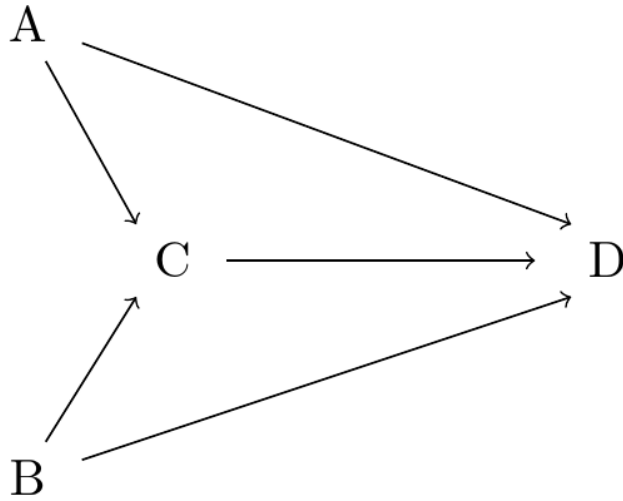


# Homework 5: Network Assignment and Validation

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Given a network of



and link travel time equations of

$$\begin{aligned}t_{AD} &= 20 + 0.01q_{AD} \\t_{AC} &= 10 + 0.005q_{AC} \\t_{CD} &= 12 + 0.005q_{CD} \\t_{BC} &= 7.25 + 0.005q_{BC} \\t_{BD} &= 20 + 0.01q_{BD},\end{aligned}$$

with 7000 trips from A to D and 500 from B to D:

## 5.1

We set up a matrix to solve the system of equations:

$$\begin{array}{cccccccccc|c}
 q_{AD} & q_{AC} & q_{CD} & q_{BC} & q_{BD} & t_{AD} & t_{AC} & t_{CD} & t_{BC} & t_{BD} & = \\
 \hline
 0.01 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & -20 \\
 0 & 0.005 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -10 \\
 0 & 0 & 0.005 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & -12 \\
 0 & 0 & 0 & 0.005 & 0 & 0 & 0 & 0 & -1 & 0 & -7.25 \\
 0 & 0 & 0 & 0 & 0.01 & 0 & 0 & 0 & 0 & -1 & -20 \\
 0 & 0 & 0 & 0 & 0 & -1 & 1 & 1 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & -1 & 0 \\
 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 7000 \\
 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 5000 \\
 0 & 1 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0
 \end{array}$$

The first about half of these rows come from the trip time equations. The remaining rows come from the following equations:

$$\begin{aligned}
 t_{AD} &= t_{AC} + t_{CD} \\
 t_{BD} &= t_{BC} + t_{CD} \\
 q_{AD} + q_{AC} &= 7000 \\
 q_{BD} + q_{BC} &= 5000 \\
 q_{CD} &= q_{AC} + q_{BC}.
 \end{aligned}$$

Solving this matrix gives us:

$$\begin{array}{cccccccccccc|c}
 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 4050 \\
 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 2950 \\
 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 4750 \\
 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1800 \\
 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 3200 \\
 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 60.5 \\
 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 24.75 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 35.75 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 16.25 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 52
 \end{array}$$

or:

$q_{AD}$	$q_{AC}$	$q_{CD}$	$q_{BC}$	$q_{BD}$	$t_{AD}$	$t_{AC}$	$t_{CD}$	$t_{BC}$	$t_{BD}$
4050	2950	4750	1800	3200	60.5	24.75	35.75	16.25	52

## 5.2

All-or-nothing (AON) Averages

Iteration	$q_{AD}$	$q_{AC}$	$q_{CD}$	$q_{BC}$	$q_{BD}$	$t_{AD}$	$t_{AC}$	$t_{CD}$	$t_{BC}$	$t_{BD}$	$T_{AD}$	$T_{ACD}$	$T_{BC}$	$T_{BCD}$
1	7000	0	5000	5000	0	90.0	10.0	37.0	32.2	20.0	90.0	47.0	20.0	69.2
2	0	7000	7000	0	5000	20.0	45.0	47.0	7.2	70.0	20.0	92.0	70.0	54.2
3	7000	0	5000	5000	0	90.0	10.0	37.0	32.2	20.0	90.0	47.0	20.0	69.2
4	0	7000	7000	0	5000	20.0	45.0	47.0	7.2	70.0	20.0	92.0	70.0	54.2
Average	3500	3500	6000	2500	2500	55.0	27.5	42.0	19.8	45.0	55.0	69.5	45.0	61.8

## 5.3

Incremental Assignment

Increment	$q_{AD}$	$q_{AC}$	$q_{CD}$	$q_{BC}$	$q_{BD}$	$t_{AD}$	$t_{AC}$	$t_{CD}$	$t_{BC}$	$t_{BD}$	$T_{AD}$	$T_{ACD}$	$T_{BC}$	$T_{BCD}$
0.4	2800	0	2000	2000	0	48.0	10.0	22.0	17.2	20.0	48.0	32.0	20.0	39.2
0.3	2800	2100	4100	2000	1500	48.0	20.5	32.5	17.2	35.0	48.0	53.0	35.0	49.8
0.2	4200	2100	4100	2000	2500	62.0	20.5	32.5	17.2	45.0	62.0	53.0	45.0	49.8
0.1	4200	2800	4800	2000	3000	62.0	24.0	36.0	17.2	50.0	62.0	60.0	50.0	53.2
Final	4200	2800	4800	2000	3000	62.0	24.0	36.0	17.2	50.0	62.0	60.0	50.0	53.2

## 5.4

FHWA Successive Averages

$n$	$q_{AD}$	$q_{AC}$	$q_{CD}$	$q_{BC}$	$q_{BD}$	$t_{AD}$	$t_{AC}$	$t_{CD}$	$t_{BC}$	$t_{BD}$	$T_{AD}$	$T_{ACD}$	$T_{BD}$	$T_{BCD}$
0	0	0	0	0	0	20.0	10.0	12.0	7.2	20.0	20.0	22.0	20.0	19.2
1	7000	0	5000	5000	0	90.0	10.0	37.0	32.2	20.0	90.0	47.0	20.0	69.2
2	3500	3500	6000	2500	2500	55.0	27.5	42.0	19.8	45.0	55.0	69.5	45.0	61.8
3	4667	2333	4000	1667	3333	66.7	21.7	32.0	15.6	53.3	66.7	53.7	53.3	47.6
4	3500	3500	6000	2500	2500	55.0	27.5	42.0	19.8	45.0	55.0	69.5	45.0	61.8
5	4200	2800	4800	2000	3000	62.0	24.0	36.0	17.2	50.0	62.0	60.0	50.0	53.2
Final	4200	2800	4800	2000	3000	62.0	24.0	36.0	17.2	50.0	62.0	60.0	50.0	53.2

## 5.5