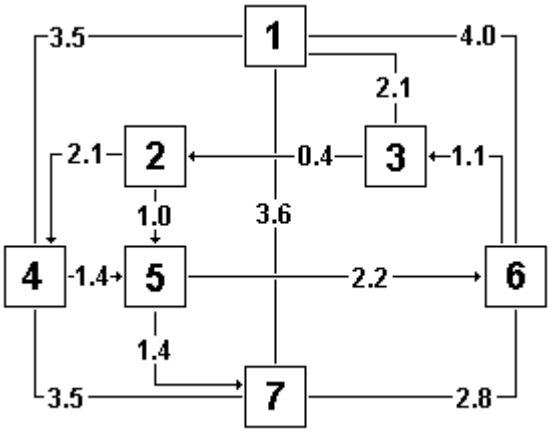
Department of Civil & Environmental Engineering Fall 2024
CEE 228a Urban Transportation Networks Dr MG McNally

Project 1. Tromaville Automated Guideway Transit System

The Tromaville Automated Guideway Personal Rapid Transit (TAGPRT) system operates in downtown Tromaville with seven stations (nodes) and nineteen connecting links, as shown in the figure below. The length of each link (in miles) is shown on the link (labeled by its origin and its destination). Note that there are both one-way (arrows) and two-way links.



PM-peak Origin/Destination Demand (Vehicle-trips/hour)

from\to	1	2	3	4	5	6	7	O(i)
1	0	0	7	10	0	3	0	20
2	20	0	5	0	0	25	10	60
3	30	0	0	20	0	20	20	90
4	5	5	0	0	0	0	15	25
5	20	10	3	15	0	2	0	50
6	5	0	0	5	5	0	25	40
7	20	5	5	20	5	20	0	75
D(j)	100	20	20	70	10	70	70	360

Inspection of the trip table indicates a substantial imbalance in the vehicle movements during the PM-peak, with generally more destinations than origins at nodes (stations) around the system perimeter, and more origins than destinations at the central nodes. This imbalance implies that empty vehicles will have to be shuttled in the system, since there are not enough vehicles to maintain a net outflow from any station for any extended period.

TAGPRT wants an optimal routing scheme for empty vehicles in the system during the PM-peak.

1. *Compute* the minimum paths in the network. Be sure to consider one-way links. Assume that sufficient capacity exists for any routing plan:
   - 1.1 *Solve* using Dijkstra's Algorithm [one node by hand; software *verify* if possible]
   - 1.2 *Solve* using Floyd's Algorithm [start by hand; *finish* via software if available]
   - 1.3 *Discuss* the two algorithms and the results.

2. *Formulate* this Transportation Problem for solution via a **Linear Program**:
   - 2.1 *Provide* the complete model specification and discuss.
   - 2.2 *Set up* the SIMPLEX Tableau; *solve* by hand if you've never done this before. *Solve* the problem using any software package. *Provide* all intermediate results.
   - 2.3 *Discuss* the optimal solution(s) and the associated sensitivity analysis.
   - 2.4 *Reformulate* the problem by specifying the **Dual**. *Discuss* this formulation relative to the sensitivity analyses and relative to potential solution algorithms.

3. *Formulate* this Transportation Problem for solution via Hitchcock's algorithm (HTA):
   - 3.1 *Produce* an initial feasible solution and solve (perform at least two iterations of the Transportation Algorithm by hand). *Verify* with available software.
   - 3.2 *Produce* an initial feasible solution using an alternative rule.
   - 3.3 What assumptions are implied concerning the optimal allocation and the capacity of the system? *Discuss*.
   - 3.4 *Compare and discuss* the LP and HTA solution techniques.

Reformulate the TAGPRT *empty vehicle* routing problem to more accurately depict the role of independent links and their capacities (link-based). The representation of the problem according to the standard format of the Transshipment Problem (TP) resolves the capacity-related problems and allows for the extension of the problem to a multi-commodity transshipment problem, a stage which enables us to properly formulate the problem of network equilibrium assignment.

4. *Formulate* the problem as a standard Transshipment Problem (NOT an extended HTP).
   - 4.1 *Develop* the problem's system of equations. **Discuss** the problem as a linear program. *Draw and compare* the "network" for HTP and TP.
   - 4.2 *Solve* the LP-problem using any available software package.
   - 4.3 *Reformulate* the problem for the Out-of-Kilter (or other general network) algorithm. *Draw* the OKA network and **discuss** the process and the results. No need to solve.

5. The minimum paths in a network: Revisited. *Formulate* a **minimum path** problem using the basics of the transshipment problem. *Find* the LP solution.

6. **Discuss** how would you approach the combined problems of distributing full vehicles (the original demand matrix) and the empty-vehicle matrix utilized above?

You must work independently: do not discuss problem formulation with anyone except me. Report Guidelines at: http://www.its.uci.edu/~mmcnally/proj-style.html]