STEP Program Description

1 Introduction

This readme file illustrates the use of STEP (Chapter 6 in the textbook) for running sample problems. Two types of examples are presented: deterministic ones and stochastic ones.

2 Deterministic Models

For a deterministic model, one needs two files. The first file called assign1.dat has the number of facilities N and the distance matrix $\mathbf{D}$. An example file Nugent 12 is below.

```
12

0 1 2 3 1 2 3 4 2 3 4 5
1 0 1 2 2 1 2 3 3 2 3 4
2 1 0 1 3 2 1 2 4 3 2 3
3 2 1 0 4 3 2 1 5 4 3 2
1 2 3 4 0 1 2 3 1 2 3 4
2 1 2 3 1 0 1 2 2 1 2 3
3 2 1 2 2 1 0 1 3 2 1 2
4 3 2 1 3 2 1 0 4 3 2 1
2 3 4 5 1 2 3 4 0 1 2 3
3 2 3 4 2 1 2 3 1 0 1 2
4 3 2 3 3 2 1 2 2 1 0 1
5 4 3 2 4 3 2 1 3 2 1 0
```

The second file assign2.dat has the traffic flow matrix $\mathbf{F}$. An example file is below.

```
0  5  2  4  1  0  0  6  2  1  1  1
5  0  3  0  2  2  2  0  4  5  0  0
2  3  0  0  0  0  0  5  5  2  2  2
4  0  0  0  5  2  2 10  0  0  5  5
1  2  0  5  0 10  0  0  0  5  1  1
0  2  0  2 10  0  5  1  1  5  4  0
0  2  0  2  0  5  0 10  5  2  3  3
6  0  5 10  0  1 10  0  0  0  5  0
2  4  5  0  0  1  5  0  0  0 10 10
1  5  2  0  5  5  2  0  0  0  5  0
1  0  2  5  1  4  3  5 10  5  0  2
1  0  2  5  1  0  3  0 10  0  2  0
```

Once when these two files reside in the same directory as the STEP program, then executing the STEP program will yield the solution:

```
Final Iteration =100
Best solution so far has value=   578.0000
5.  9.  1.  8. 12. 11.  3.  7.  2. 10.  6.  4.
```

which is the same as the solution in the Table 6.2 on page 188 of the textbook.

3 Stochastic Models

Stochastic models have an assign1.dat similar to deterministic models but the traffic flow matrix is called $\mathbf{Q}$ because it represents the product of the elements of the traffic flow entering the facility and a transition matrix $\mathbf{P}$, so that

$$q_{ij} = \lambda_i * p_{ij}$$

Let's follow the example in the book on page 184. We have a distance matrix with $N = 6$ related to Figure 6.18. This is file assign1.dat

```
6

0 1 1 2 2 3
1 0 2 1 3 2
1 2 0 1 1 2
2 1 1 0 2 1
2 3 1 2 0 1
3 2 2 1 1 0
```

We then have a $\mathbf{Q}$ flow matrix which actually is the product of elements of $\lambda_i = (4, 1, 1, 1, 3, 1)$ and p_{ij}.

$$\mathbf{P} = \begin{array}{c} \text{activities} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \\ A_6 \end{array} \begin{array}{c} \begin{array}{cccccc} A_1 & A_2 & A_3 & A_4 & A_5 & A_6 \end{array} \\ \begin{bmatrix} - & 0.13 & 0.20 & 0.15 & 0.37 & 0.15 \\ 0.50 & - & 0.00 & 0.10 & 0.40 & 0.00 \\ 0.62 & 0.00 & - & 0.18 & 0.10 & 0.10 \\ 0.28 & 0.18 & 0.20 & - & 0.34 & 0.00 \\ 0.76 & 0.10 & 0.00 & 0.04 & - & 0.10 \\ 0.32 & 0.00 & 0.00 & 0.00 & 0.68 & - \end{bmatrix} \end{array}$$

$$\mathbf{Q} = \begin{array}{c|cccccc} \text{activities} & A_1 & A_2 & A_3 & A_4 & A_5 & A_6 \\ \hline A_1 & 0.00 & .52 & .80 & .60 & 1.48 & .60 \\ A_2 & 0.50 & 0.00 & 0.00 & 0.10 & 0.40 & 0.00 \\ A_3 & 0.62 & 0.00 & 0.00 & 0.18 & 0.10 & 0.10 \\ A_4 & 0.28 & 0.18 & 0.20 & 0.00 & 0.34 & 0.00 \\ A_5 & 2.28 & .30 & 0.00 & 0.12 & 0.00 & 0.30 \\ A_6 & 0.32 & 0.00 & 0.00 & 0.00 & 0.68 & 0.00 \end{array}$$

Here is the assign2.dat file with the $\mathbf{Q}$ matrix.

```
   0    .52    .80   .60  1.48    .60
 .50     0    0.0    .10   .40  0.0
 .62    0.0    0     .18   .10   .10
 .28    0.18   .20    0    .34  0.0
2.28     .30  0.0    .12    0     .30
 .32    0.0   0.0   0.0    .68    0
```

When you execute the step algorithm, you get the following solution.dat file which is the same solution as in the book.

```
Final Iteration =100
Best solution so far has value=   13.88000
4.  5.  2.  6.  3.  1.
```

Finally as a check on the solution if you multiply

$$\lambda = \lambda * \mathbf{P}$$

since the row sums of $\mathbf{P}$ all should add up to 1.