

DATA ANALYSIS:

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Represent Discrete/Table Data in Functional Form, $y(x)$, for Interpolation, Integration, and Other Calculation in MathCAD

Objective: Represent arbitrary discrete data in functional form and integrate, etc. This is **particularly useful** for measured/data-acquisition or table-property data.

If arbitrary X-Y data ^{*)} are given in a "data" matrix form: data :=

0	1.792
5	1.519
10	1.308
15	1.14
20	1.005
30	0.801
40	0.656
50	0.549
60	0.469
70	0.406
80	0.357
90	0.317
100	0.284

Since the independent data vector X must be in ascending order, sort the data matrix with respect to "0-th (i.e. X) column first, if needed:

$$\text{data} := \text{csort}(\text{data}, 0)$$

Extract data vectors X & Y from the data matrix:

$$X := \text{data}^{\langle 0 \rangle}$$

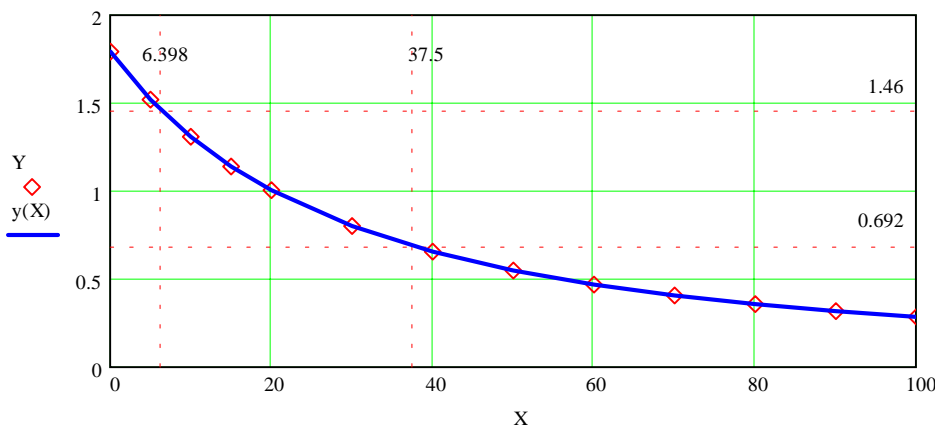
$$Y := \text{data}^{\langle 1 \rangle}$$

NOTE: If you have ready X & Y data vectors, you may ignore the above procedure!

To demonstrate the principle, we will use the simple Linear interpolation (Similarly, Cubic-Spline or Parabolic/Polynomial interpolation may be used):

Fitting function: $y(x) := \text{linterp}(X, Y, x)$

^{*)}The above data are water viscosity (in SI unit) as function of temperature



NOW it is easy to interpolate, integrate, or whatever, or to use function "y(x)" in equations and use MathCAD solving/iterative functions, like "Root," "Given-Find," etc.:

For example: $x_1 := 37.5$ $y_1 := y(x_1)$ $y_1 = 0.692$... value of y_1 for $x_1=37.5$
 $x := 10$... a guess $y_2 := 1.46$ $x_2 := \text{root}(y(x) - y_2, x)$ $x_2 = 6.398$... value of x_2 for $y_2=1.46$

Integral of the fitting function over an "a-b" range:

$$I_r(a, b) := \int_a^b y(x) dx$$

$a := \min(X)$ $a = 0$ $b := \max(X)$ $b = 100$

$I_{\text{range}} := I_r(a, b)$ $I_{\text{range}} = 68.832$ i.e.:

$$\int_a^b y(x) dx = 68.832$$

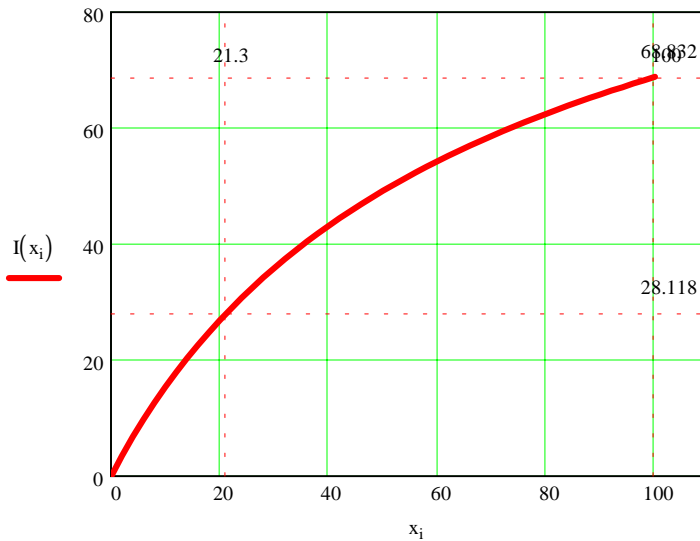
Or, the integral as a function of "x":

$$I(x) := \int_0^x y(\xi) d\xi$$

Note, $I_{a-b} := I(b) - I(a)$

Plot with arbitrary (N+1) points:

$N := 50$ $i := 0..N$ $x_i := a + i \cdot \left(\frac{b-a}{N}\right)$



$b = 100$ $I(b) = 68.832$

$I_{\text{range}} = 68.832$

For any x (e.g., $x=21.3$):

$I(21.3) = 28.118$

NOTE: The "fitting" discrete table data function, $y(x)$, may be used in any formula or math expression, for example:

$$\int_{2.5}^{12.3} \sqrt{y(x)} dx = 11.684 \quad \text{etc.}$$

IMPORTANT NOTE: Interpolation is only reliable within the data range, very risky outside it!