# LPG Dialog Boxes

The following is a list of all the dialog boxes used in the **LPG** program.


**2-Point Line/Slope/Intercept**
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**Formula Editor**
**Graph Print**
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**Numeric Formats**
**Objective Function Table**
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**Printer Setup**
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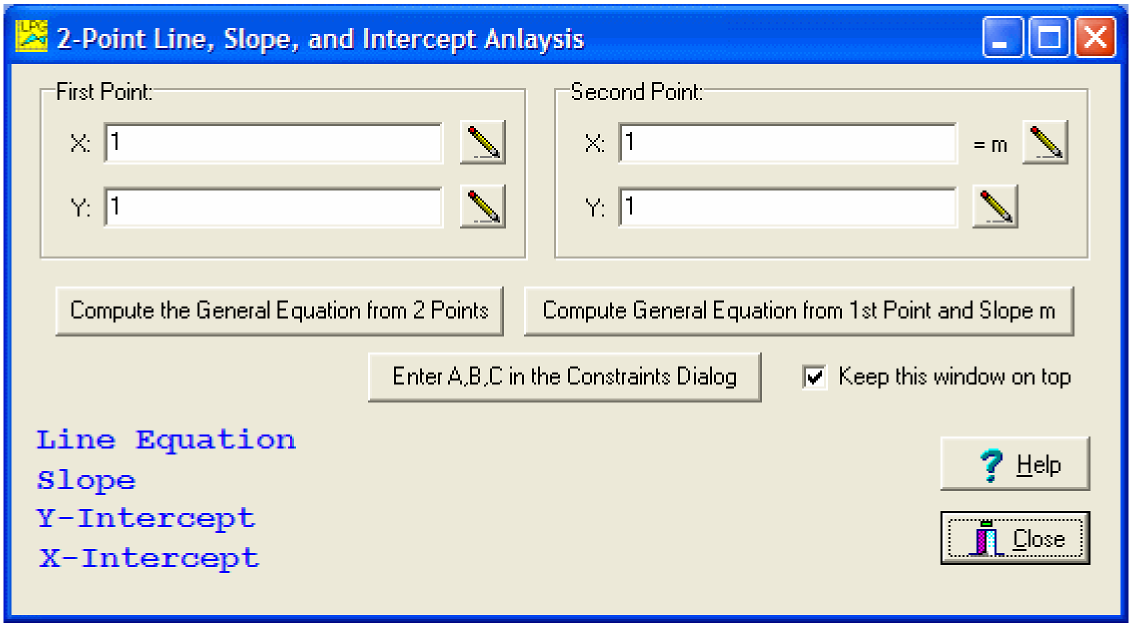
**Set Exact Graph Window Size**
**World Graph**

## 2-Points Line/Slope/Intercept Dialog

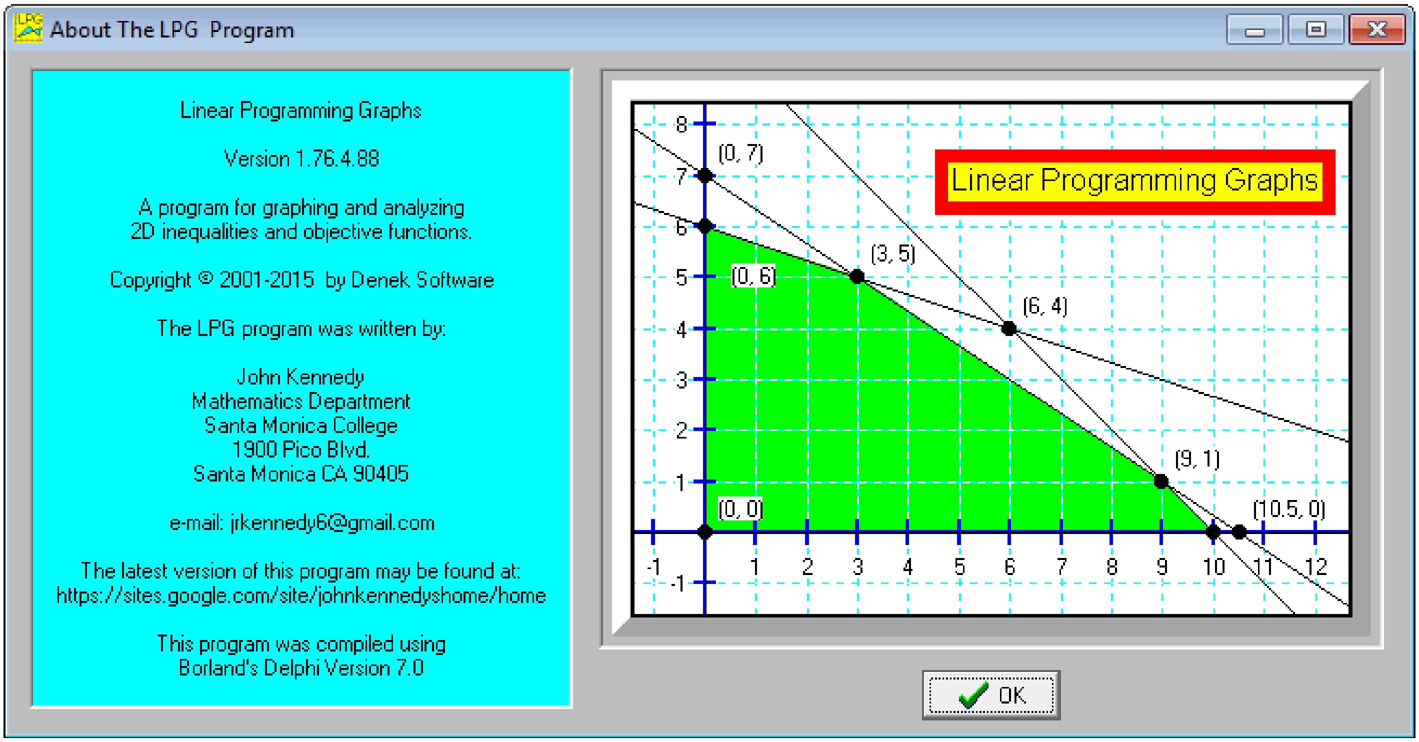
This dialog box can only be brought up by first opening the **Edit Constraints** dialog and then clicking the button [Show 2-Point Form] in that dialog box. You should then see the following.




This dialog box is used to compute the general equation of a line that is defined in either of two ways. The line may simply be a line between two points, or the line may have a given slope (use the second point $x$ for the slope $m$) and go through a given point. In either case, after you compute the line the blue text in the lower-left corner will show you the results. After viewing the results you can also press the button that will automatically enter the A, B, and C coefficients for you in the **Edit Constraints** dialog. These A, B, C coefficients apply to the current line number selected in the **Edit Constraints** dialog.

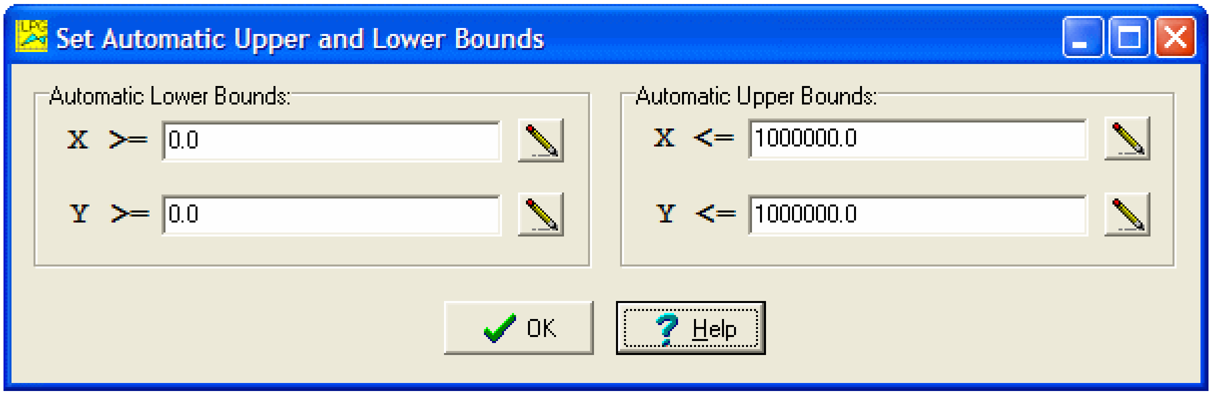
## About Dialog

This dialog box just gives information about the author and the current version of the program you are running. The latest version can always be found at the author's web site.



## Automatic Bounds

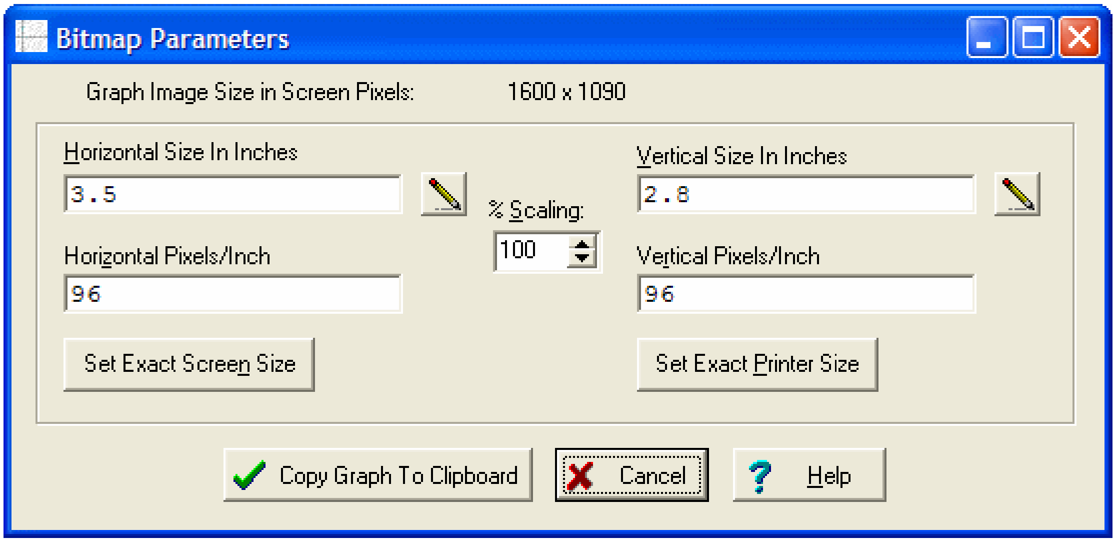
This dialog box allows you to set both the upper and lower automatic bounds that may be applied to any problem. This dialog can be brought up by selection the menu **Edit | Edit Automatic Upper/Lower Bounds...**.




By default, only the lower bounds are used. There are two items in the Options menu that allow you to use or not use these default values.

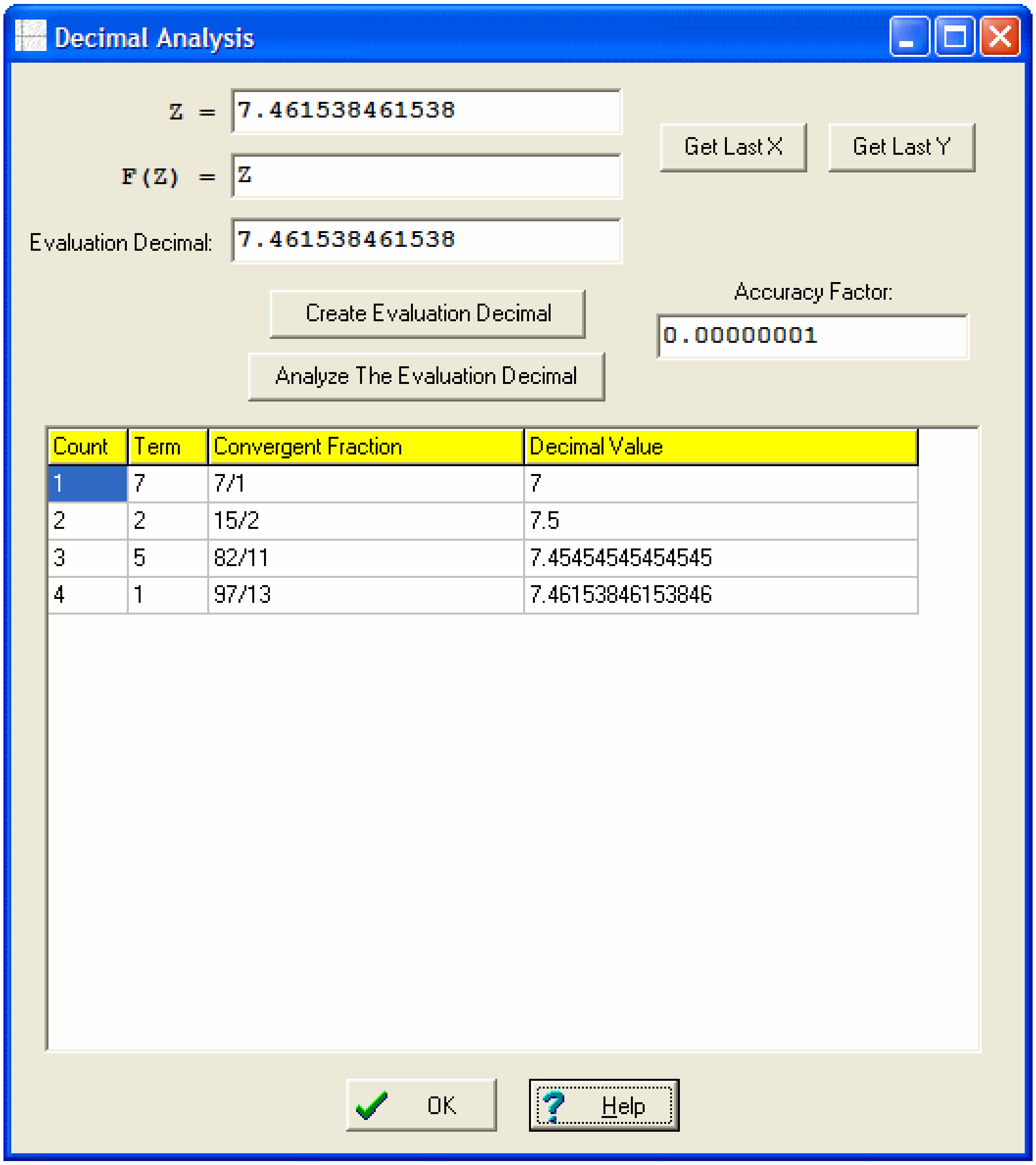
## Copy Bitmap to the Clipboard

When you bring up this dialog box you should see the following. Depending on how you are going to use the copy of the bitmap we always recommend you press either the **Set Exact Screen Size** button or press the **Set Exact Printer Size** button. Probably the **Exact Screen Size** will be used most often, but especially when you intend to import the graph into another word processing program.



## Decimal Analysis

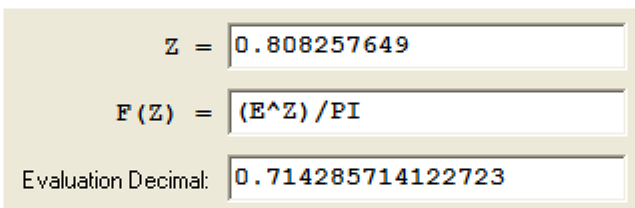
A special dialog box can be brought up for the purpose of analyzing decimal results. This dialog box can be opened by using the menu items **Options | Decimal Analysis…**




As an example of how decimal analysis works and why it's a useful feature to have as part of **JKDifEq** suppose you calculate an answer that is 7.461538461538. You might guess that this is a repeating decimal that repeats every six digits and thus it must be some rational number. But which rational number is it? There are millions of rational numbers to choose from.

You can determine the fraction by keying in this decimal as the Z value in the first edit box. Then if the F(Z)= expression is just Z, you can press the button labeled **Create Evaluation Decimal** and the **Evaluation Decimal** edit box will be filled with this number. Finally, when you press the **Analyze The Evaluation Decimal** button, the program will make a table of values like those shown in the above picture. The leftmost column counts the number of terms in the continued fraction approximation of the **Evaluation Decimal**. The 2nd column shows the terms of the continued fraction and the third column shows the convergent fractions. Finally, the last column just shows the decimal values of the convergent fractions that are in the 3rd column. In the above example, the fraction 7/1 was the nearest whole number approximation to Z=7.461538461538. Then the fraction 15/2 gives the first decimal approximation and 82/11 is the next approximation. Finally, the last fraction is 97/13 and like magic we see that the decimal value of this fraction matches our Z decimal exactly. Thus we have used this tool to discover the exact fraction that represents our particular Z value.

Another example will help explain why, given a decimal value Z, we might want to first calculate a function of Z and then use F(Z) as the **Evaluation Decimal**. Suppose your textbook gives the answer to a problem as $ln\left(\frac{5\pi}{7}\right)$ but all you see the program gives you is the decimal answer of 0.808257649. This doesn't look like a repeating decimal. If you had a calculator you could calculate the natural log answer the book has, but suppose you don't have a calculator either. No problem, given the functions in this dialog box. In this case you could type in the decimal 0.808257649 in the first edit box. Then you could type in the F(Z)= expression as $e^z/\pi$ which is basically the inverse function that eliminates the natural log and eliminates the multiple of $\pi$. When you press the button to **Calculate The Evaluation Decimal**, the program will assume Z=0.808257649 from the first edit box, and it will calculate the value of the expression F(Z) and leave the decimal answer in the **Evaluation Decimal** edit box. Finally when you press the button to **Analyze The Evaluation Decimal** you will see the following table gets generated.




| Count | Term | Convergent Fraction | Decimal Value |
|---|---|---|---|
| 1 | 0 | 0/1 | 0 |
| 2 | 1 | 1/1 | 1 |
| 3 | 2 | 2/3 | 0.666666666666667 |
| 4 | 2 | 5/7 | 0.714285714285714 |

The last line in the table (3rd column) shows the evaluation decimal is really the fraction 5/7.

Now there is even better news. Whenever **JKDifEq** solves an initial value problem, it saves the decimal values that it calculates. Depending on the current procedure, saved values might be regular X and Y coordinates The purpose of the two buttons that are labeled **Get Last X**, **Get Last Y**, is to save you from ever having to type in a decimal answer.

Most of the time you will simply use F(Z)=Z. In this case, pressing the button **Create Evaluation Decimal** simply acts like a copy function that copies the decimal in the first edit box into the 3rd edit box. However, the intermediate step of calculating F(Z) allows you to use this dialog box as a general purpose calculator. You could even use the F(Z) function to calculate a number whose decimal value you never need to analyze.

You can type any complex expression that evaluates to a constant in the Z = edit box. You can also enter any complex expression in the F(Z) = edit box. That expression will normally be some function of Z although in a rare case it could also just be another constant. After you press the button labeled **Create Evaluation Decimal** both the Z = edit box and the F(Z) = edit box will have their contents normalized and the result of calculating F(Z) will be left in the **Evaluation Decimal** edit box as a pure decimal value.

The **Accuracy Factor** controls how many convergent terms get made in the table. When the difference between the divided fraction in the 3rd table column, and the evaluation decimal is less than the accuracy factor value, then the algorithm stops computing convergent fraction terms. The smaller the accuracy factor the more terms and convergent fractions that will be computed. For example, if the accuracy factor is set to only 0.001 and if the evaluation decimal is $\pi$=3.14159265358979 then the program will only compute 3 fractions in the table.

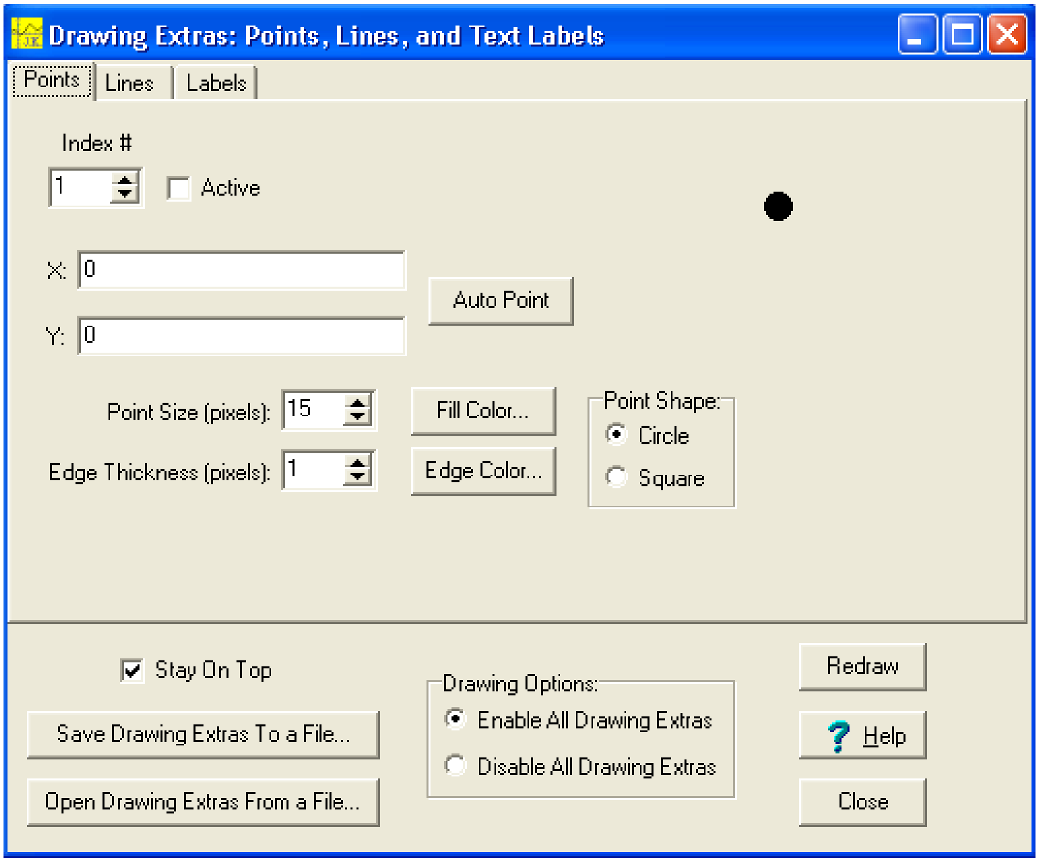
| Count | Term | Convergent Fraction | Decimal Value |
|---|---|---|---|
| 1 | 3 | 3/1 | 3 |
| 2 | 7 | 22/7 | 3.14285714285714 |
| 3 | 15 | 333/106 | 3.14150943396226 |

But for the same $\pi$ evaluation decimal value, if we set the accuracy factor to 0.00000000001 then six more terms will be calculated before the divided fractions make decimals that agree with our $\pi$ value to within a tolerance that is less than the accuracy factor.

| Count | Term | Convergent Fraction | Decimal Value |
|---|---|---|---|
| 1 | 3 | 3/1 | 3 |
| 2 | 7 | 22/7 | 3.14285714285714 |
| 3 | 15 | 333/106 | 3.14150943396226 |
| 4 | 1 | 355/113 | 3.14159292035398 |
| 5 | 292 | 103993/33102 | 3.1415926530119 |
| 6 | 1 | 104348/33215 | 3.14159265392142 |
| 7 | 1 | 208341/66317 | 3.14159265346744 |
| 8 | 1 | 312689/99532 | 3.14159265361894 |
| 9 | 2 | 833719/265381 | 3.14159265358108 |

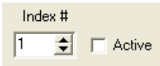
## Drawing Extras

When you select the menu item **Options | Drawing Extras…** you should see the following dialog box. There are three main tabs at the top of the dialog with the names **Points**, **Lines**, **Labels**. There are several global use buttons in the bottom portion of the dialog.




The **Drawing Options** radio group at the bottom is used to temporarily turn on or turn off the drawing of all the extra graphic elements. You must **Enable All Drawing Extras** in order to show any of the graphic elements. Since you can have as many as 120 individual extra graphic elements, the **Disable** radio button provides a quick means to turn off all 120 elements at once without having to turn them off individually one at a time.

All three main tab sheets have two special controls in their upper-left corner.



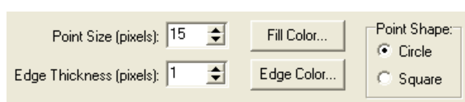

The **Index #** control is used to select any one of 40 elements of the corresponding type for the tab sheet you have currently selected. Thus index numbers always range between 1 and 40. This means you have 40 Points, 40 Lines and 40 Labels to work with. Of course you can only work with or edit one element at a time. For example, to select the 4th element you would change the index number to 4. The purpose of the **Active** checkbox is to turn on or turn off the drawing of that individual element. Thus the **Active** checkbox controls theindividual object, versus the **Enable All Drawing Extras** radio button that is global for all elements. Whenever an object seems not be drawn when it should be drawn, be sure to see whether the **Active** checkbox for that element is checked or not. If the checkbox is turned on (checked) then check the **Enable All Drawing Extras** radio button. If that radio button is also turned on then insure that the $x$ and $y$ coordinates define a point that is within the current graph window.

The **Points** tab sheet is used to create special points.

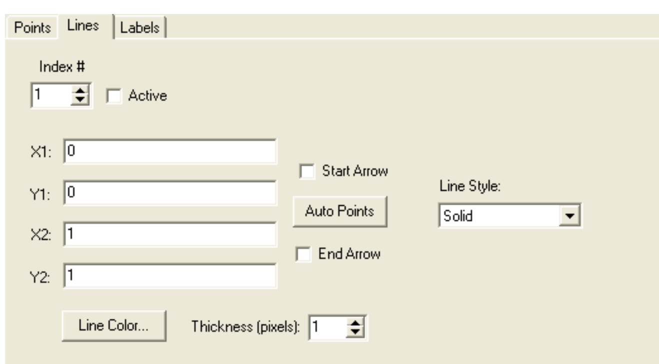
The center of a point is determined by the two numbers you enter in the two controls with X and Y coordinates. These two numbers should be the World Graph numbers of where you want to see the point. The default position is at the origin (0, 0).


The purpose of the **Auto Point** button is to allow you to determine the coordinates of a point without actually typing in any coordinates. Just click any point in the graph window with the left mouse button and then come back to this dialog box and click the **Auto Point** button. The X and Y coordinates of the last point you clicked in the graph window will be entered for you automatically in the above two edit boxes. If you want to make another slight adjustment of where the point should be, just left-click again anywhere in the graph window and then re-click the **Auto Point** button. This program always remembers the last point you left-clicked in the graph window, even between invocations of this dialog box.

The only other aspects of points that you would want to change are the shape, size, and color of the point. So points don't have to be solid black and they can be as small as 2 pixels in diameter or as large as 100 pixels in diameter. When you click the **Fill Color** button you will see another dialog box that allows you to select any fill color for your point. The **Edge Color** button is used to define the color of the line border around the point. When the edge color is the same as the fill color then the point will appear as a dot with a single solid color. Note that you can also change the thickness of the edge. Points can also be either circular or square in shape.




The **Lines** tab sheet is used to create extra lines.

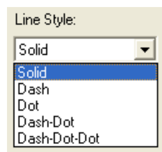


A line is determined by two points whose X and Y coordinates you enter in the four edit boxes. (X1, Y1) is the first or starting point. (X2, Y2) is the second or ending point.


The purpose of the **Auto Points** button is the same as described above for the **Points** tabbed sheet. You don't have to actually type in any X or Y coordinates if you just use your mouse to left-click any two points in the graph window. Then click the above **Auto Points** button and the program will enter all four coordinates for you automatically and redraw the line between the two points you clicked. This program remembers the last two points you clicked in the graph window and uses those points to determine the four required coordinates.

Either one or both the starting and ending points can have an arrow drawn when you wish the line to point to something special in your graph. Just turn on the corresponding checkbox. The **Start Arrow** checkbox only applies to the (X1, Y1) point. The **End Arrow** checkbox only applies to the (X2, Y2) point.

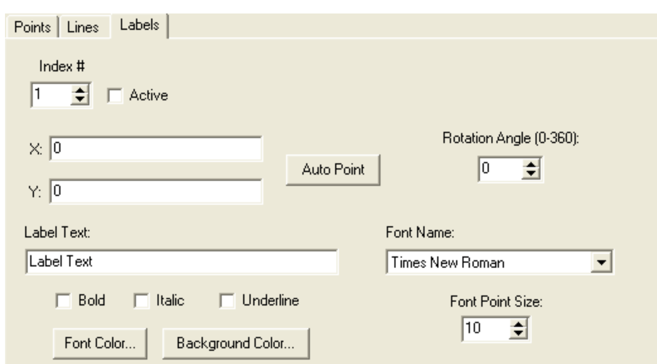
A line can also have a style. When you click the down arrow of the Line Style control you will see the following list of choices:




Most lines you make will be only 1 pixel thick. But you can increase the thickness of a line to make it look more bold and solid. The only caution here is that you will lose the line style whenever your line is 2 or more pixels thick. Thus you shouldn't change the thickness if you want anything other than a solid line.

You can also change the color of the line by clicking the **Line Color** button.

The third tab sheet is for defining text **Labels**.



The position of a text label is determined by a single point with (X, Y) coordinates. Actually, this point references the position of the upper-left corner of the text string. The **Auto Point** button can be used to let the program type in the X and Y coordinates for you automatically. Just click the left mouse button anywhere in the graph window and then click the **Auto Point** button. This button works the same as it does for points and lines as already described above.

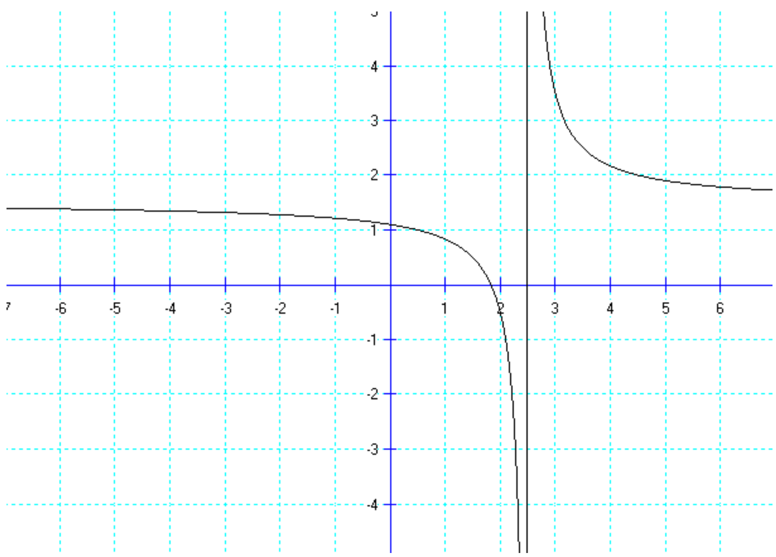
In the above figure the text is shown in the Label Text edit box. But of course you can enter any string of characters for your label.

Your text string can have Bold, or Italic or Underline attributes and it can be made with any font in any font point size. Your text label can have any color and even its background can be colored.

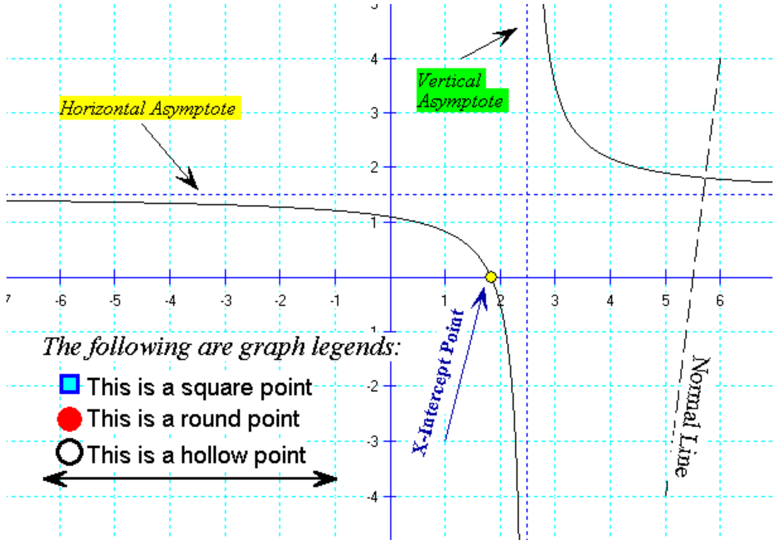
The last special thing you can do with a label is to rotate it at any angle between 0 and 360 degrees.

These extra graphing elements act like global variables within this program. If you quit the program without saving your function you will lose all your work. You have the option to save these elements with your function or not, at the time you save a function. You can also save the extra graphing elements in a text file all by themselves. Each graph you make will have its own set of graphing extras. However, the drawing extras can be added to any kind of a function, including an infinite series or a Fourier series.

Now that you know about the three kinds of extra elements, we can state that you only need to use these when you wish to add something special to a graph. This program is not intended to be a drawing program, but the above dialog box allows you to create some special effects in a graph. Below we show a plain graph and then the same graph in which we have added some extra elements.




The above graph is just sort of plain.




We have added some graphic elements to the above graph. You can see that we have added several text labels, three lines with arrows and two dotted lines that emphasize the horizontal and vertical asymptotes. One dashed line is a normal line. There is one special point that is colored yellow that represents the $x$-intercept point just to the left of 2 on the x-axis.

Using the **File Save** and **File Open** buttons at the bottom of the dialog box we can save all these extra graphic elements in a text file. The contents of a sample text file is shown below. You can read the attributes of all these graphic elements.

```
Points[1].Active = TRUE
Points[1].X = 1.85
Points[1].Y = 0
Points[1].EdgeColor = 0
Points[1].FillColor = 65535
Points[1].PixelSize = 11
Points[1].EdgeSize = 1
Points[1].ShapeIndex = 0

Points[2].Active = TRUE
Points[2].X = -5.8
Points[2].Y = -1.9623
Points[2].EdgeColor = 16711680
Points[2].FillColor = 16776960
Points[2].PixelSize = 15
Points[2].EdgeSize = 3
Points[2].ShapeIndex = 1

Points[3].Active = TRUE
Points[3].X = -5.8145
Points[3].Y = -2.6
Points[3].EdgeColor = 255
```

```
Points[3].FillColor = 255
Points[3].PixelSize = 20
Points[3].EdgeSize = 1
Points[3].ShapeIndex = 0

Points[4].Active = TRUE
Points[4].X = -5.8
Points[4].Y = -3.2
Points[4].EdgeColor = 0
Points[4].FillColor = 16777215
Points[4].PixelSize = 20
Points[4].EdgeSize = 3
Points[4].ShapeIndex = 0

Lines[1].Active = TRUE
Lines[1].X1 = 1.7
Lines[1].Y1 = -0.2
Lines[1].X2 = 1
Lines[1].Y2 = -3
Lines[1].Color = 10485760
Lines[1].ArrowStart = TRUE
Lines[1].ArrowEnd = FALSE
Lines[1].Thickness = 1
Lines[1].StyleIndex = 0

Lines[2].Active = TRUE
Lines[2].X1 = 2.49
Lines[2].Y1 = 5
Lines[2].X2 = 2.49
Lines[2].Y2 = -5
Lines[2].Color = 16711680
Lines[2].ArrowStart = FALSE
Lines[2].ArrowEnd = FALSE
Lines[2].Thickness = 1
Lines[2].StyleIndex = 2

Lines[3].Active = TRUE
Lines[3].X1 = -7
Lines[3].Y1 = 1.5
Lines[3].X2 = 7
Lines[3].Y2 = 1.5
Lines[3].Color = 16711680
Lines[3].ArrowStart = FALSE
Lines[3].ArrowEnd = FALSE
Lines[3].Thickness = 1
Lines[3].StyleIndex = 2

Lines[4].Active = TRUE
```

```
Lines[4].X1 = -4.51
Lines[4].Y1 = 2.8
Lines[4].X2 = -3.5
Lines[4].Y2 = 1.6
Lines[4].Color = 0
Lines[4].ArrowStart = FALSE
Lines[4].ArrowEnd = TRUE
Lines[4].Thickness = 1
Lines[4].StyleIndex = 0

Lines[5].Active = TRUE
Lines[5].X1 = 1.3
Lines[5].Y1 = 4
Lines[5].X2 = 2.3
Lines[5].Y2 = 4.55
Lines[5].Color = 0
Lines[5].ArrowStart = FALSE
Lines[5].ArrowEnd = TRUE
Lines[5].Thickness = 1
Lines[5].StyleIndex = 0

Lines[6].Active = TRUE
Lines[6].X1 = 6
Lines[6].Y1 = 4
Lines[6].X2 = 5
Lines[6].Y2 = -4
Lines[6].Color = 0
Lines[6].ArrowStart = FALSE
Lines[6].ArrowEnd = FALSE
Lines[6].Thickness = 1
Lines[6].StyleIndex = 1

Lines[7].Active = TRUE
Lines[7].X1 = -6.2849
Lines[7].Y1 = -3.7
Lines[7].X2 = -0.97849
Lines[7].Y2 = -3.7
Lines[7].Color = 0
Lines[7].ArrowStart = TRUE
Lines[7].ArrowEnd = TRUE
Lines[7].Thickness = 2
Lines[7].StyleIndex = 0

Labels[1].Active = TRUE
Labels[1].X = 0.27
Labels[1].Y = -3.2
Labels[1].RotationAngle = 75
Labels[1].FontName = Times New Roman
```

```
Labels[1].FontPointSize = 12
Labels[1].FontColor = 10485760
Labels[1].BackgroundColor = 16777215
Labels[1].FontBold = TRUE
Labels[1].FontItalic = FALSE
Labels[1].FontUnderline = FALSE
Labels[1].TextMessage = X-Intercept Point

Labels[2].Active = TRUE
Labels[2].X = -6
Labels[2].Y = 3.3
Labels[2].RotationAngle = 0
Labels[2].FontName = Times New Roman
Labels[2].FontPointSize = 12
Labels[2].FontColor = 0
Labels[2].BackgroundColor = 65535
Labels[2].FontBold = FALSE
Labels[2].FontItalic = TRUE
Labels[2].FontUnderline = FALSE
Labels[2].TextMessage = Horizontal Asymptote

Labels[3].Active = TRUE
Labels[3].X = 0.5
Labels[3].Y = 3.8
Labels[3].RotationAngle = 0
Labels[3].FontName = Times New Roman
Labels[3].FontPointSize = 12
Labels[3].FontColor = 0
Labels[3].BackgroundColor = 65280
Labels[3].FontBold = FALSE
Labels[3].FontItalic = TRUE
Labels[3].FontUnderline = FALSE
Labels[3].TextMessage = Vertical

Labels[4].Active = TRUE
Labels[4].X = 0.52688
Labels[4].Y = 3.434
Labels[4].RotationAngle = 0
Labels[4].FontName = Times New Roman
Labels[4].FontPointSize = 12
Labels[4].FontColor = 0
Labels[4].BackgroundColor = 65280
Labels[4].FontBold = FALSE
Labels[4].FontItalic = TRUE
Labels[4].FontUnderline = FALSE
Labels[4].TextMessage = Asymptote
```

```
Labels[5].Active = TRUE
Labels[5].X = -5.5
Labels[5].Y = -1.7547
Labels[5].RotationAngle = 0
Labels[5].FontName = Courier Bold
Labels[5].FontPointSize = 14
Labels[5].FontColor = 0
Labels[5].BackgroundColor = 16777215
Labels[5].FontBold = FALSE
Labels[5].FontItalic = FALSE
Labels[5].FontUnderline = FALSE
Labels[5].TextMessage = This is a square point

Labels[6].Active = TRUE
Labels[6].X = 6
Labels[6].Y = -1.5
Labels[6].RotationAngle = 261
Labels[6].FontName = Times New Roman
Labels[6].FontPointSize = 14
Labels[6].FontColor = 0
Labels[6].BackgroundColor = 16777215
Labels[6].FontBold = FALSE
Labels[6].FontItalic = FALSE
Labels[6].FontUnderline = FALSE
Labels[6].TextMessage = Normal Line

Labels[7].Active = TRUE
Labels[7].X = -6.3038
Labels[7].Y = -1.0189
Labels[7].RotationAngle = 0
Labels[7].FontName = Times New Roman
Labels[7].FontPointSize = 16
Labels[7].FontColor = 0
Labels[7].BackgroundColor = 16777215
Labels[7].FontBold = FALSE
Labels[7].FontItalic = TRUE
Labels[7].FontUnderline = FALSE
Labels[7].TextMessage = The following are graph legends:

Labels[8].Active = TRUE
Labels[8].X = -5.5
Labels[8].Y = -2.3396
Labels[8].RotationAngle = 0
Labels[8].FontName = Courier Bold
Labels[8].FontPointSize = 14
Labels[8].FontColor = 0
Labels[8].BackgroundColor = 16777215
Labels[8].FontBold = FALSE
```

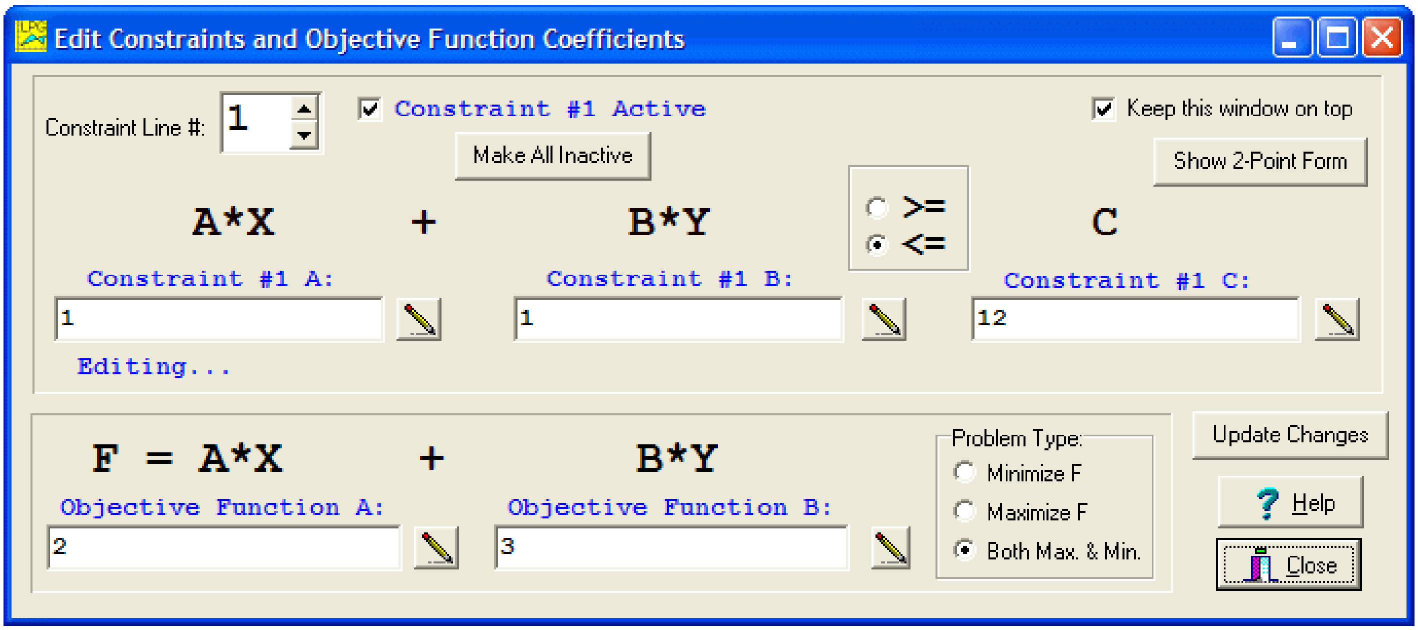
```
Labels[8].FontItalic = FALSE
Labels[8].FontUnderline = FALSE
Labels[8].TextMessage = This is a round point

Labels[9].Active = TRUE
Labels[9].X = -5.5
Labels[9].Y = -3
Labels[9].RotationAngle = 0
Labels[9].FontName = Courier Bold
Labels[9].FontPointSize = 14
Labels[9].FontColor = 0
Labels[9].BackgroundColor = 16777215
Labels[9].FontBold = FALSE
Labels[9].FontItalic = FALSE
Labels[9].FontUnderline = FALSE
Labels[9].TextMessage = This is a hollow point
```

The reason for saving these elements is so you can quickly load them and have them display. Although it takes a little time to setup these extra graphing elements, once you have your graph made you can save these elements for quickly re-loading later.

## Edit Constraints

This dialog box is used to enter and edit all constraint lines and to enter and edit the objective function coefficients and the problem type. This dialog can be brought up by selecting **Edit | Edit Constraints and Objective Function...**.

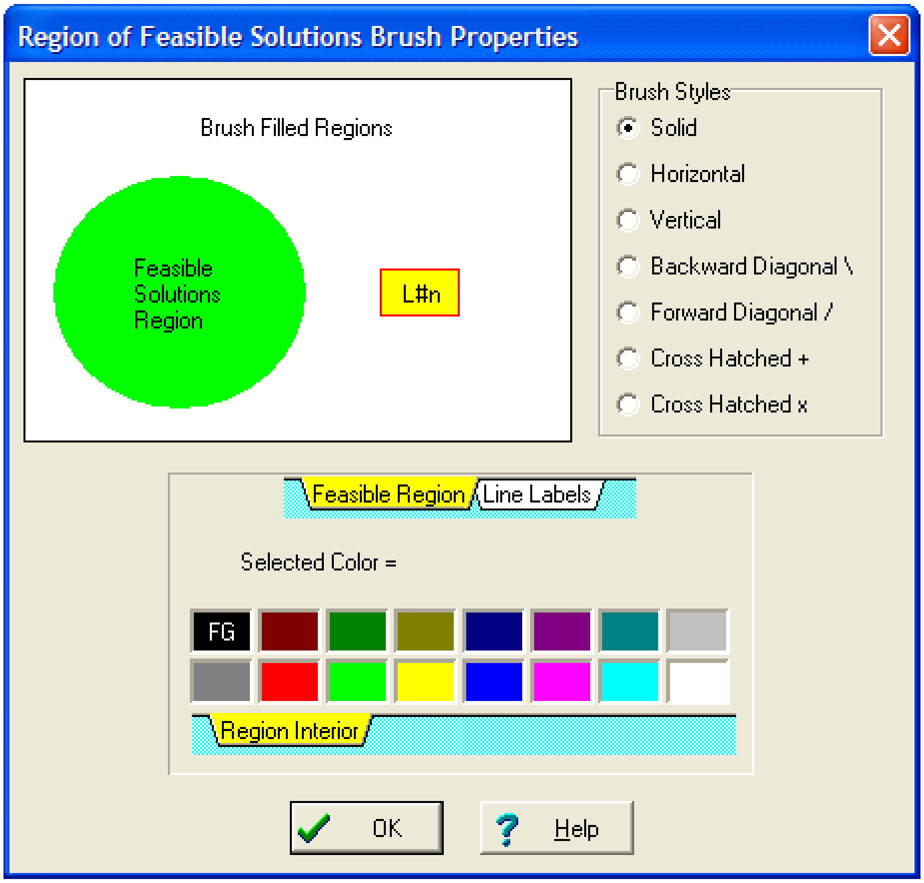



Note that you should first select the **Constraint Line** number in the upper-left corner. Then you can enter its ABC coefficients and enter the type of inequality for that constraint. It is important that you then press the button with the caption Update Changes to record your editing changes for that line.

You can then choose another line and repeat the same process.

# Fill Colors Dialog

This dialog box is used to set the color and style of the region of feasible solutions as well as the background color of the line labels. This dialog can be brought up by selecting **Options | Fill Area Colors...**.

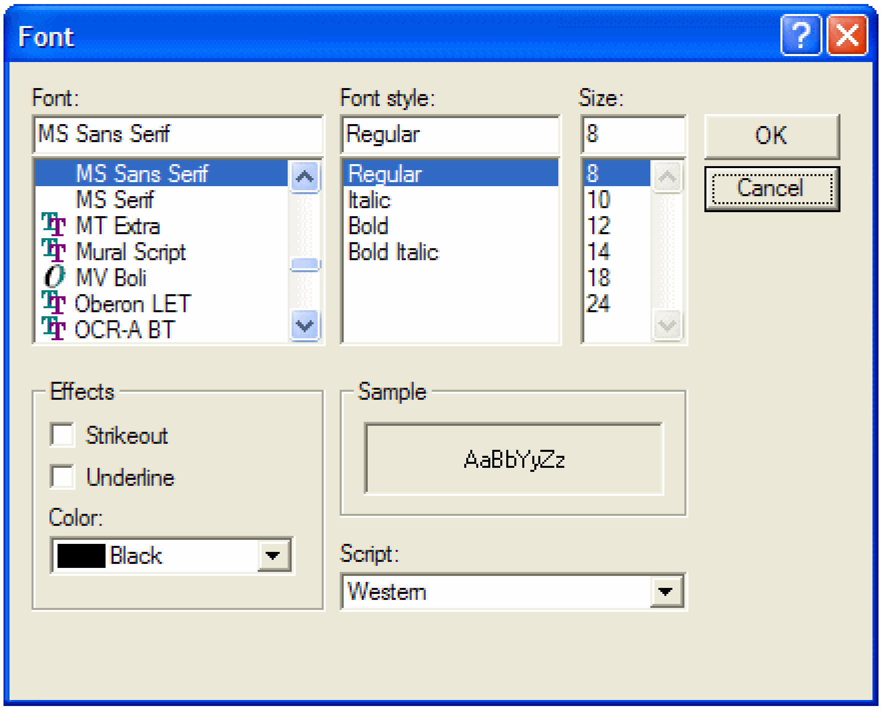



For the **Line Labels** you can set two colors, the interior fill color and the border color.

For the region of feasible solutions you can only set the interior fill color.

## Font Dialog

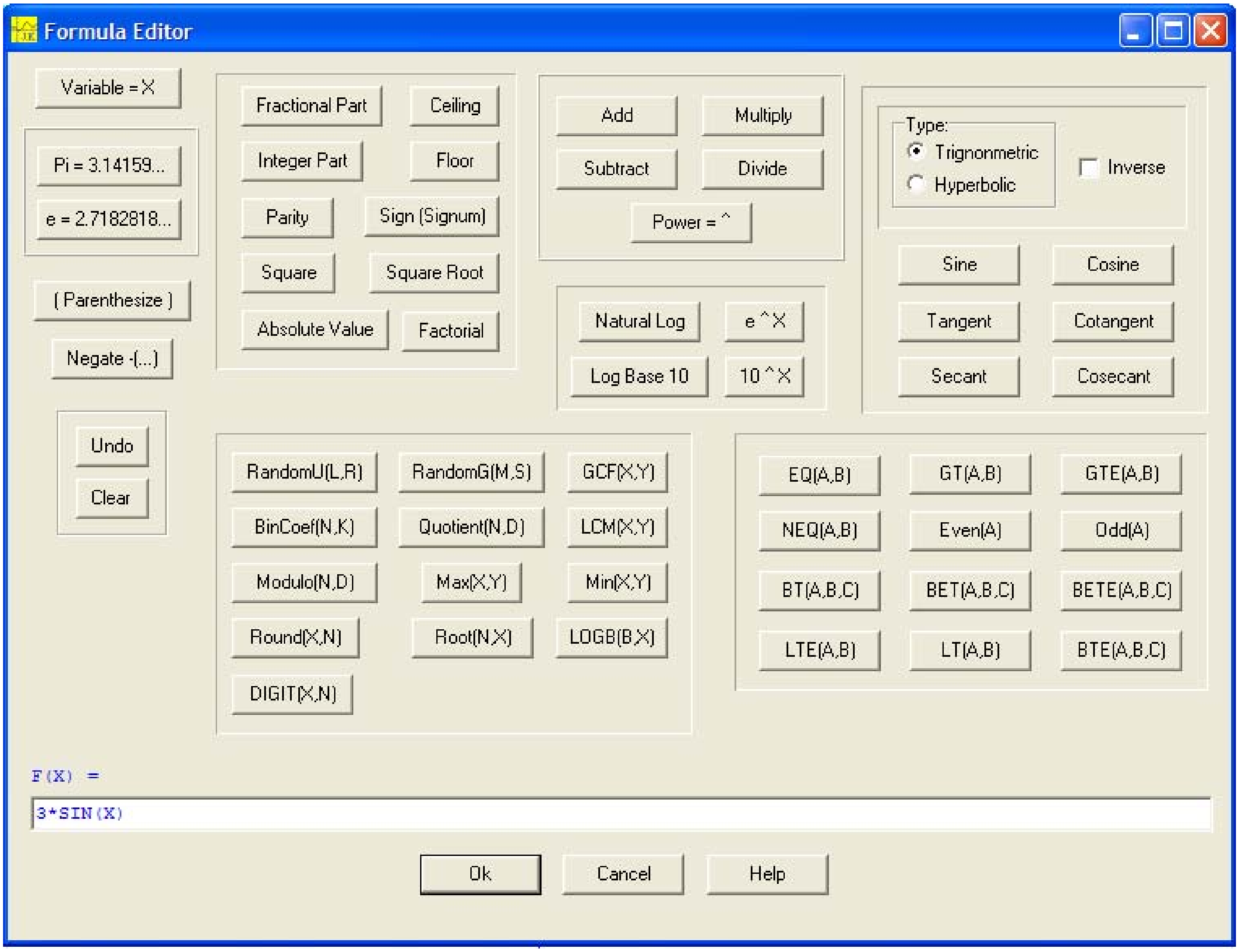
The font dialog is a Windows standard dialog that allows you to set all aspects of the current font. This font is used to label the axes in your graph as well as the XY-plane extents when you choose to show the four numbers at the edges of the graph. These are the only items for which you can set the font.



## Formula Editor

Most dialog boxes and edit box entries contain a special means of editing floating point real numbers. This is indicated at the right of any edit box using a pencil icon for a button label. Clicking the pencil button brings up the **Formula Editor** dialog box.

This dialog box is a special typing aide for editing function formulas and expressions. This dialog box can be brought up from any dialog box that contains another edit box with a pencil icon. Clicking the pencil icon opens this dialog box.



There are two parts in the above dialog box that dynamically change. The button in the upper-left corner has a label denoting the currently used variable. In the above figure the variable is **X.** At other times when you are entering a constant expression (not a function formula expression) then the variable button will not appear in the dialog box.

The other part that dynamically changes is the blue-colored text that lies to the left and just above the edit box. The purpose of this text is to remind you of exactly what quantity you are currently editing. This label will take on many different captions depending on what value you are editing.

There are two special buttons with the labels **Clear** and **Undo**. Pressing the **Clear** button causes the edit line to be set to an empty blank edit line. The **Undo** button can be used to undo the last button that was pressed and restore the previous formula. Thus this button provides one step of undo for each of the push buttons.

The rest of the dialog box works it wonders whenever you press one of the buttons. Most of the buttons represent unary functions and so when you press the button the action taken is to first wrap the entire contents of the current line in parentheses and then apply the function you just selected.

As an example, the above edit line has **3*SIN(X)**. If you were to press the **Square Root** button then the edit line would quickly change to **SQRT(3*SIN(X))**.

The special functions with two or more arguments usually enter the entire current expression in the first parameter position and leave a blank for you to edit the second and any other remaining parameter positions. As an example, if we go back to the original edit line as **3*SIN(X)** and if we press the button labeled **MAX(X,Y)** then the new edit line becomes **MAX(3*SIN(X), )** with the cursor positioned in the position of the blank argument. You must enter expressions that fill in any and all remaining blank arguments.

The logical functions are all grouped together under the trigonometric functions. Other groups include the binary and unary functions.

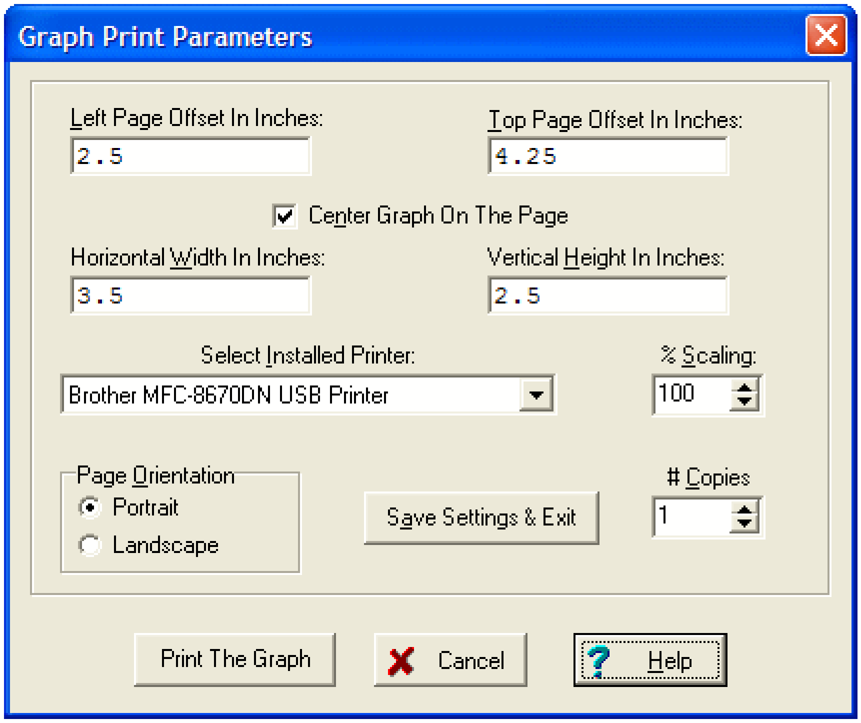
If the edit line is empty (say after pressing the **Clear** button) then when you press the **MAX(X,Y)** button the new edit line becomes **MAX( ,X)** and the cursor will be positioned in the first blank. In this case where there is no expression, the program assumes you want the variable inserted as the second argument.

Other buttons as the **Add** and **Subtract** buttons and the **Pi** and **e** buttons simply type the corresponding operation characters at the current position of the focus point. If you have any selected text then the new text simply overwrites the selected text when it gets inserted.

One special thing to note about entering trigonometric and hyperbolic functions. Obviously, you select the function type using the two radio buttons labeled **Trigonometric** and **Hyperbolic**. Use the **Inverse** check box to enter an inverse function. Note that there are 6 regular trig functions plus their inverses that makes for 12 regular trigonometric functions. Then using the **Hyperbolic** option you get another 12 hyperbolic functions for a total of 24 related functions just using the few controls on the screen.

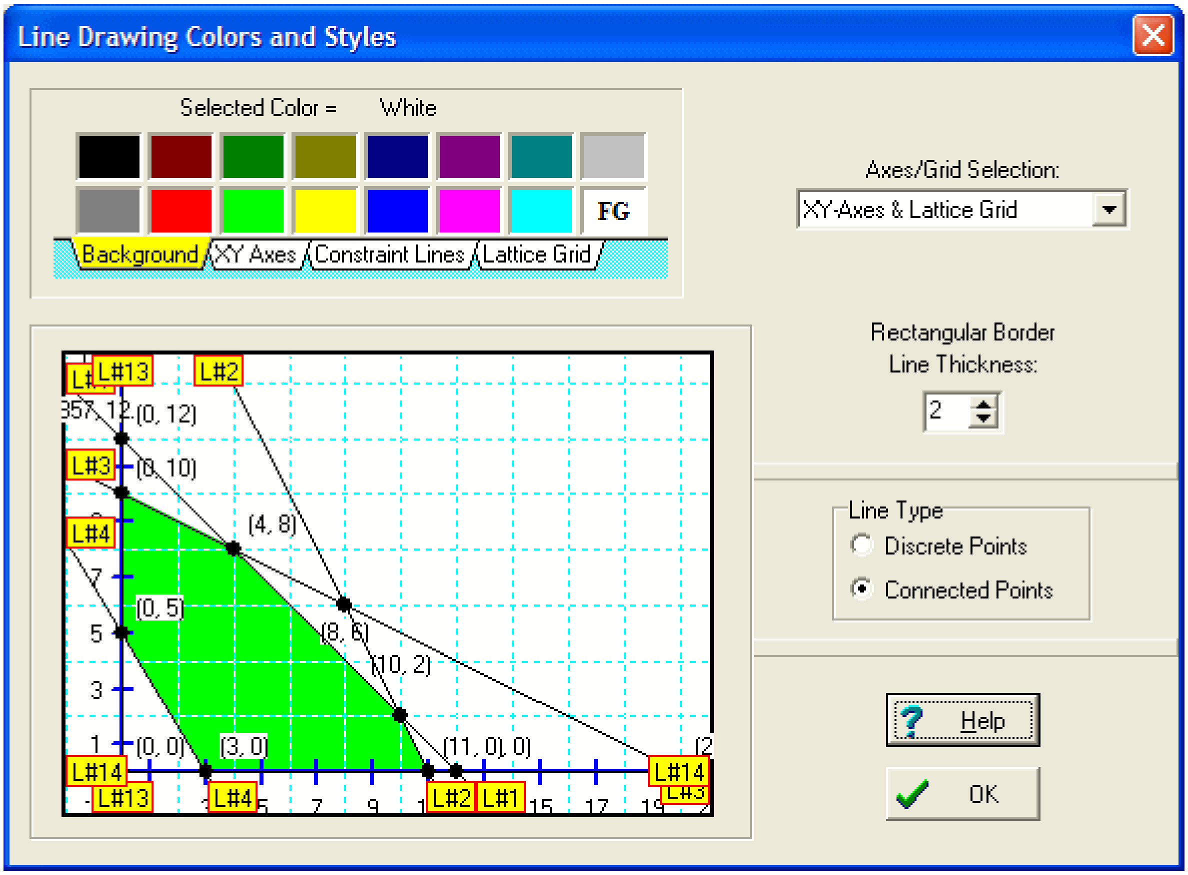
## Graph Print

This dialog box appears anytime you try to print a graph. Note that the controls allow you to set the exact position of the graph on the page as well as its exact size.



## Line Colors

This dialog box is used to select the colors of all lines that get drawn, and it also sets the Background color for the $xy$-plane. This can be brought up by selecting **Options | Line Colors and Styles...**.

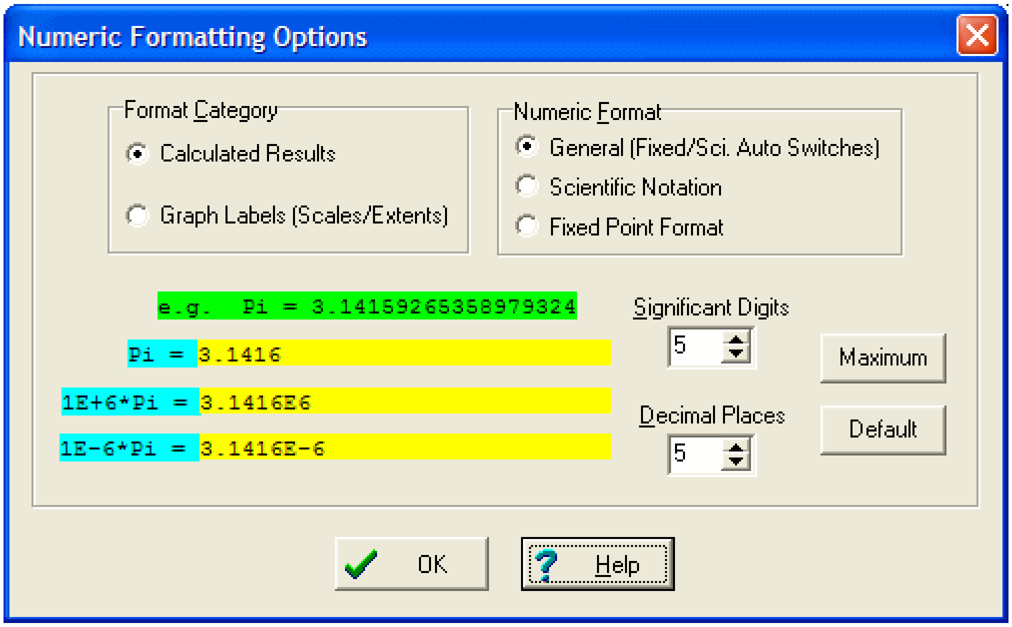



The upper-left corner has what is called a color grid. Just below that are a series of tabs with the names **Background**, **XY Axes**, **Constraint Lines** and **Lattice Grid**. To change the color of any item you first click on the tab and that tab should turn yellow to indicate it is selected. In the above figure the **Background** tab is selected.

Once the item tab is selected then you can just click on any color in the color grid and the selected item will immediately change to that color. The sample graph should be updated to show how your graph will look.

# Numeric Formats

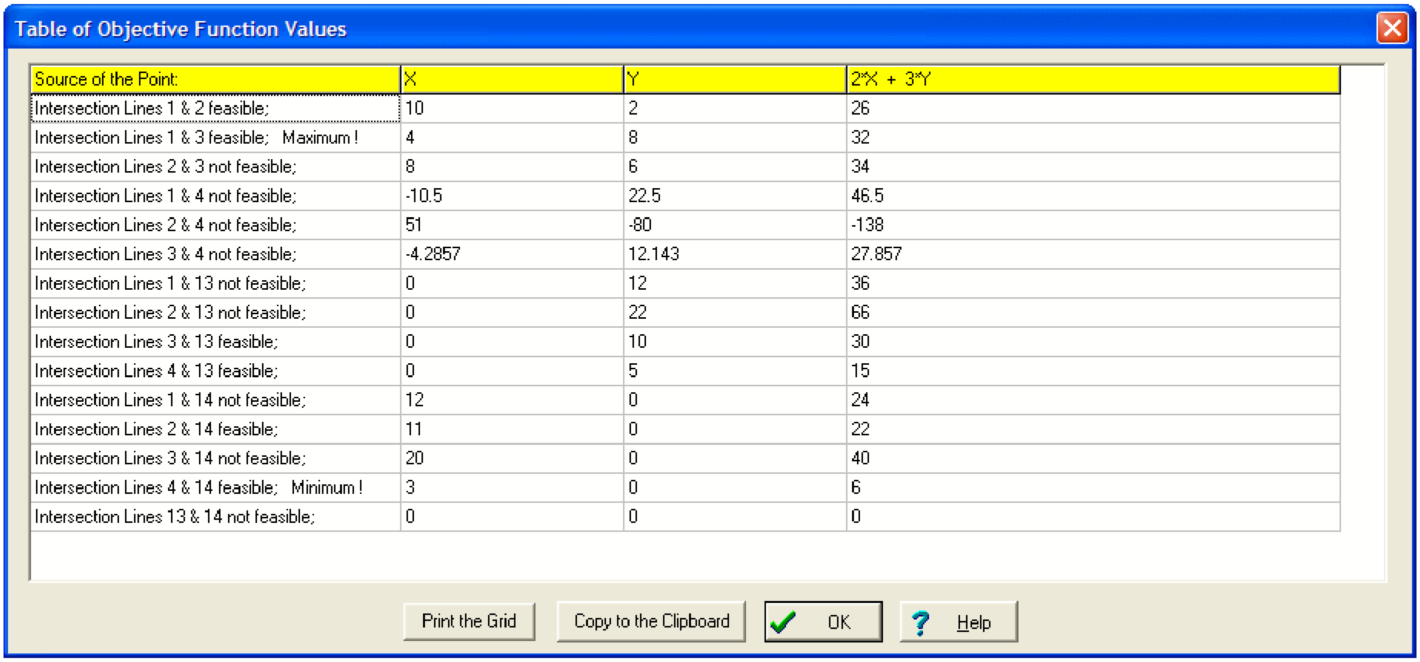
This dialog box is used to set the numeric format for displayed numbers. There are two format categories; one is for calculated results, such as might be seen in the status line, and the other is for graph labels. This can be brought up by selecting the menu item **Options | Numeric Formats...**.




Pressing the Maximum button gives you the maximum precision while pressing the Default button gives you 5 significant digits. The only difference between the general format and the scientific and fixed formats is that the general format will automatically switch to scientific notation if the numbers are too small or too large to display as is indicated. The default format is general and you will probably have little reason to ever change this. However, fixed point and scientific formats are available.

# Objective Function Table

You will see this dialog after you select the **Action** menu item that says **Make a Table of Objective Function Values**.

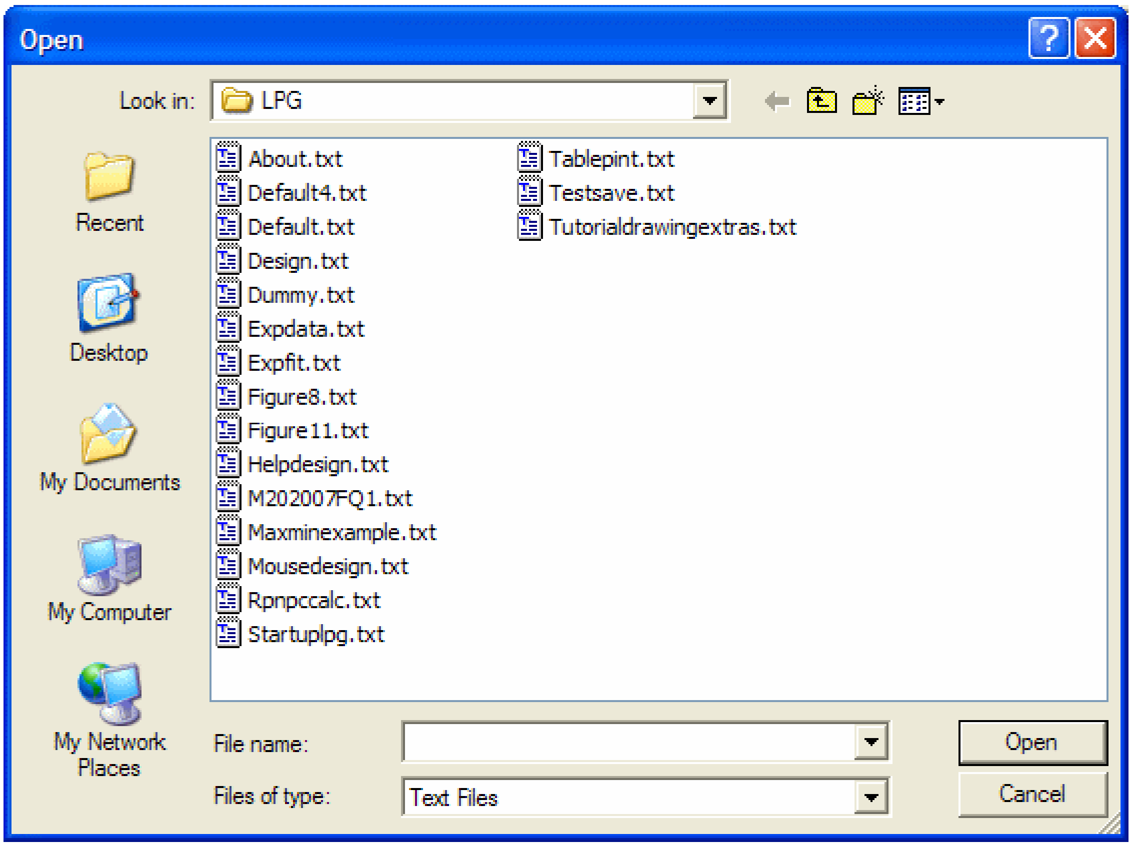



| Source of the Point: | X | Y | 2*X + 3*Y |
|---|---|---|---|
| Intersection Lines 1 & 2 feasible; | 10 | 2 | 26 |
| Intersection Lines 1 & 3 feasible;   Maximum ! | 4 | 8 | 32 |
| Intersection Lines 2 & 3 not feasible; | 8 | 6 | 34 |
| Intersection Lines 1 & 4 not feasible; | -10.5 | 22.5 | 46.5 |
| Intersection Lines 2 & 4 not feasible; | 51 | -80 | -138 |
| Intersection Lines 3 & 4 not feasible; | -4.2857 | 12.143 | 27.857 |
| Intersection Lines 1 & 13 not feasible; | 0 | 12 | 36 |
| Intersection Lines 2 & 13 not feasible; | 0 | 22 | 66 |
| Intersection Lines 3 & 13 feasible; | 0 | 10 | 30 |
| Intersection Lines 4 & 13 feasible; | 0 | 5 | 15 |
| Intersection Lines 1 & 14 not feasible; | 12 | 0 | 24 |
| Intersection Lines 2 & 14 feasible; | 11 | 0 | 22 |
| Intersection Lines 3 & 14 not feasible; | 20 | 0 | 40 |
| Intersection Lines 4 & 14 feasible;   Minimum ! | 3 | 0 | 6 |
| Intersection Lines 13 & 14 not feasible; | 0 | 0 | 0 |

It will rarely happen, but if a source point ever shows an asterisk symbol as part of a Maximum ! * or Minimum ! * then the asterisk means that maximum or minimum is not unique along one of the edges of the region of feasible solutions.

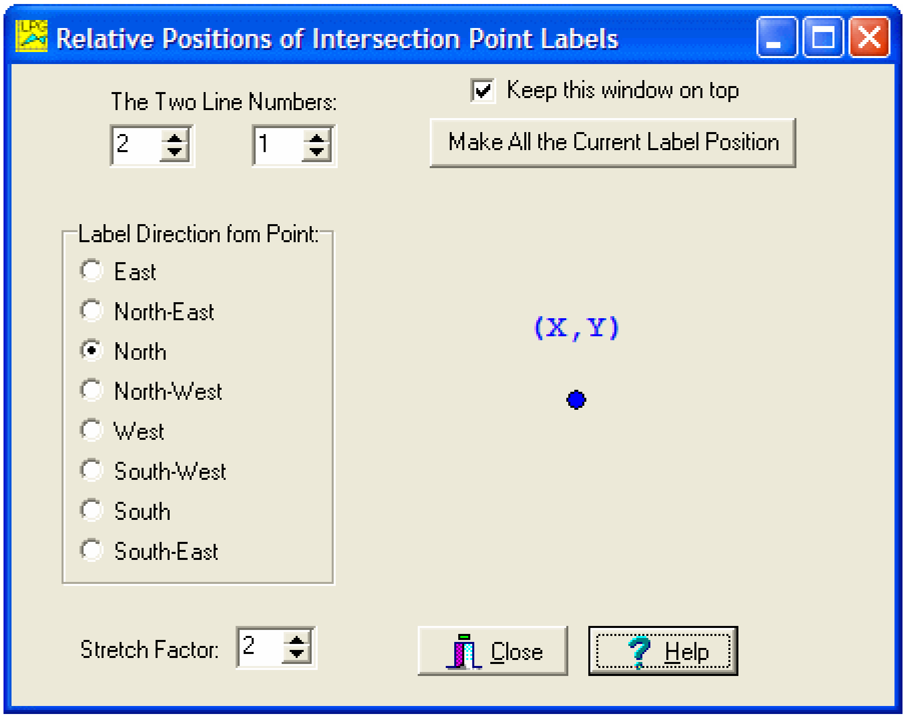
# Open File

This is a standard Windows File Open dialog box. It allows you to navigate your directories and find an existing file that you can open. Of course you should only open files that were created by this program. Such files are ordinary ASCII text files.



# Point/Labels Positioning

This dialog box is used to position any point label around a point of intersection of two lines.

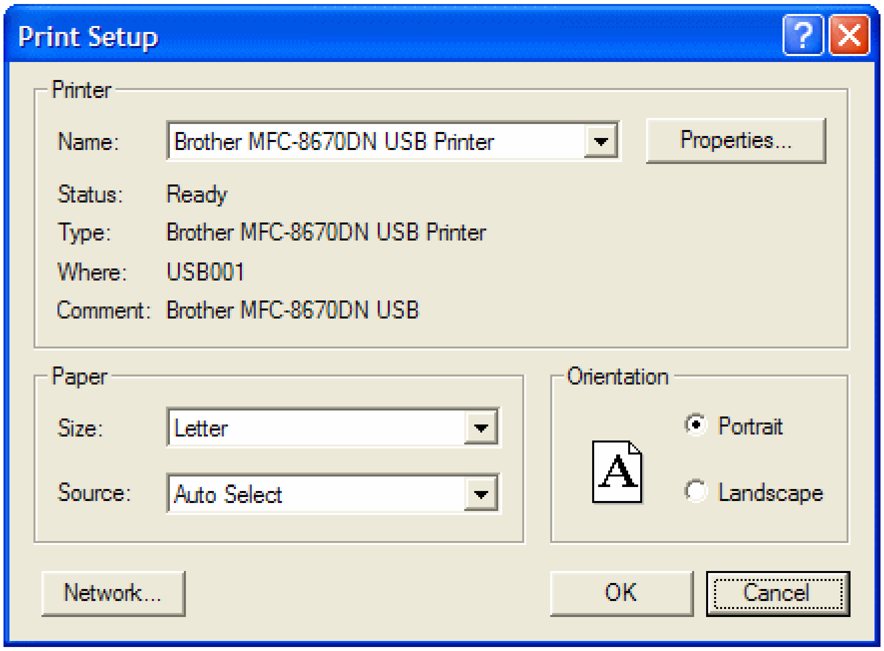



To use this dialog box you should first select the two line numbers. Then you select the label direction. The Tutorial Help file discusses how using this feature allows you to get precisely positioned point labels.

Each point not only has a direction, it also has what is called a stretch factor. The Stretch Factor is a number between 1 and 5 that acts as a multiplier on the default distance from the given point. So selecting a higher stretch factor number causes the label to move even further from the point.

## Printer Setup

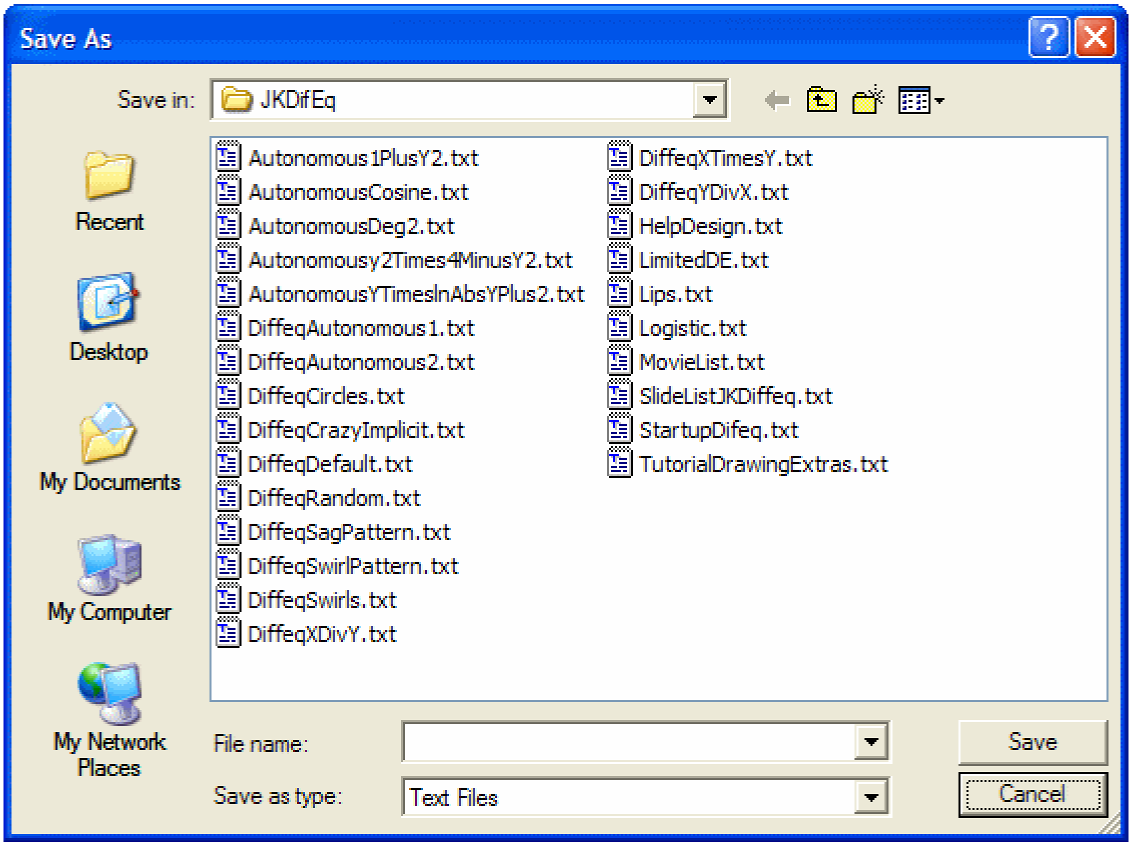
This is a standard Windows printer setup dialog box.




Basically all this does is allow you to select the printer you want to print on.

## Save File

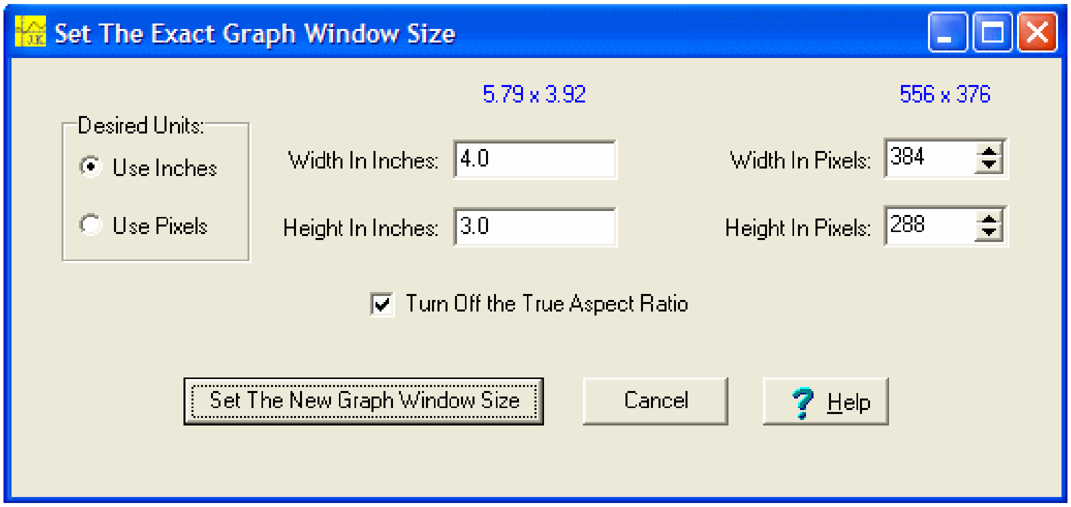
This is a standard Windows File Save As dialog.




When you save a file this dialog allows you to navigate your directories and name the file that you are saving.

## Set Exact Graph Window Size

This dialog box can be used to set the exact size of the program graph window. This dialog box can be brought up in one of two ways. Under the **Edit** menu you can select the menu item that says **Set the Exact Graph Window Size…**, or you can right-click the **Zoom** button in the tool bar provided you also hold down the **CTRL** key on the keyboard. Either way you should see the following dialog box.




The graph window is only that part of the program window that shows the graph of the current slope field. The graph window does NOT include the menu bar, or the tool bar, or the status line at the bottom of the program window. The graph window only refers to the actual slope field graph part.

You can enter the exact size of the graph window using units that are either inches or pixels. The blue text shows the current graph window size at the time this dialog is displayed. Those numbers will change after you click the button to set a new graph window size. You can then re-open this dialog to read the new and current graph window size.

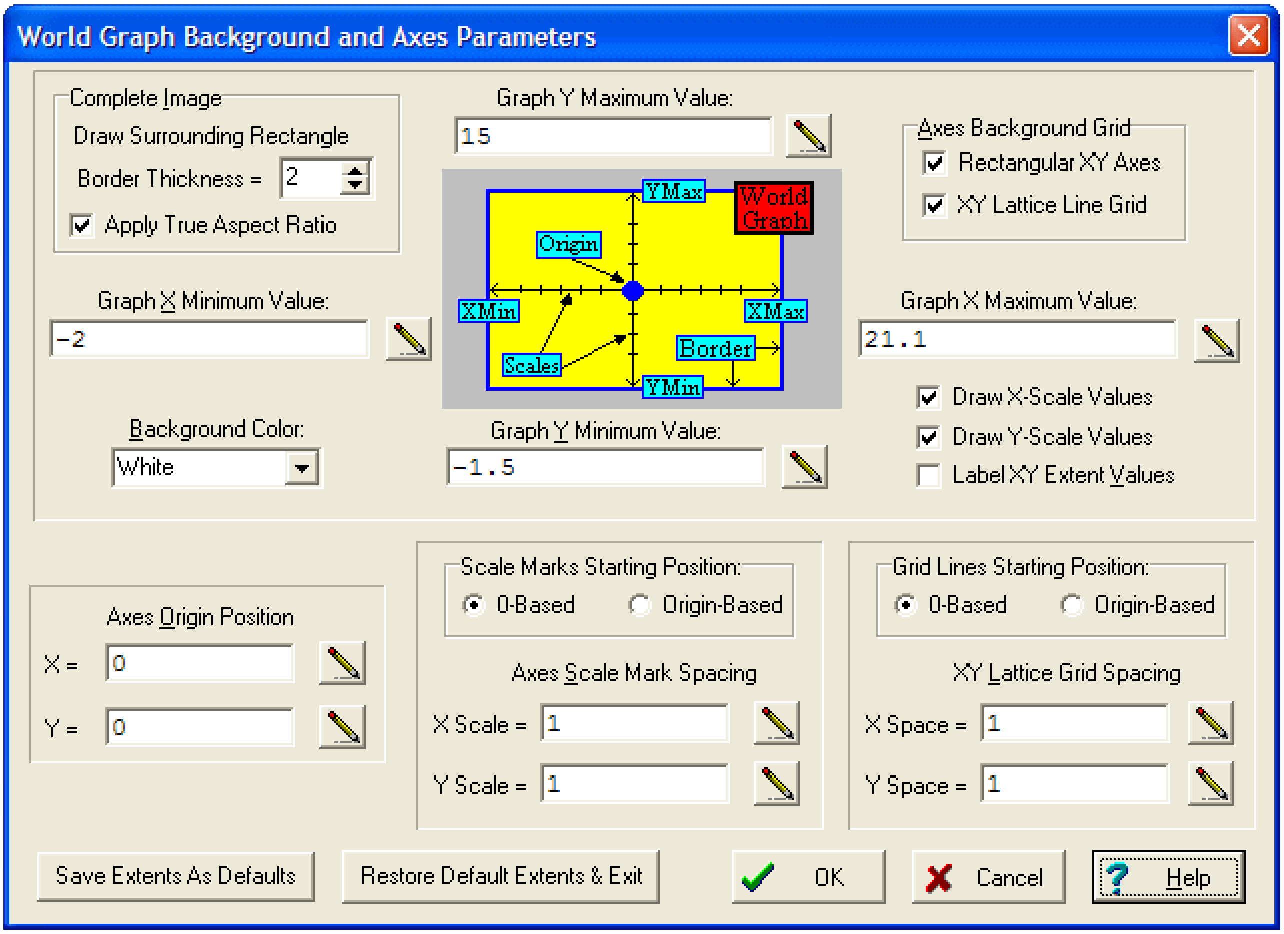
We generally recommend leaving the checkbox to **Turn Off the True Aspect Ratio** in its checked state. Otherwise the program will limit how the window size gets set. When the **True Aspect Ratio** is turned off then you are not limited in how you can set the window size.

If you should enter inappropriate values for inches the program will default to 4 inches by 3 inches. The program will also not allow pixel values below 40 nor greater than the maximum allowable window size. If you violate one of these conditions the program will automatically set the window size to half your monitor screen size.

## World Graph

This dialog box contains a lot of important controls that determine all the parts of the graph image except the constraint lines.

This dialog box is normally opened by right-clicking either the **Zoom Mode** button or the **Grid** button on the toolbar. It can also be opened by using the menu items **Edit | Graph Background Domain...**.




### Graph X Minimum Value
This value determines the left edge of the $xy$-plane that you see in your graph.

### Graph X Maximum Value
This value determines the right edge of the $xy$-plane that you see in your graph.

### Graph Y Minimum Value
This value determines the bottom edge of the $xy$-plane that you see in your graph.

### Graph Y Maximum Value

This value determines the top edge of the $xy$-plane that you see in your graph.

### Border Thickness

Your graph may be surrounded by a rectangular border. The **Border Thickness** control tells how many pixels thick to make the rectangular border. Set the thickness value to 0 to turn the rectangular border off. The default value is 2, but on a high resolution laser printer the border may appear a little thin, so you can increase the thickness to make a bolder border. The thickness values range between 0 and 25.

### Apply True Aspect Ratio

When this checkbox is marked, and when you resize the program window, the program will let you change the vertical window height, but it will automatically calculate and control the width of the window as well as the X Maximum extent value. Whatever $xy$ extent values you may have set, the graph normally fills the rectangular window area. Normally the window will have an aspect ratio so that it appears a little wider than it is tall. But with this control you can make sure square boxes are truly square and round circles are truly round. Otherwise, circles may appear as ellipses, depending on the aspect ratio of your display screen and the $xy$-extent values you may have set. This control compensates for both the aspect ratio of your display and the $xy$ extent values you may have entered. To see the effect however, you must resize the program window. Marking this checkbox alone without manually resizing the window does not make for a true aspect ratio. When this checkbox is not marked then you can resize the program window just like any other window. See also the Special Topic under Help named **Aspect Ratio**.

### Rectangular XY Axes

This checkbox control is the first of three that appear in the group for making the **Axes Background Grid**. When marked, this causes the $xy$-axes to be drawn. When unmarked, no $xy$-axes will be drawn.

### XY Lattice Line Grid

This checkbox control is the third of three that appear in the group for making the **Axes Background Grid**. When marked, this causes the XY lattice grid to be drawn. When unmarked, no XY lattice grid will be drawn. The XY lattice grid appears as a series of horizontal and vertical lines that are usually drawn in a broken-line style. In fact, if you set their line thickness to anything other than 1 then you lose the broken-line style.

### Background Color

This control is a drop-down list box from which you can choose any color for the background color of the entire graph. The default value is white, but there are a total of 16 colors from which you can choose.

### Draw X-Scale Values

When this checkbox is marked your graph will numerically label the tic marks that are on the $x$-axis. When this checkbox is unmarked then no numeric labels are drawn for the $x$-axis.

### Draw Y-Scale Values

When this checkbox is marked your graph will numerically label the tic marks that are on the $y$-axis. When this checkbox is unmarked then no numeric labels are drawn for the $y$-axis.

### Label $xy$ Extent Values

When this checkbox is marked your graph will show four numbers at the extreme edges of the graph. The two values left and right are the X-minimum and X-maximum values for the entire graph. The two values top and bottom are the Y-maximum and Y-minimum values for the entire graph. When this checkbox is unmarked then no numeric labels are drawn on the graph. Usually you will not check this box when you do check the two boxes for drawing the $x$-scale and $y$-scale values. On the other hand, you might label the $xy$ extent values whenever you do not label the axes scale values.

### Axes Origin Position

These two edit box controls determine the placement of the $xy$-axes. The normal origin position is at $x$=0 and $y$=0, but you can translate the origin to any other point in the plane to make a local coordinate system.

### Axes Scale Mark Spacing and the 0-Based Option

The axes scale marks are always drawn with the spacing values you specify here. The one additional option is to choose where the marks are started. Normally they are started at the true zero values for both the $x$ and $y$ axes. However, the marks don't have to be drawn relative to the true 0 values on the axes. The marks can be drawn starting from the current origin point. Thus we say the scale marks can be either 0-based or origin-based.

When the 0-Based option is selected then the scale marks are started relative to the true 0 values on both axes and they are said to be 0-based in that case. When the Origin-Based option is selected then the scale marks are started relative to the current origin point and they are said to be origin-based in that case.

Note that there is no difference between the two settings of the checkbox when the origin is at (0,0). However, if the origin were moved to say (1.5, 1.5) then the scale marks can be drawn relative to that origin meaning they will be drawn at 2.5,3.5, and 4.5 etc., assuming the scale mark spacing is 1. But when the scale marks are drawn 0-based then they would be marked at the usual positions of 1, 2, 3, 4 etc..

The two scale mark spacing values determine the distance between the scale marks that appear on the $xy$-axes.

This program also applies a form of automatic scaling when you perform zooming operations. If the world graph window is sufficiently large such that too large a number of axes scale marks would be drawn then the program will skip drawing certain tic marks and numeric labels. Any tic marks that you see drawn will always be spaced apart from each other that is some multiple of the spacing value you set here.

### XY Lattice Grid Spacing and the 0-Based Option

There is a 0-based option for the lattice grid lines that operates identical to the 0-based option for the scale marks. The grid lines can be started from the usual 0-based position or they can be started relative to the origin point. When the origin point is not (0,0) then there is a difference between drawing the grid lines starting at 0 or drawing the grid lines starting from the origin point.

The two spacing values act much like the scale values for the $xy$-axes, except they determine the spacing between the vertical and horizontal lines that make up the $xy$ lattice grid. The $x$= value controls the spacing between the parallel vertical grid lines. The $y$= value controls the spacing between the parallel horizontal lines.

This program also applies a form of automatic scaling when you perform zooming operations. If the world graph window is sufficiently large such that too large a number of grid lines would be drawn then the program will skip drawing certain grid lines. Any grid lines that you see drawn will always be drawn apart from each other at a distance that is some multiple of the spacing value you set here.

### Save Extents As Defaults

This push-button is normally used before you perform a series of zooming operations. When you press this button the **XMax/Min** and **YMax/Min** extent values are saved. Then any time later after you have performed one or more zooming operations and you wish to return to the default values for a graph you can do so by pressing the next button described below.

### Restore Default Extents and Exit

This push-button is normally used after you have performed one or more zooming operations and you wish to return to the default values for a graph that you saved when you pressed the button described above. Regardless of the current function type, pressing this button remakes the graph window in the $xy$-plane so that the $x$ and $y$ extents are whatever you previously saved. This push-button only resets the four extent values and leaves all the other graph background parameters alone.