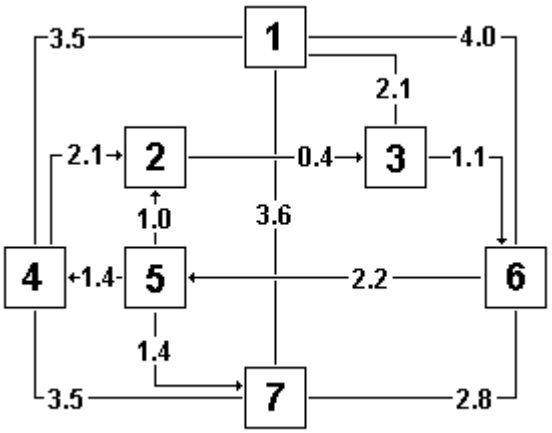
Project 1. Tromaville Automated Guideway Transit System

The Tromaville Automated Guideway Transit System (TAGTS) 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.



AM-peak Origin/Destination Demand (Person-trips/hour)

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

Assume a capacity of one person per vehicle. Inspection of the trip table indicates an imbalance in vehicle movements during the AM-peak, with generally more origins than destinations at nodes (stations) around the system perimeter, and more destinations than origins 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.

TAGTS wants an optimal routing scheme for empty vehicles in the system during the AM-peak.

CEE 228a Urban Transportation Networks I Winter 2024
Project 1. Tromaville Automated Guideway Transit Dr MG McNally

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 [Recommend doing one node by hand]
   1.2 *Solve* using Floyd's Algorithm [recommend start by hand; *finish* via software]
   1.3 *Discuss* and *compare* the two algorithms and the results.

2. *Formulate* this Transportation Problem for solution via a **Linear Program**:
   2.1 *Provide* the complete model specification (path-based) and discuss.
   2.2 *Set up* the SIMPLEX Tableau (recommend *solving* by hand if you've never done this before). *Solve* the problem using any software. *Provide* 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**:
   3.1 *Produce* an initial feasible solution and solve (perform at least two iterations of the Transportation Algorithm by hand). *Verify* with LP2 or other 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* the two solution techniques (LP vs. HTP).

Reformulate the TAGTS *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 that enables us to properly formulate the problem of network equilibrium assignment.

4. *Formulate* the problem as a standard **Transshipment Problem** (NOT extended HTP).
   4.1 *Develop* the problem's system of equations. **Discuss** the problem as a linear program. *Compare* the "network" for the path-based HTP and the link-based TP.
   4.2 *Solve* the LP-problem using any available software package.
   4.3 *Reformulate* the network for use with an Out-of-Kilter (or other general network) algorithm. *Draw* the OKA network and **discuss** the process (do **not** solve).

5. Minimum paths in a network: Revisited. *Formulate* a **minimum path** mathematical program 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 (do not solve)?

You must formulate the empty vehicle problem **independently**: don't discuss problem formulation with anyone except me. You may work on the remainder together. It's practice for the midterm.