Sequencing of Jobs

Background Information on VBA Programming in Business Economics by Sanne Wøhlk

There are many types of sequencing and scheduling problems ranging from the scheduling of units to facilities, scheduling jobs on a single machine or on multiple machines, to the creation of production plans for complicated productions. The literature regarding the subject is abundant and it is beyond the scope of this text to consider the subject in depth. We refer the interested reader to Nahmias, 1997 - a classic textbook on the subject.

The variation to be considered in this text is as follows: *n* jobs are to be processed on a single machine. The setup time, i.e. the time it takes to prepare the machine for the processing of a single job, depends both on the current job and on the preceding job. The goal is to determine a processing sequence starting from an initial setup such that the sum of the setup times is minimized. This problem was first considered by Gavett, 1965.

Let t_{ij} be the setup time for job *j* if job *i* has just been processed and let t_{0j} be the setup time of job *j* if this is the first job to be processed. As an example, consider the following table of setup times.

i \ j	**1**	**2**	**3**	**4**
0	5	6	3	4
1		4	7	5
2	4		6	6
3	2	7		5
4	7	5	2	

Gavett, 1965, suggests three heuristics for the problem. In this text we consider two of these: The *Next Best* strategy and the *Next Best After Column Deductions*. The former is often referred to as a greedy strategy.

The *Next Best* strategy is as follows: First process the job with the smallest initial setup time, i.e the job *j* for which t_{0j} is smallest. Then, until all jobs have been processed, select among the unprocessed jobs a job *j* with smallest t_{ij}, where *i* is the job just processed.

When applying the *Next Best* strategy to the above data, first job 3 is selected since it has the smallest initial setup time (which is 3). The next job is found by choosing the smallest value of 2, 7, and 5, which is 2. Hence job 1 is selected. After job 1, the job with smallest setup time is selected among jobs 2 and 4 because job 3 has already been processed. Job 2 is selected leaving only job 4. Hence, the processing sequence based on this strategy is 0-3-1-2-4 with a total setup time is 3+2+4+6 = 15.

The *Next Best After Column Deductions* is as follows: First the smallest value in each column is subtracted from every value in that column to create a transformed table. Then the *Next Best* strategy is applied to that table. To clarify the transformation we let t'_{ij} be the values of the transformed table. For each j = 1, … n let $t'_{ij} = t_{ij} - \min_{k=0,\dots n}\{t_{kj}\}$. Note that when applying this strategy the setup time should be calculated based t_{ij} not on t'_{ij}.

When applying the *Next Best After Column Deductions* to the above data, first the smallest number in each column is identified to be 2, 4, 2, and 4, respectively. These values are subtracted from every value in the column they represent. The resulting transformed table is shown below. Note that due to the construction each column will contain at least one zero.

i \ j	1	2	3	4
0	3	2	1	0
1		0	5	1
2	2		4	2
3	0	3		1
4	5	1	0	

After transforming the data, the *Next Best* strategy is applied to the transformed data. Doing that we obtain the sequence 0 – 4 – 3 – 1 – 2. The total setup time, determined using the original data table is 4+2+2+4 = 12.

Bibliography

Gavett. (1965). Three Heuristics for Sequencing Jobs to a Single Production Facility. *Management science , 11* (8), B-166 - B-176.

Nahmias. (1997). *Production and Operations Analysis* (3rd Edition ed.). McGraw-Hill.