

CE 3500: Group Assignment 1 (30 points)
Due Friday, February 25

Your team of consultants has been hired by the city of Laramie to help them design an effective bus system. The city has given you their planning map as a starting point, containing major streets (see Figure 1). There are six zones, shaded in gray in the figure (North Laramie, South Laramie, East Laramie, West Laramie, UW, and Downtown). They also give you files containing node coordinates (`laramie_node.txt` on the course website) and link information (`laramie_net_ampapeak.txt` and `laramie_net_offpeak.txt`) but they have left the OD matrix blank because their model is out of date. You are also given zone information from the census (Table 1), results from a recent travel survey (Table 2) and a table of friction factors (Table 3).

The city's budget allows them to operate three buses, and they want to know how to do so in the way which is the most helpful to Laramie citizens, measured according to the total ridership. To satisfy your contract with the city, your team has to accomplish the following tasks:

1. Run the four-step model to identify the travel time on each roadway link during the AM peak, offpeak, and PM peak. For this base case, there is no bus system, so you should skip mode choice and assume everyone will drive.
2. Identify the routes each bus will take during the AM peak, offpeak, and PM peak periods. Each route must be a loop, and you can describe it by the node numbers it passes. More than one bus can use the same route.
3. Calculate the total bus ridership for your route choices (described below).

You might need the following information as well for the first task:

- As described in class, we only consider work and shopping trips. (For this assignment you might think of “work” trips to UW including students going to class.) Each work production results in one trip from home to work in the AM peak, and one from work to home in the PM peak. Each shopping production results in one trip from home to shopping *and* a return trip from shopping to home during the offpeak period.
- The equation for work attractions to a zone is $A_w = 125w$, where w is the number of workplaces or schools in that zone.
- The equation for shopping attractions to a zone is $A_s = I/10 + T/100$ where I is the average income in that zone, and T is the sales tax receipts from that zone (in thousands of dollars).
- Assume that the travel times will not change after the bus system is in place (that is, you do not have to redo route choice after).
- Separate network files are provided for the AM/PM peak periods and the off-peak because the latter is longer (and therefore roadway “capacity” is higher).

For the third task, you calculate ridership using the following procedure:

1. Identify the OD pairs which might possibly use the bus — Assume that *if there is no bus route directly connecting an origin to a destination, nobody from that OD pair will travel by bus*. That is to say, we assume nobody will transfer buses, take a bus to UW and walk downtown, etc.
2. For these OD pairs, calculate the travel time by driving (shortest path from origin to destination using the travel times found in the first task) and the travel time on the bus (take the travel time on the bus links from that origin to that destination and increase it by 20% to account for the bus stopping and driving more slowly)

3. Calculate the “frequency” of each bus as the reciprocal of the total travel time on its route. (e.g., if the bus takes 50 minutes to complete its loop, its frequency is $1/50$.)
4. For each OD pair using the bus:
 - (a) Calculate the “total frequency” as the sum of the frequencies of each bus connecting that OD pair. (e.g., if there two buses connecting that origin and destination, one of which comes every 50 minutes and one of which comes every 20 minutes, the total frequency is $1/50 + 1/20$)
 - (b) Calculate the utility of the driving as $U_{dr} = -T_{dr}$ where T_{dr} is the travel time driving.
 - (c) Calculate the utility of taking the bus as $U_{bus} = -1.25T_{bus} + F_{bus}$ where T_{bus} is the travel time by bus and F_{bus} is the total frequency.
 - (d) Find the bus ridership from this OD pair using these utilities.
5. Add the ridership from each OD pair to get the total ridership.

Turn in your answers to the above tasks, along with any supporting documents (spreadsheets can be sent to me via email). Members of the team choosing the best bus routes (highest total ridership) each receive five bonus points. Second and third place receive three bonus points and two bonus points, respectively. If there is a tie, the winning team is the one whose analysis is most thorough and correct¹. If there is still a tie, the team presenting their results most professionally will win.

¹That is to say, you still have a chance at selecting the best alternatives even if you make a calculation mistake somewhere along the way.

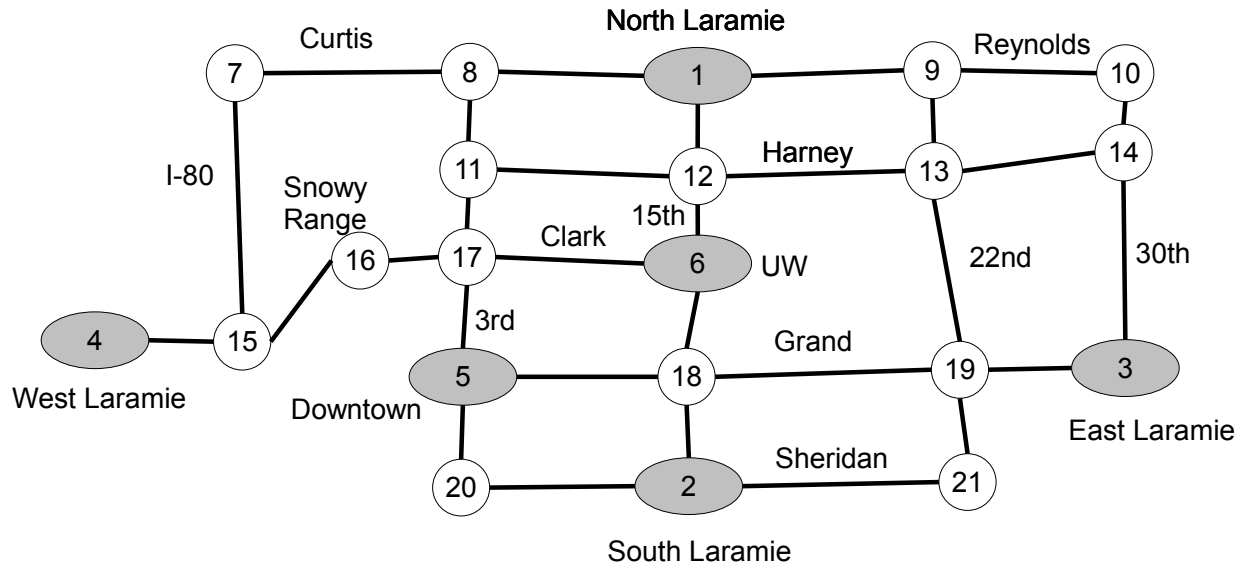


Figure 1: Planning network for Laramie.

Table 1: Zone data for Laramie.

Zone	Households	Income	Workers	Size	Workplaces/Schools	Sales tax receipts
North Laramie	7000	41000	1.4	2.1	8	950
South Laramie	8000	43000	1.1	2.3	13	1150
East Laramie	5000	55000	1.5	3.1	21	14750
West Laramie	4000	35000	1.7	3.2	14	2200
Downtown	2000	71000	1.2	1.7	45	15100
Univ. of Wyoming	10000	13000	3	3.1	65	1800

Sales tax receipts reported in thousands of dollars.

Table 2: Travel survey results.

Household	Size	Workers	Income	Work trips	Shopping trips
1	5	5	86000	1.6	1.3
2	6	3	57000	0.9	1.5
3	1	1	56000	0	0.3
4	5	5	99000	2.1	1.1
5	2	1	69000	0.6	1
6	2	2	39000	0.7	1
7	1	1	61000	0	0.7
8	2	2	29000	0.4	0.7
9	4	3	57000	1.1	1.4
10	6	4	21000	1	0.8
11	3	3	43000	0.5	0.3
12	5	4	81000	1.8	1
13	6	2	109000	0.3	1.6
14	5	4	99000	0.9	1.5
15	1	1	26000	1.2	0.6
16	4	3	96000	0.2	0.8
17	2	2	101000	0.9	0.9
18	4	2	43000	0.2	0.8
19	1	1	85000	0.8	0.7
20	3	2	13000	0.7	1.3
21	4	2	57000	0	0.9
22	5	1	65000	0.9	0.6
23	5	3	13000	0.6	0.4

Table 3: Friction factors.

	NL	SL	EL	WL	DT	UW
NL	1.0	0.3	0.2	0.2	0.5	0.5
SL	0.3	1.0	0.5	0.4	0.7	0.8
EL	0.2	0.5	1.0	0.1	0.5	0.6
WL	0.2	0.4	0.1	1.0	0.4	0.3
DT	0.5	0.7	0.5	0.4	1.0	0.9
UW	0.5	0.8	0.6	0.3	0.9	1.0