

Chapter 479

Assignment

Introduction

The object of the assignment algorithm is to assign n objects (workers, machines, etc.) to the same number of jobs (tasks) in such a way that will minimize the total cost. The problem assumes that only one task is assigned to each object. Although special assignment algorithms exist, NCSS solves the problem using the Mixed Integer Programming algorithm available in the *Extreme Optimization* mathematical subroutine package.

Assignment Model

We will present the assignment model using the following example. Suppose four consultants are available to work on four tasks. Each task is expected to take about one week to complete and all must be completed during this week (no consultant can be assigned two tasks). The consultants have bid on each of the tasks. The following table gives their bids. The challenge is to find solution that will minimize the total cost of performing all four tasks. The solution is shown by the entries that are underlined and bolded.

Consultant Bids

<u>Consultant</u>	<u>Task1</u>	<u>Task2</u>	<u>Task3</u>	<u>Task4</u>
A	1050	1300	<u>1625</u>	900
B	1050	1350	1650	<u>1000</u>
C	<u>1000</u>	1400	1700	950
D	1150	<u>1300</u>	1660	1250

In this example, you might have been able to guess the solution by hand. However, this would become increasingly hard to do as the size of the problem becomes larger. The solution is found using mixed integer programming. You could code this problem to run in that procedure or in the transportation algorithm procedure. This separate, specialized procedure simplifies the input.

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Data Structure

This procedure requires a special data format in which the rows represent the objects (workers, machines, etc.) and the columns represent the tasks. The cell entries are the costs for the worker to complete the task. Here is the way the above example would be entered. It is stored in the dataset *Assignment*.

Assignment dataset

Consultant	Task1	Task2	Task3	Task4
A	1050	1300	1625	975
B	1050	1350	1650	1000
C	1000	1400	1700	950
D	1150	1300	1660	1250

Procedure Options

This section describes the options available in this procedure.

Specifications Tab

Set the specifications for the analysis.

Optimum Type

Type of Optimum

Specify whether to find the minimum or the maximum.

Cost or Profit Matrix (Workers as Rows, Jobs as Columns)

Jobs Columns

Specify the columns containing the costs (or profits). Each column represents a possible task or job. Each row represents a different worker or person available to perform the tasks. The cell entries give the cost of have the corresponding person (row) perform the corresponding task (column).

Usually, the cost values are positive. Blanks are treated as zeros.

Label of Worker Column

Optionally specify a column containing a label for each row (worker). These labels are used to make the output easier to interpret.

Reports Tab

Select Reports

Costs Report, Solution Report

Indicate which reports you want to view.

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Report Options

Variable Names

This option lets you select whether to display only variable names, variable labels, or both.

Precision

Specify the precision of numbers in the report. Single precision will display seven-place accuracy, while double precision will display thirteen-place accuracy.

Report Options – Decimal Places

Input Values

These options let you designate the number of decimal places to be displayed for each type of variable.

Example 1 – Consultant Assignment

This section presents an example of how to run the data presented in the example given above. The data are contained in the *Assignment* database. Here is the data.

Assignment dataset

Consultant	Task1	Task2	Task3	Task4
A	1050	1300	1625	975
B	1050	1350	1650	1000
C	1000	1400	1700	950
D	1150	1300	1660	1250

You may follow along here by making the appropriate entries or load the completed template **Example 1** by clicking on Open Example Template from the File menu of the Assignment window.

1 Open the Assignment dataset.

- From the **File** menu of the NCSS Data window, select **Open Example Data**.
- Click on the file **Assignment.NCSS**.
- Click **Open**.

2 Open the Assignment window.

- Using the Analysis menu or the Procedure Navigator, find and select the **Assignment** procedure.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the problem.

- On the Assignment window, select the **Specifications tab**.
- Set **Type of Optimum** to **Minimum**.
- Double-click in the **Job Columns** text box. This will bring up the column selection window.
- Select columns **Job1-Job4** from the list of columns and then click **Ok**. “Job1-Job4” will appear in this box.
- Double-click in the **Labels of Worker Column** text box. This will bring up the column selection window.
- Select **Consultant** from the list of columns and then click **Ok**. “Consultant” will appear in this box.

4 Run the procedure.

- From the **Run** menu, select **Run Procedure**. Alternatively, just click the green Run button.

Assignment

Costs for Workers Assigned to Jobs

Worker	Possible Jobs			
	Job1	Job2	Job3	Job4
A	1050	1300	1625	975
B	1050	1350	1650	1000
C	1000	1400	1700	950
D	1150	1300	1660	1250

This report lists the individual costs that were input.

Job Assignment Solution to Minimize Cost

Worker	Assigned Task	Cost
A	Job3	1625
B	Job4	1000
C	Job1	1000
D	Job2	1300
Minimum Cost		4925
Solution Status: The model is optimal.		

This report presents the solution. The report lists each worker with the task they are assigned to and the cost of having them perform that job.

Worker Assignment Solution to Minimize Cost

Task	Assigned Worker	Cost
Job1	C	1000
Job2	D	1300
Job3	A	1625
Job4	B	1000
Minimum Cost		4925
Solution Status: The model is optimal.		

This report presents the solution. The report lists each worker with the task they are assigned to and the cost of having them perform that job.