University of Texas MD Anderson Cancer Center
Department of Biostatistics

Parameter Solver, Version 3.0
November 22, 2013
User's Guide

0. Overview

The main purpose of the software is to calculate the parameters describing a standard probability distribution when given either some input quantiles or some input mean and variance. The software can also accept the parameters of a distribution as input and compute the corresponding mean and variance, plus any user-specified quantile. This last feature is equivalent to evaluating an inverse cumulative distribution function. The standard distributions currently supported are: beta, gamma, inverse gamma, normal, log normal and Weibull.

The software may be downloaded from the web site:
http://biostatistics.mdanderson.org/SoftwareDownload/

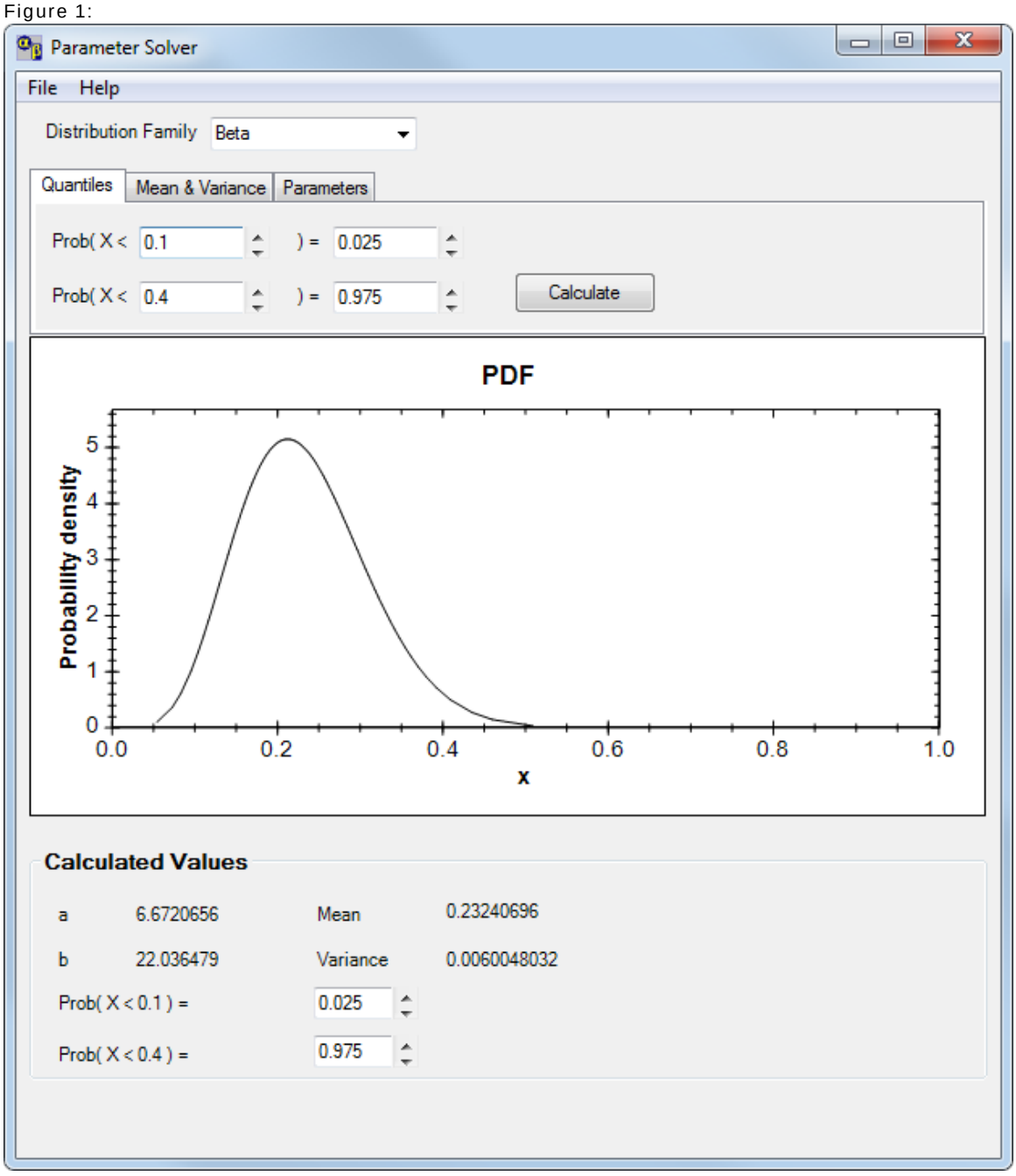
This software occasionally sends usage statistics and crash reports to our biostatistics software support team to improve your experience using it.

License:

1. Quantiles as Input

The program has three options for specifying a probability distribution, which are organized into the three tab pages labeled “Quantiles”, “Mean & Variance” and “Parameters”. Figure 1 shows the first tab page "Quantiles" for computing the parameters of a distribution when given two input quantiles characterizing that distribution. In this example, we wish to find the parameters "a" and "b" of the beta distribution X that has the cumulative probabilities Prob(X < 0.1) = 0.025 and Prob(X < 0.4) = 0.975. After clicking "Calculate", the program returns the approximate values a = 6.672 and b = 22.036 at the bottom, as well as the mean and variance of this distribution. The user may compute another quantile value for this distribution by clicking on a text box at the bottom and using the up/down arrow keys, or by typing in a value and hitting the *Enter* key.

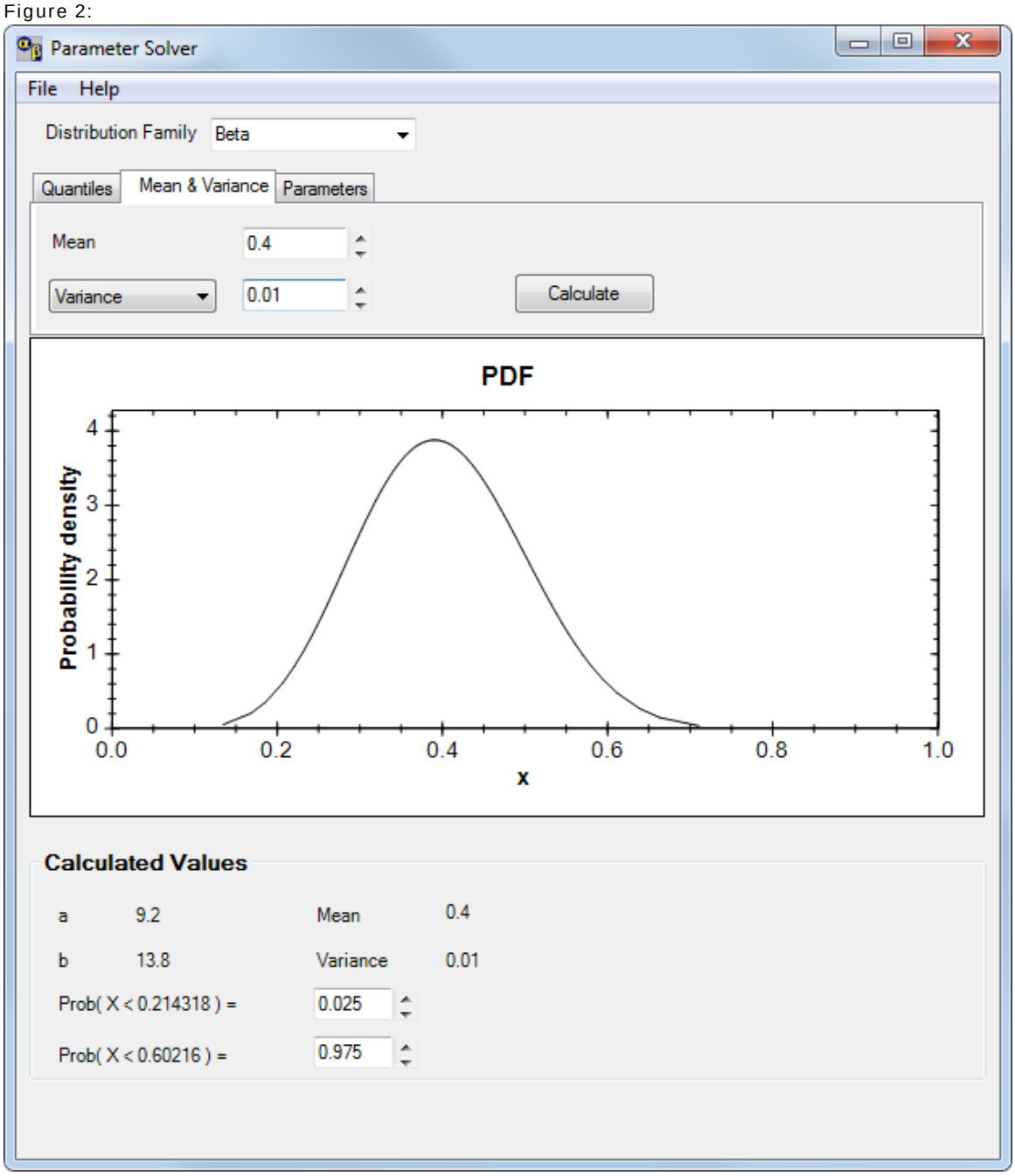
Figure 1:



2. Mean and Variance as Input

Figure 2 shows the second tab page "Mean & Variance" for computing the parameters of a distribution when given the mean and variance of that distribution. The user has the option of specifying a standard deviation rather than a variance as the second parameter. In this example, we specify the mean of a beta distribution as 0.4 and the variance as 0.01. Clicking “Calculate" returns the parameters a = 9.2 and b = 13.8 for this distribution, along with two quantiles shown at the bottom. The user may change the default cut-off probability 0.025 or 0.975 in the text box and hit the *Enter* key to recalculate that quantile.

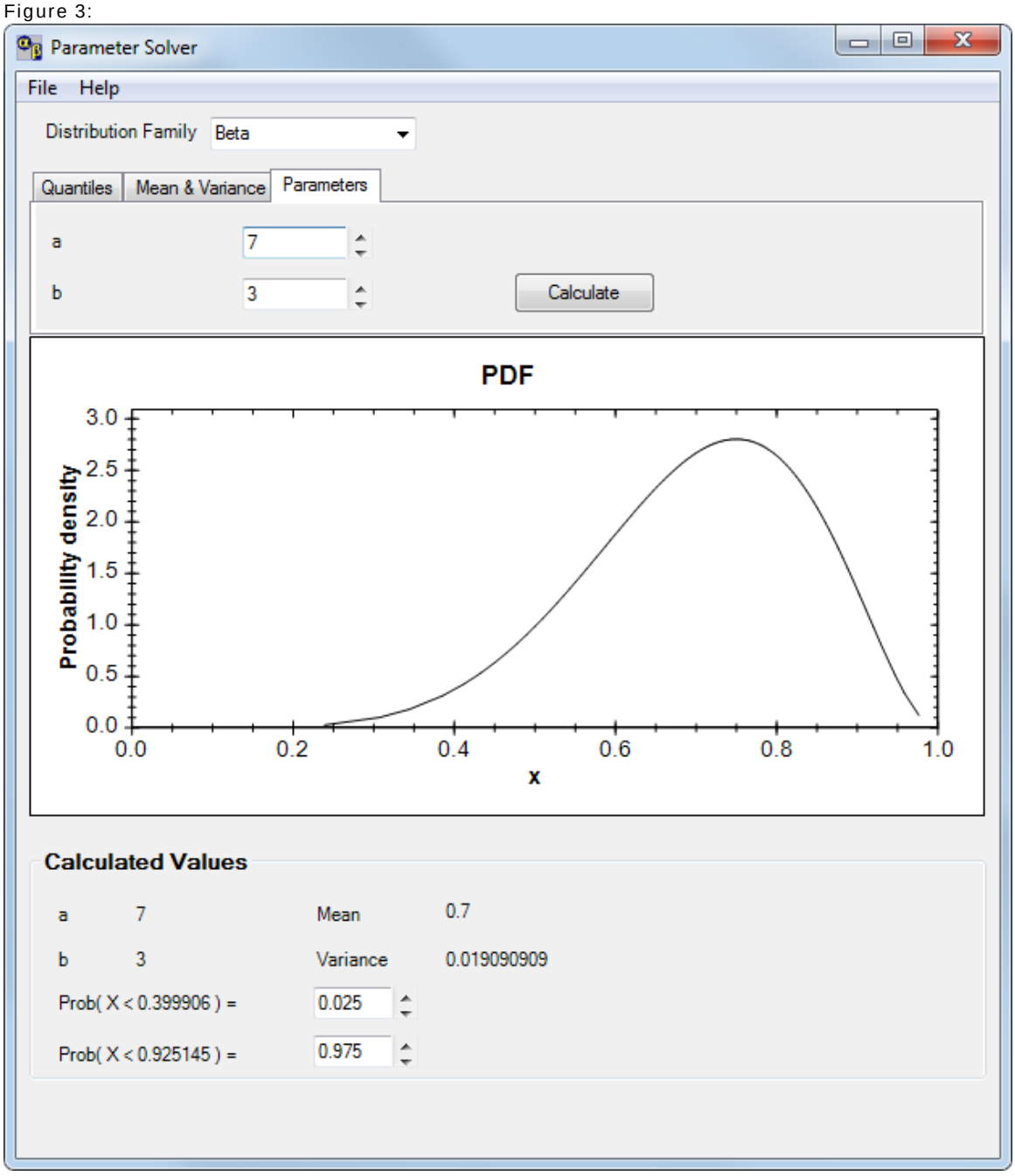
Figure 2:



3. Parameters as Input

Figure 3 shows the third tab page “Parameters”, where the user enters the standard parameters describing a distribution and calculates the resulting mean and variance. In this example, the Beta distribution with parameters a = 7, b = 3 has mean 0.7 and variance 0.0191. It also has approximate quantile probabilities Prob(X < 0.4) = 0.025 and Prob(X < 0.925) = 0.975. Again, the user may change a cut-off probability value, which is equivalent to re-evaluating the inverse cumulative distribution function.

Figure 3:



4. Parameterizations

The software generally follows the conventions (with some exception) in the book *Statistical Distributions* by Merran Evans, Nicholas Hastings, and Brian Peacock.

4.1 Beta

The beta distribution with parameters a and b and has PDF

$$\frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} x^{a-1}(1-x)^{b-1}$$

with mean

$$\frac{a}{a+b}$$

and variance

$$\frac{ab}{(a+b)^2(a+b+1)}$$

4.2 Gamma

The gamma distribution with shape parameter a and scale parameter b has mean ab, variance ab^2 and PDF

$$\frac{1}{\Gamma(a)b^a} x^{a-1}e^{-x/b}$$

4.3 Inverse Gamma

The inverse gamma distribution with shape parameter a and scale parameter b has PDF

$$\left(\frac{b^a}{x^{a+1}\Gamma(a)}\right)e^{-b/x}$$

If $a > 1$ then the mean is

$$\frac{b}{a-1}$$

If $a > 2$ then the variance is

$$\frac{b^2}{(a-1)^2(a-2)}$$

If X is distributed as a gamma distribution with parameters *(a, b)* then $1/X$ is distributed as an inverse gamma with parameters *(a, 1/b)*. Note that the b in our parameterization of the inverse gamma corresponds to *1/b* in another popular convention.

4.4 Normal

The normal distribution parameterized by its mean m and variance s^2 has PDF

$$\frac{1}{s\sqrt{2\pi}} e^{-\frac{1}{2s^2}(x-m)^2}$$

4.5 Log Normal

The log normal distribution is parameterized by m and s. If X is log normal with these parameters, $\log X$ is N(m,s). Note that m and s are *not* the mean and standard deviation of X but rather of $\log X$. The PDF is given by

$$\frac{1}{xs\sqrt{2\pi}} \exp\left(\frac{-(\log(x)-m)^2}{2s^2} \right)$$

with mean

$$\exp\left(m + \frac{1}{2} s^2 \right)$$

and variance

$$\exp(2m+s^2)(\exp(s^2)-1)$$

4.6 Weibull

The Weibull distribution has a shape parameter a and scale parameter b. It has PDF

$$\frac{ax^{a-1}}{b^a} \exp(-(x/b)^a)$$

with mean

$$b\Gamma((a+1)/a)$$

and variance

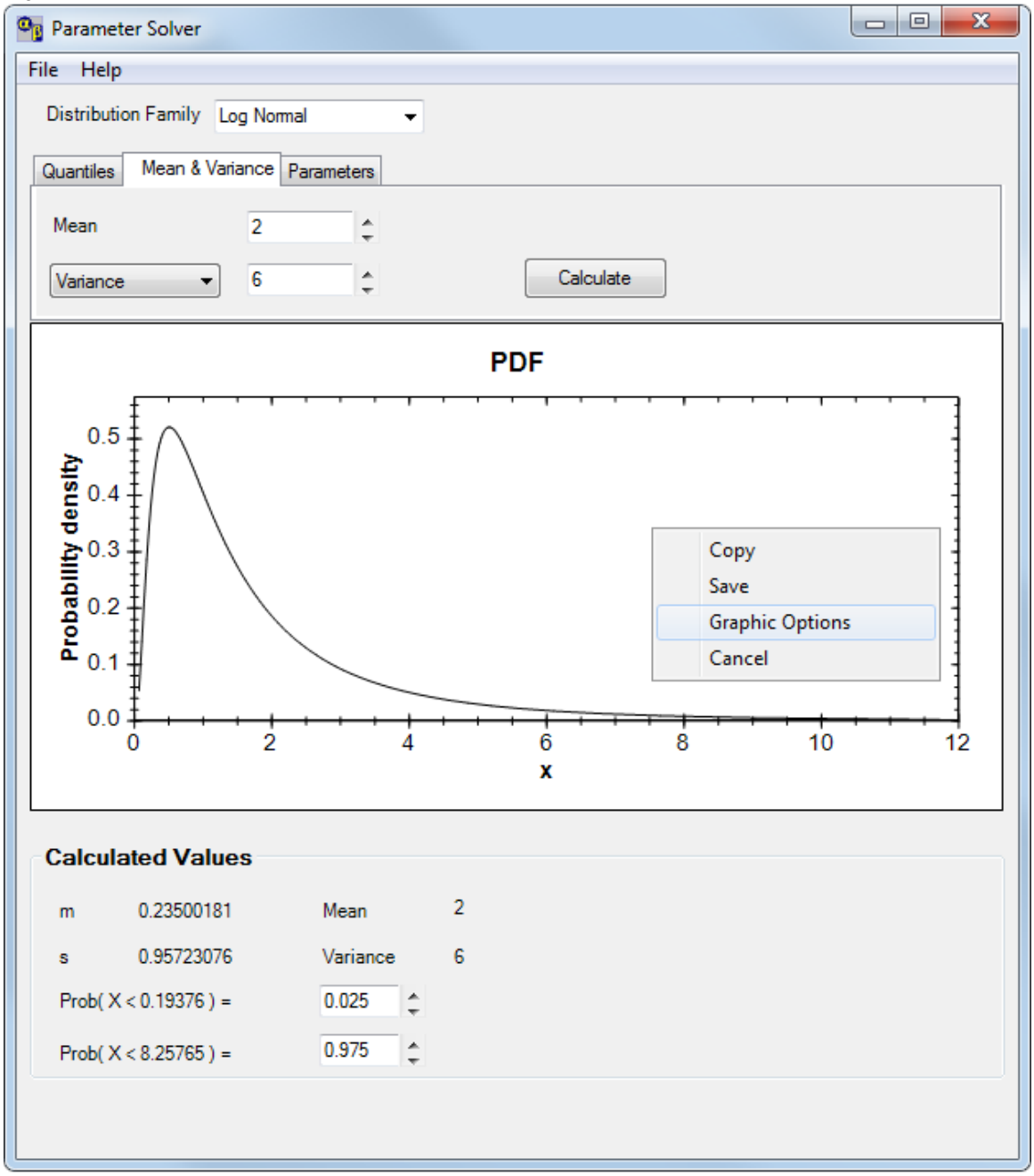
$$b^2\left(\Gamma((a+2)/a) - \Gamma((a+1)/a)^2\right)$$

5. Miscellaneous

5.1 Graphic Options

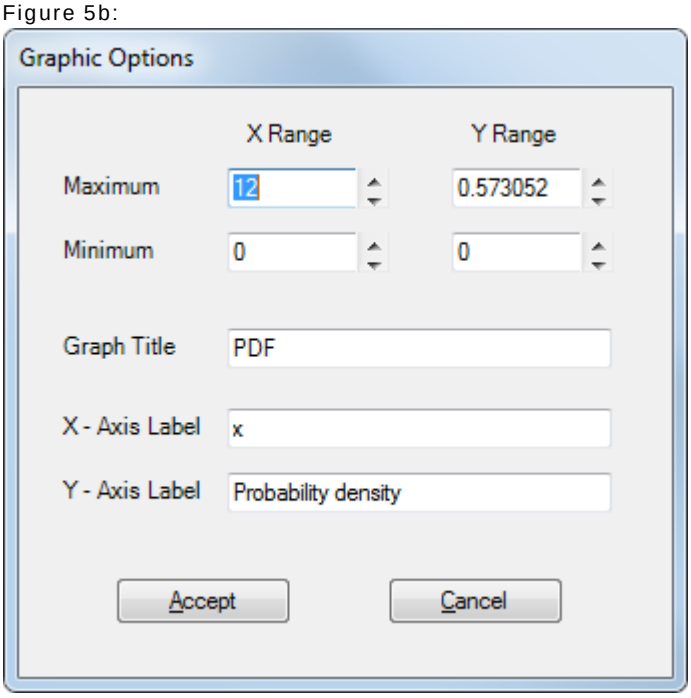
The user may customize the PDF plot by right-clicking on the window to bring up a menu with the item “Graphic Options” (Figure 5a).

Figure 5a:



Choosing this item will bring up the dialog box in Figure 5b. Any change to one of these dialog fields will be reflected immediately in the graph pane. Clicking the “Accept” button will save changes to the graph, while clicking “Cancel” will discard all changes.

Figure 5b:



The “Copy” menu item in the popup menu of Figure 5a will copy the graph image to the clipboard where it can be pasted into another document.

The “Save” menu item will bring up a "Save As..." dialog box for selecting the name and location of the file to be saved. The quality of the graph is dependent on the size of the graph when it is copied or saved. Therefore, it is suggested that the window be maximized before copying or saving the graph. This will produce a clearer image when enlarged.

5.2 Error Indicator

Each numerical input field is equipped with an error indicator. When the symbol is displayed, its adjacent field contains an invalid entry. By moving the mouse cursor over this symbol, a tip will be displayed as shown in Figure 5c.

Figure 5c: