

Chapter 390

Area Under Curve

Introduction

Suppose you are studying a drug that influences plasma concentration. A popular method of looking at the absorption and elimination properties of the drug is to follow the plasma concentration across time. When the concentration values are plotted on the vertical axis, the time values are plotted on the horizontal axis, and the points are joined with a line, a curve results. One method of making comparisons among different types of drugs and different doses of the same drug is to compute the area under the curve (AUC).

AUC is computed by the trapezoidal rule as follows:

$$AUC = \frac{1}{2} \sum_{i=1}^{n-1} (T_{i+1} - T_i)(C_{i+1} + C_i - 2B)$$

where T_i is the i^{th} time value, C_i is the i^{th} concentration value, n is the number of time values, and B is the baseline value. The area between the baseline and the curve is computed by this formula.

The AUC should be calculated from zero to a time at which the concentration has returned to its regular levels. Also, when making comparisons, you should insure that all AUC's are computed for the same time intervals.

Data Structure

Two different data structures may be used to store data for analysis by this procedure. In the first format, the X (time) values are stored in one variable and the Y (concentration) values are stored in other variables, one variable per group. The AUC dataset is in this format.

In the other format, the X values are stored in one variable, group values are stored in a second variable, and the measurements are stored in a third variable. The data in the AUC dataset was reorganized to be in this format in the AUC1 dataset.

Format Type 1

AUC dataset

Time	P1	P2	P3
0	5	4	6
1	15	14	17
2	20	16	22
3	21	18	23
4	21	17	25
5	19	15	22
10	15	12	18
50	6	3	7

Format Type 2

AUC1 dataset

Time	Subject	Concentration
0	P1	5
1	P1	15
2	P1	20
3	P1	21
4	P1	21
5	P1	19
10	P1	15
50	P1	6
0	P2	4
1	P2	14
2	P2	16
3	P2	18
4	P2	17
5	P2	15
10	P2	12
50	P2	3
0	P3	6
1	P3	17
2	P3	22
3	P3	23
4	P3	25
5	P3	22
10	P3	18
50	P3	7

Procedure Options

This section describes the options available in this procedure.

Variables Tab

Specify the variables on which to run the analysis.

Variables

Y Variables

Specify one or more vertical (Y) variables. These variables contain the measurements.

When multiple Y variables are specified, a separate AUC calculation is made for each variable. When only one Y variable is given, you must also specify a Break Variable. You cannot specify both a break variable and multiple Y variables.

X Variable

This option specifies the horizontal (X) variable. Usually, X represents the time at which the measurement was made.

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Break Variable

Specify an optional break variable used to separate the X and Y variables into groups. A separate AUC calculation is made for each unique value of this variable. When this variable is specified, only one Y variable may be used.

Model

Baseline

This option specifies a baseline value for the area under the curve. Usually, this value is zero.

The area between a horizontal line at this value and the data points is calculated. Points below this amount count as negative area (they are subtracted). Points above this value are added. The trapezoidal formula is used to calculate the area.

Reports Tab

Select Reports

AUC Report and Data Report

These options specify whether the corresponding reports are displayed.

Report Options

Precision

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

Variable Names

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

Value Labels

This option lets you select whether to display only values, value labels, or both. Use this option if you want the table to automatically attach labels to the values (like 1=Yes, 2=No, etc.). See the section on specifying *Value Labels* elsewhere in this manual.

Plots Tab

These options specify the data plot.

Select Plots

Data Plot

This option specifies whether to display the data plot. Click the plot format button to change the plot settings.

Example 1 – Calculating Area Under the Curve

This section presents a tutorial of calculating the AUC for three individuals labeled P1, P2, and P3. The data are contained on the AUC dataset.

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 Area Under Curve window. The corresponding setup for the AUC1 dataset is given as the **Example 2** template.

1 Open the AUC dataset.

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

2 Open the Area Under Curve window.

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

3 Specify the variables.

- On the Area Under Curve window, select the **Variables tab**.
- Double-click in the **Y Variables** text box. This will bring up the variable selection window.
- Select variables **P1, P2, P3** from the list of variables and then click **Ok**. “P1-P3” will appear in this box.
- Double-click in the **X Variable** text box. This will bring up the variable selection window.
- Select **Time** and then click **Ok**. “Time” will appear in this box.

4 Specify the reports.

- On the Area Under Curve window, select the **Reports tab**.
- Check the **Data Report**. The other reports should be checked already.

5 Run the procedure.

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

Area Section

Area Section	Area Under Curve	Y Max	Time at Max of Y	Time Min	Time Max	Count
P1	594	21	3	0	50	8
P2	442	18	3	0	50	8
P3	701	25	4	0	50	8

This report shows the area under curve as well as supporting information.

Y Variables

This gives the value of the Y variable (if multiple Y variables were specified) or the value of the break variable (if a break variable was specified).

Area Under Curve

This is the area under the curve calculated in the interval between Time Min and Time Max. It is calculated using the trapezoidal formula presented earlier.

Y Max

This is the maximum value of the vertical (concentration) variable. This is an alternative measure of absorption that is sometimes used.

Area Under Curve

Time at Max of Y

This is the value of the time (X) variable at which the maximum Y value (Y Max) was found.

Time Min and Max

These give the horizontal range over which the area was calculated. These values are given so that you can compare them. Under normal circumstances, these values should be equal across groups.

Count

This is the number of X values that were found on the database for this group. This report helps you find missing values.

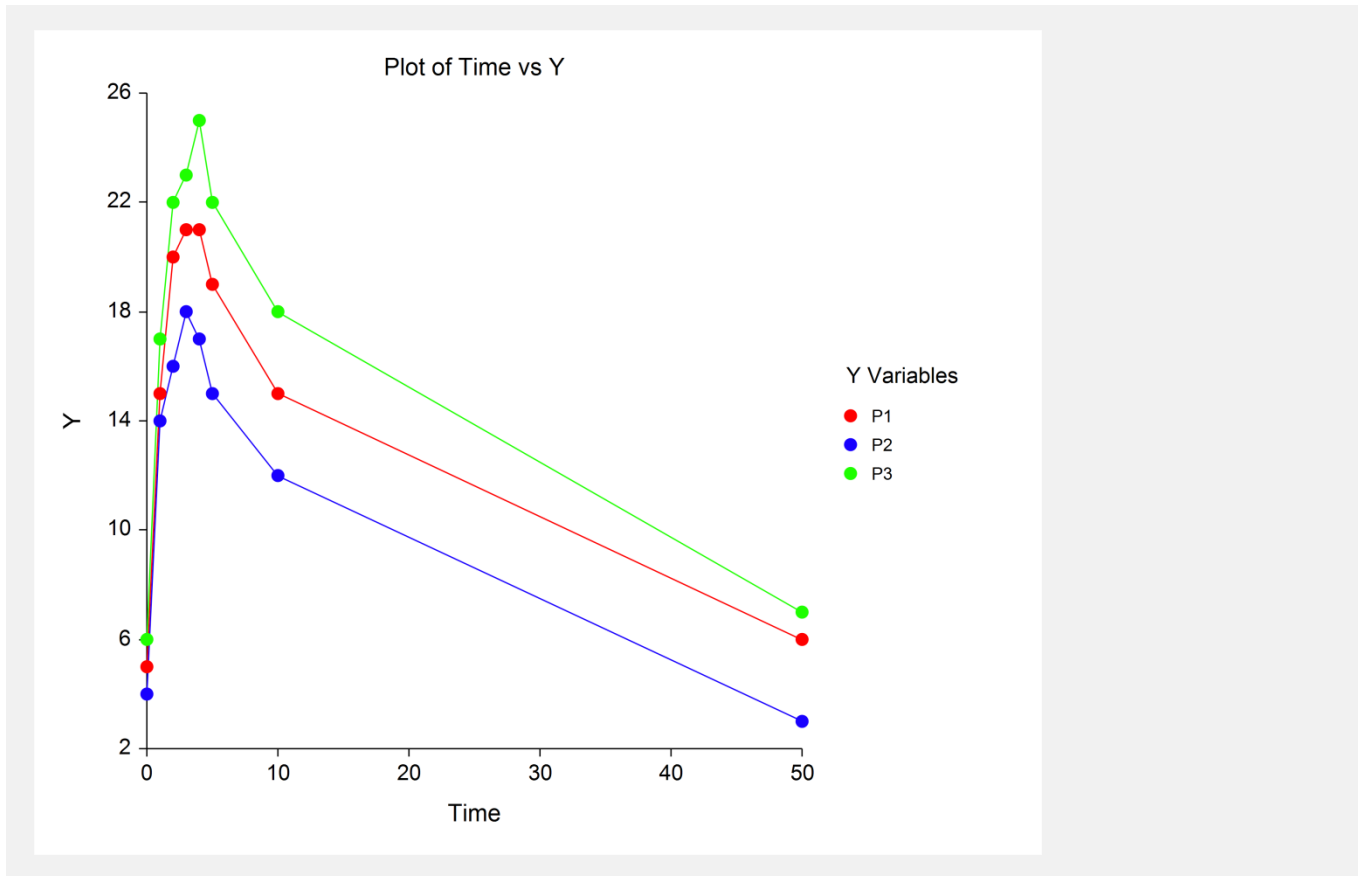
Data Section

Data Section

Y Variables	Time	Y
P1	0	5
P1	1	15
P1	2	20
P1	3	21
P1	4	21
P1	5	19
P1	10	15
P1	50	6
P2	0	4
P2	1	14
P2	2	16
P2	3	18
P2	4	17
P2	5	15
P2	10	12
P2	50	3
P3	0	6
P3	1	17
P3	2	22
P3	3	23
P3	4	25
P3	5	22
P3	10	18
P3	50	7

This report displays the data that are plotted. Note that if you have several measurements at the same time value, only their average is plotted.

Plots Section



This is a plot of the three curves under which the area was calculated. These plots let you spot any data inadequacies.