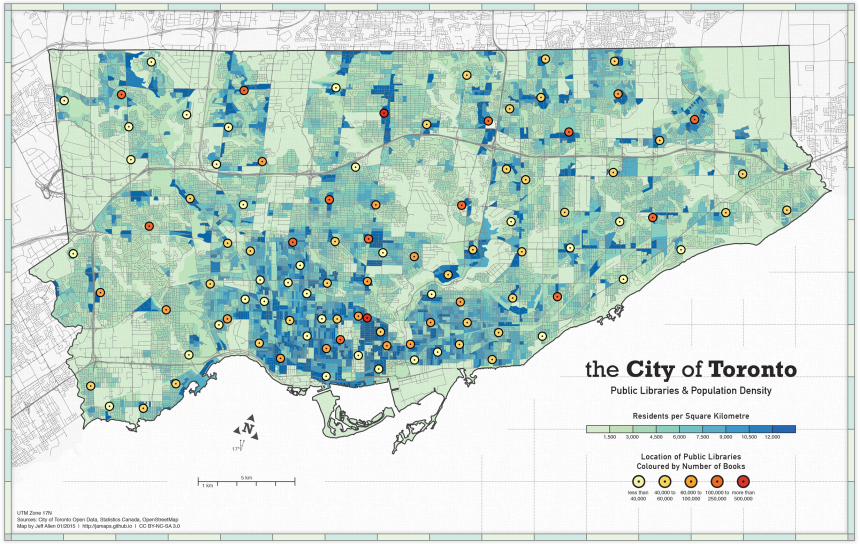
Closest Facility Analysis - finding the nearest location(s) from a set of locations distributed over space

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)

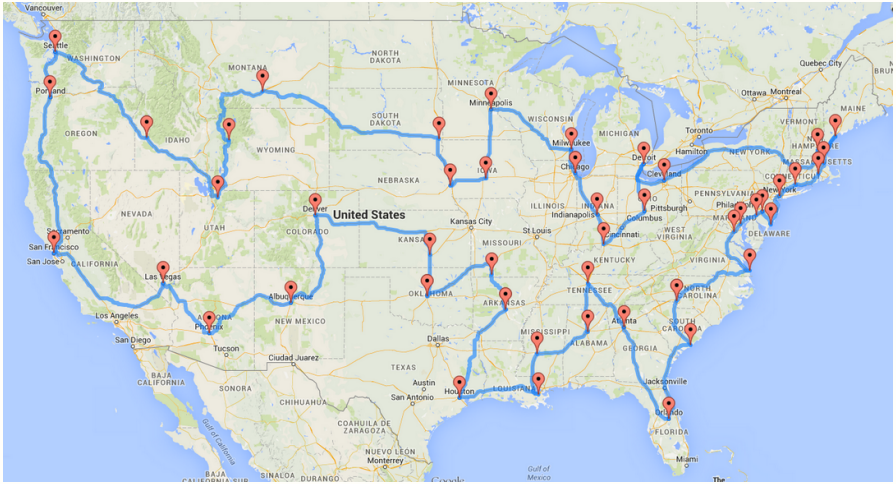


Source: https://commons.wikimedia.org/wiki/File:Toronto_Public_Libraries_and_Population_Density.png

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/