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 ith time value, C_i is the ith 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 ensure 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

Example 1 – Calculating Area Under the Curve (Multiple Y Columns)

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

Setup

To run this example, complete the following steps:

1   Open the AUC example dataset

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Select **AUC** and click **OK**.

2   Specify the Area Under Curve procedure options

- Find and open the **Area Under Curve** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 1** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

Variables Tab
_____

Y Variable(s)...**P1-P3**
X Variable ....**Time**

Reports Tab
_____

AUC Report ....**Checked**
Data Report ....**Checked**

3   Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Area Section

Area Section with Baseline = 0

Y Variables	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

The 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.

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
.	.	.
.	.	.
.	.	.

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
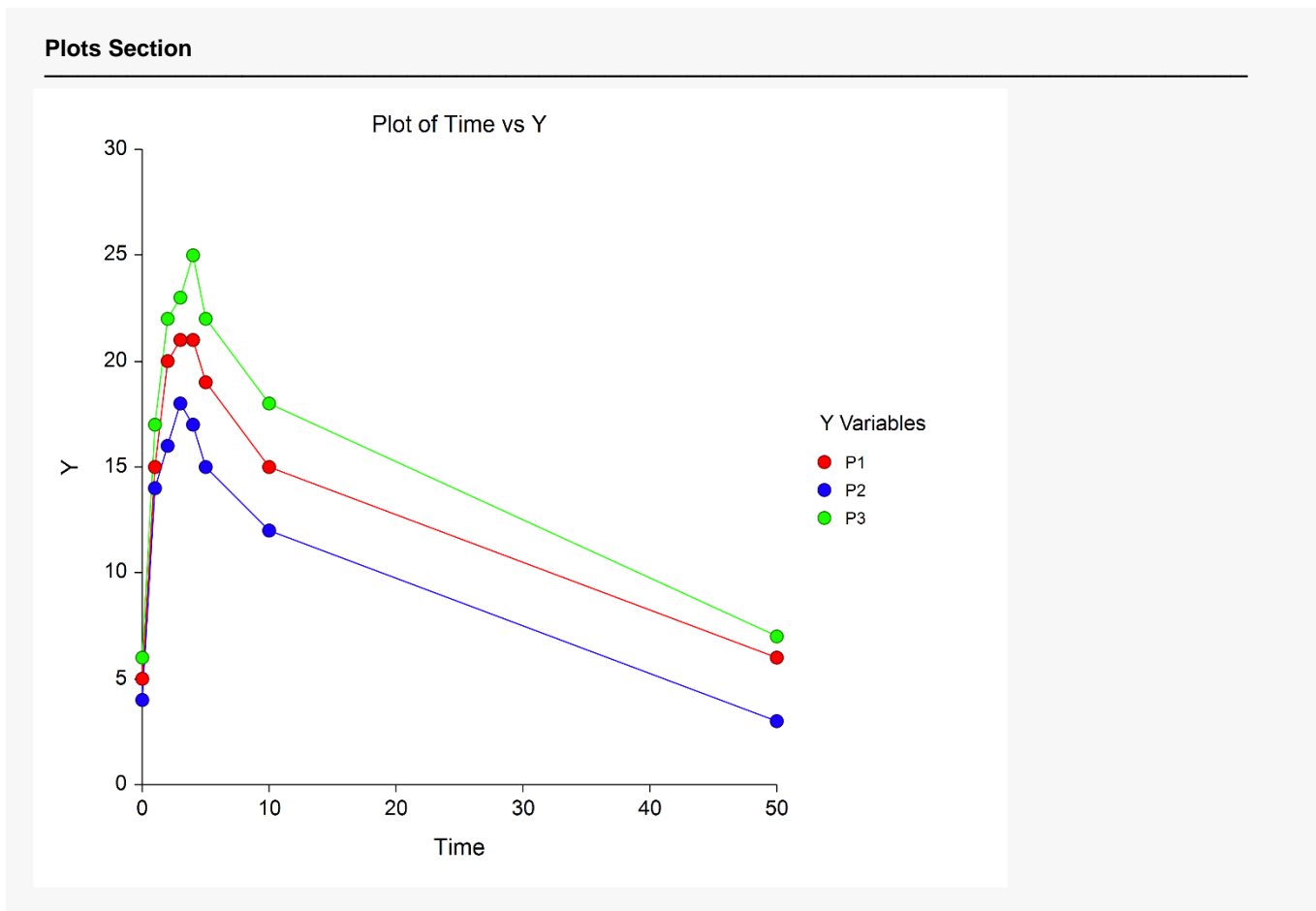
Plots Section
_____

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

Example 2 – Calculating Area Under the Curve (One Y Column and a Break Variable)

This section presents a tutorial of calculating the AUC for three individuals labeled P1, P2, and P3 when the responses for each individual are stacked in a single column. The data are contained on the AUC1 dataset, which is that same as the AUC dataset except that the data have been stacked.

Setup

To run this example, complete the following steps:

1   Open the AUC1 example dataset
- From the File menu of the NCSS Data window, select **Open Example Data**.
- Select **AUC1** and click **OK**.

2   Specify the Area Under Curve procedure options
- Find and open the **Area Under Curve** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 2** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

Variables Tab
_____

Y Variable(s)..**Concentration**
X Variable ....**Time**
Break Variable ....**Subject**

Reports Tab
_____

AUC Report ....**Checked**
Data Report ....**Checked**

3   Run the procedure
- Click the **Run** button to perform the calculations and generate the output.

The results are the same as in those in Example 1.