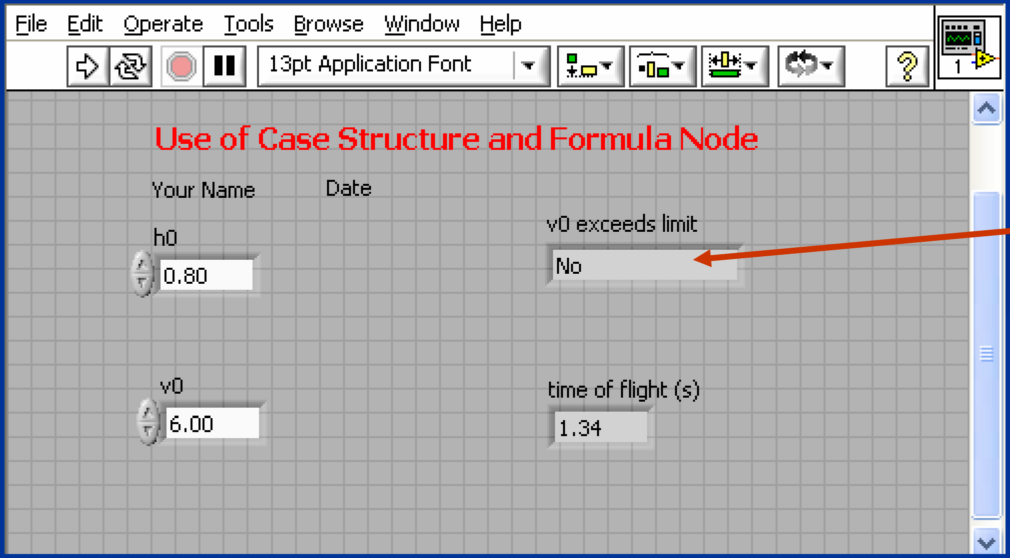
Meeting #22: HW3 will be due this Thursday Apr. 21; tips in previous class notes.
Today we did CW8 which introduces two programming elements:

What is a Case Structure?
We use it to perform different actions depending on whether a condition is satisfied or not, similar to an IF/THEN in a conventional programming language.

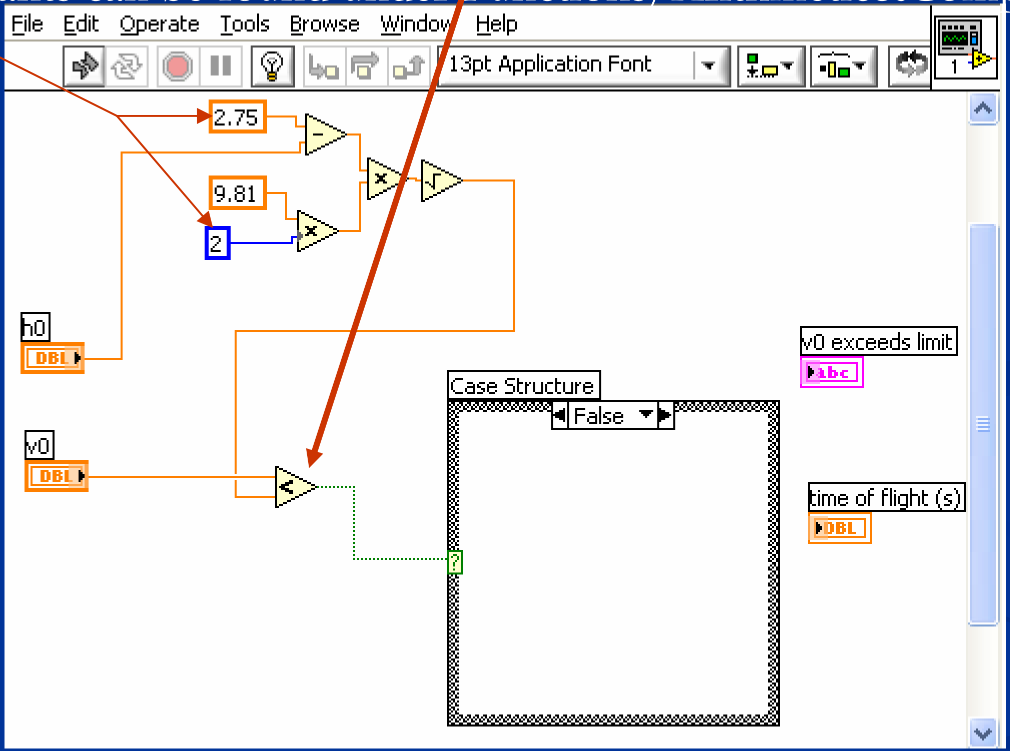
What is a Formula Node?
We use it to enter a formula as an expression, as in a conventional programming language.



1) In the Front Panel, place Two Numeric Controls for h0 and v0; one String Indicator (Controls/Text Indicators); and one Numeric Indicator for the Time of flight t.

2) In the Block Diagram produce the upper limit for v0 using the given formula (see E-syllabus) in term of h0. Note for the "Less?" operator (Functions/ Arithmetic&Comparison/Express Comparison): <u>it is checking whether the upper terminal is less than the lower terminal, giving a result of true or false.</u>

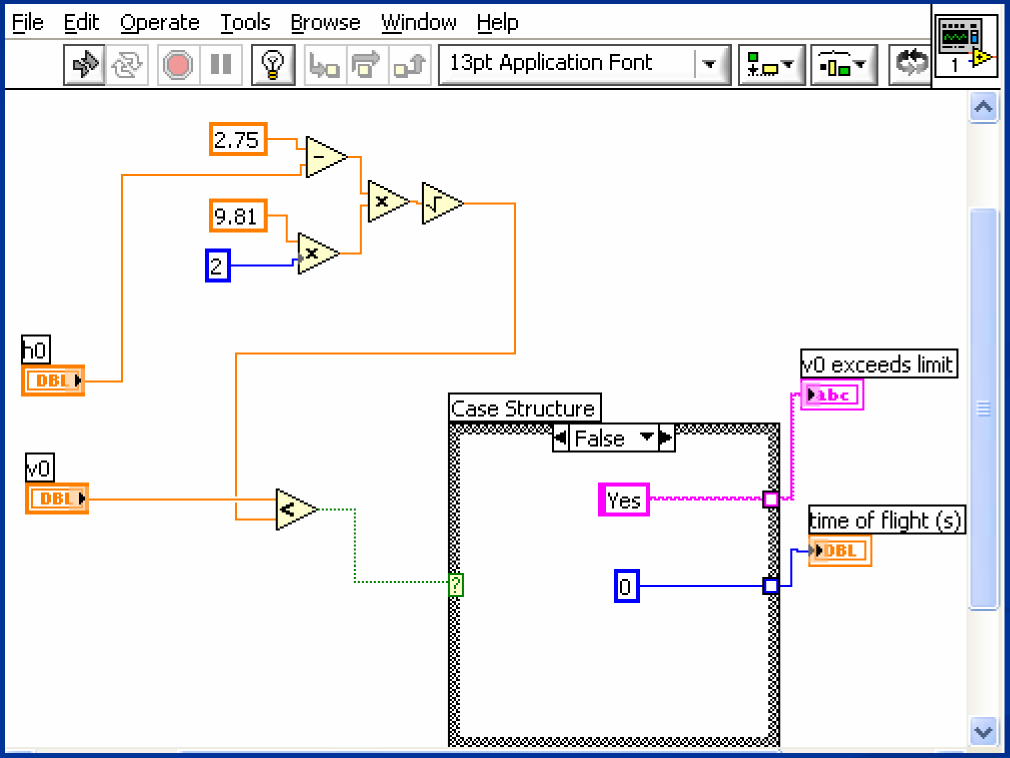
Numeric constants can be found under Functions/Arithmetic&Comparison/Express Numeric



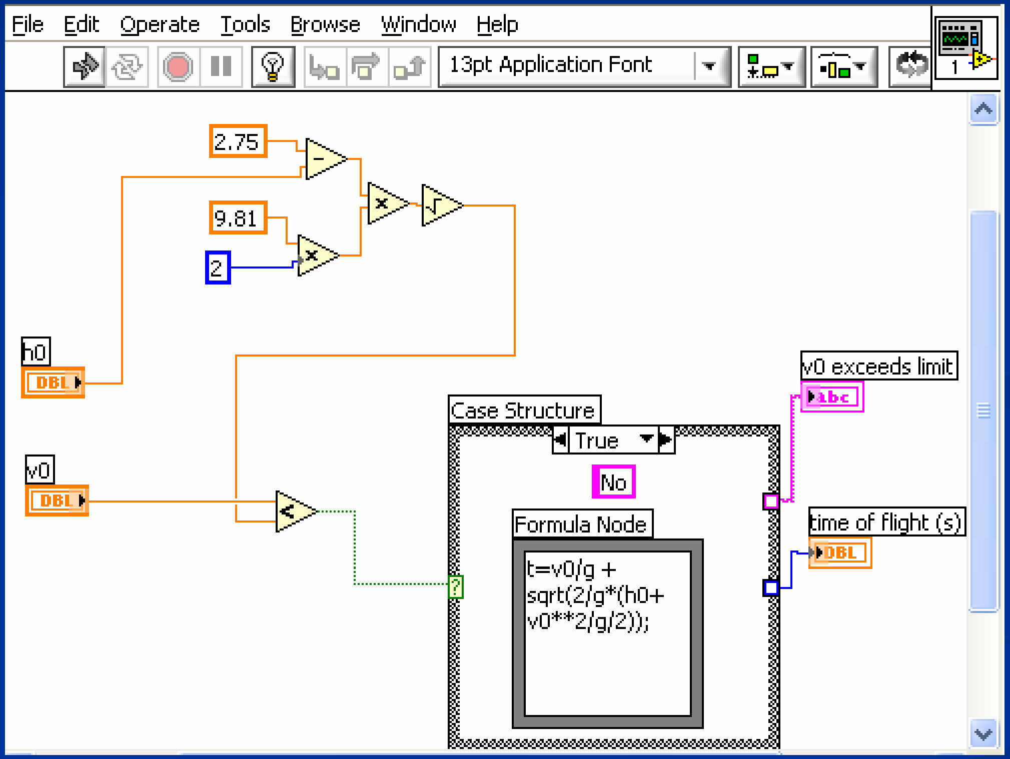
The case structure can be found in Functions/Exec Ctrl/Case Structure or All Functions/Structure. Note it has two windows: False and True. The result of the Less? Operator will dictate which window to use.

3) **What is a String Constant?**

Enter a String Constant (All Functions/String) to say Yes in the False window (when v0 Is NOT less than its maximum allowed value, then connect it to the String Indicator ("Vo exceeds limit"). And a Numeric Constant of 0 connected to the time of flight.

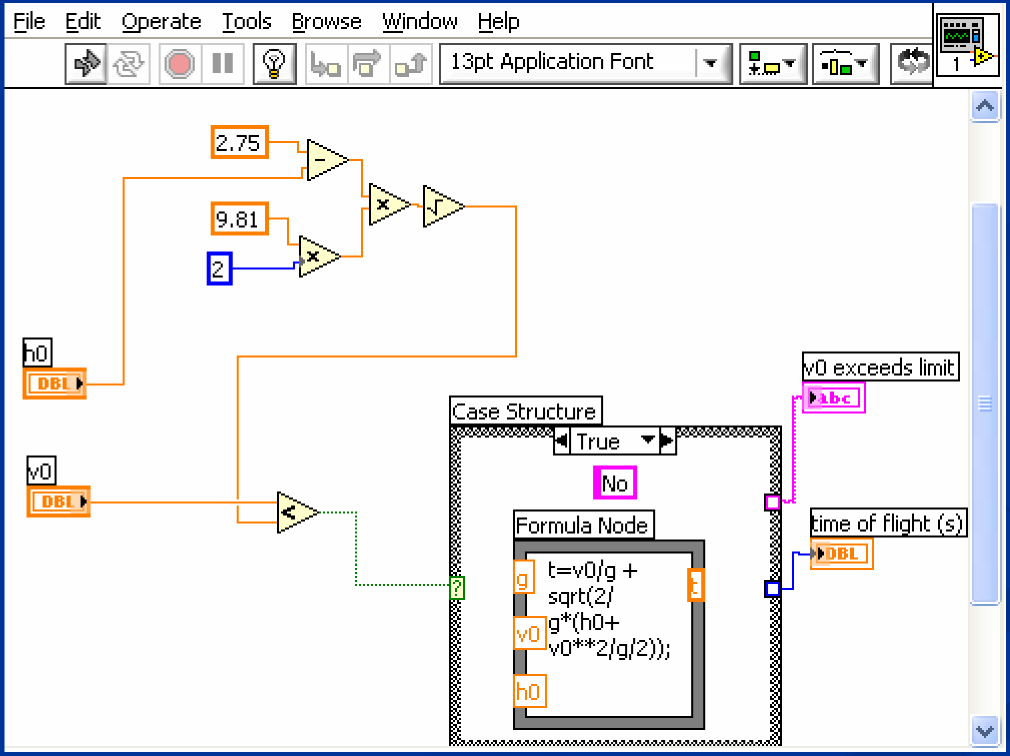


4) Switch to the True window, enter a Formula Node (All Functions/Structures); type in The formula as indicated in equation (2) in the link using "**" for power (not "^" as In Excel). Enter a String Constant for to indicate NO then connect to String Indicator "v0 exceeds limit".



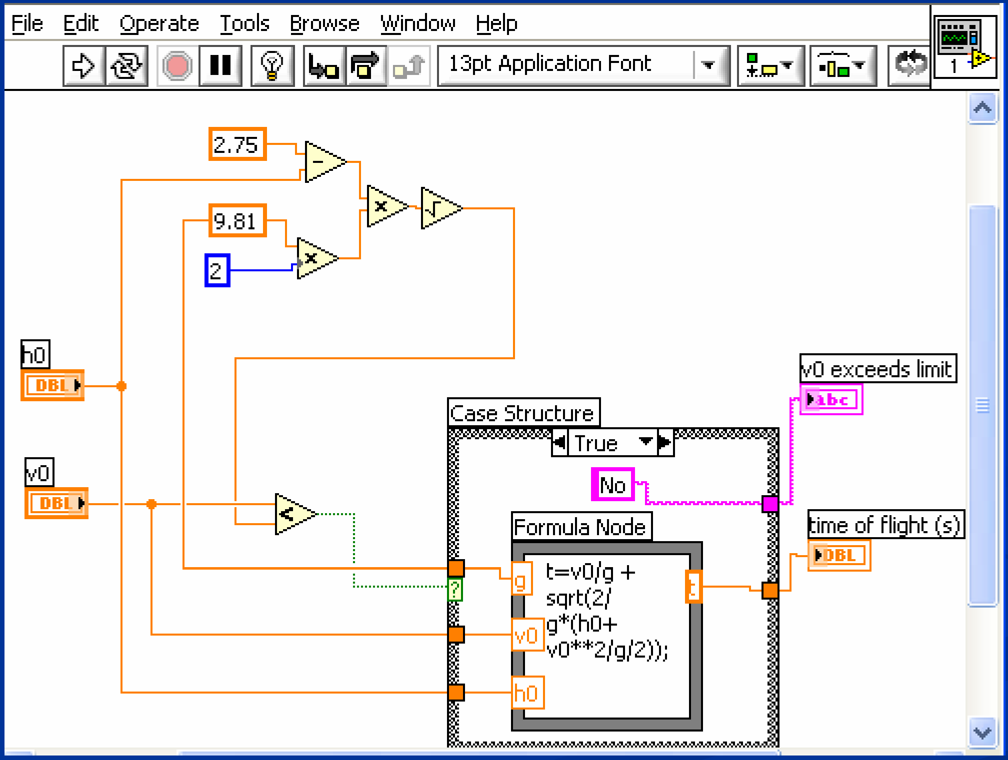
What is the meaning of the blank squares on the right border of the Case Structure?

5) To connect the Formula Node to the rest of the Diagram, right-click on the left border Of the Formula Node, select Add Input, an orange box appears, type in "v0", the same way as you refer to the initial speed in your formula within the Formula Node. Then repeat for "g" and "h0". Also right-click on the right border of the Formula Node, select Add Output, then type "t" in the orange box, remember to use the same variable as You refer to the time of flight in your expression within the Formula Node.



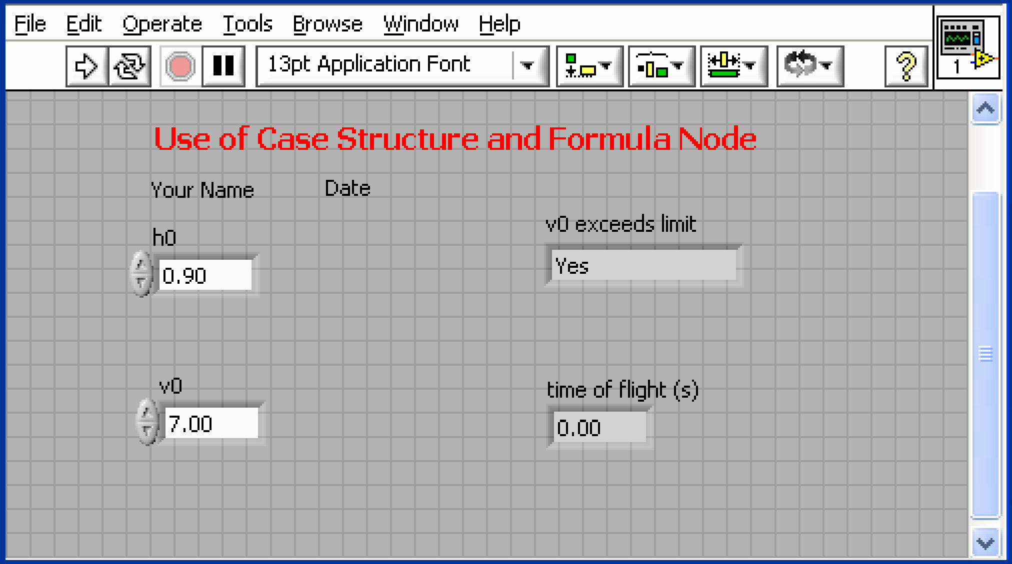
Why does the little square on the right side of the formula node has a thicker border?

6) Wire the “Inputs and Output” variables for the Formula Node as you defined in the Previous step to the corresponding elements in the Diagram as shown below. The “Run” button should become continuous now if you did not get any grammar Error. To check other type of hidden errors (non-grammar errors are not detected by the software) test the VI following step 7).

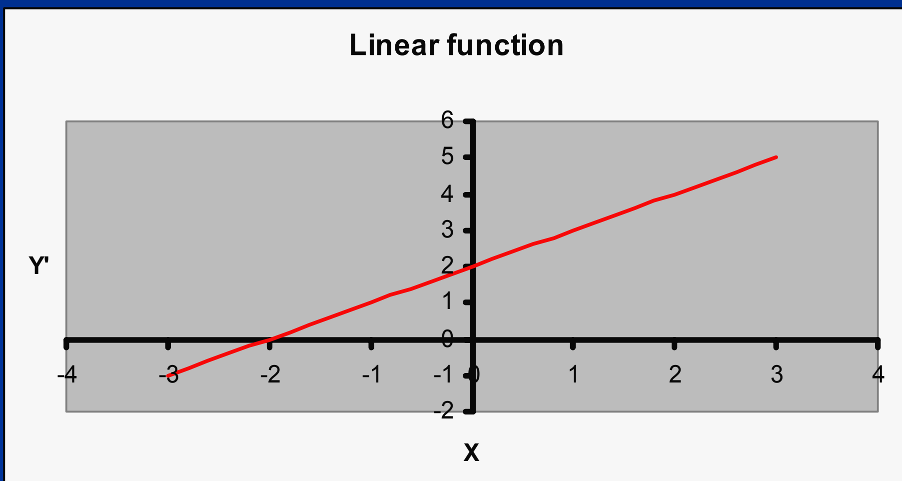


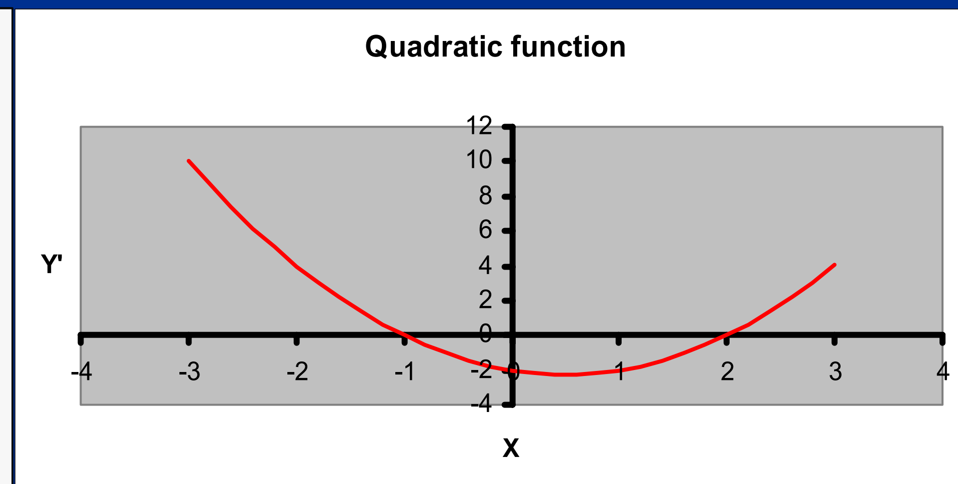
7) **Why do I need to test the program?**

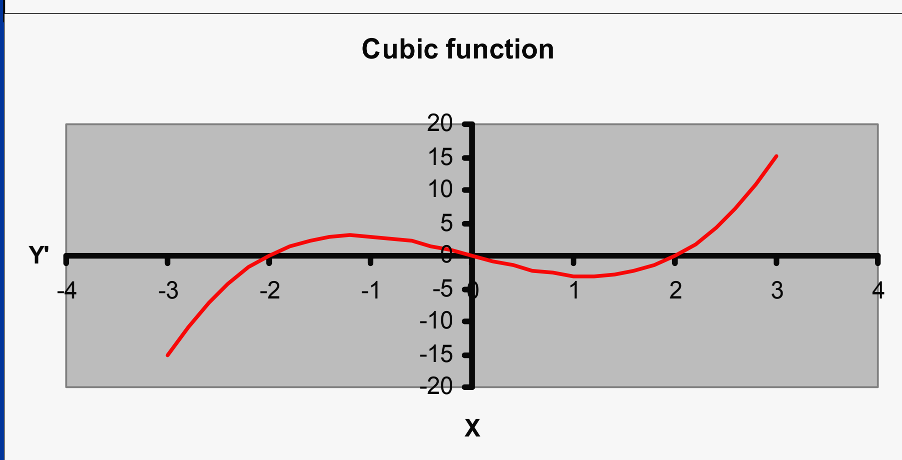
The testing step is important to detect "hidden" errors or non-grammar errors which Cannot be detected by the software. You should get the same outputs for the inputs Shown below. Also in the link there is a table of different input values for a more Thorough testing. This constitutes CW8 that is due today (note the values you need to Use in the CW and do Operate/Save Current Values as Default before you save.

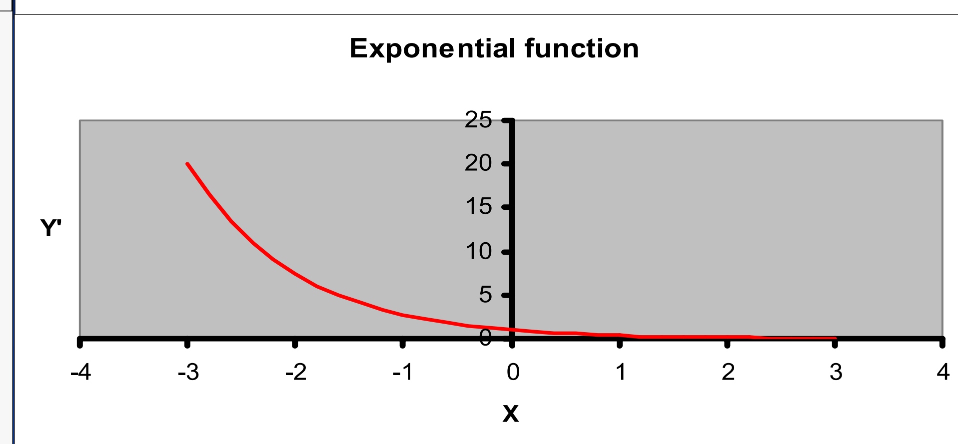


Background/Tips for HW3.10:
In a curve-fitting process you are trying to find a model that best describes a set of data. In the previous classworks (CW3 and CW4) we made models using linear, quadratic, and cubic functions. These functions are polynomials, i.e., if you try to find their roots or crossing points with the x-axis, you will get one, two, three, respectively. The number of roots is equal to the order of the polynomial. A function that can never touch the x-axis is the plain exponential function.

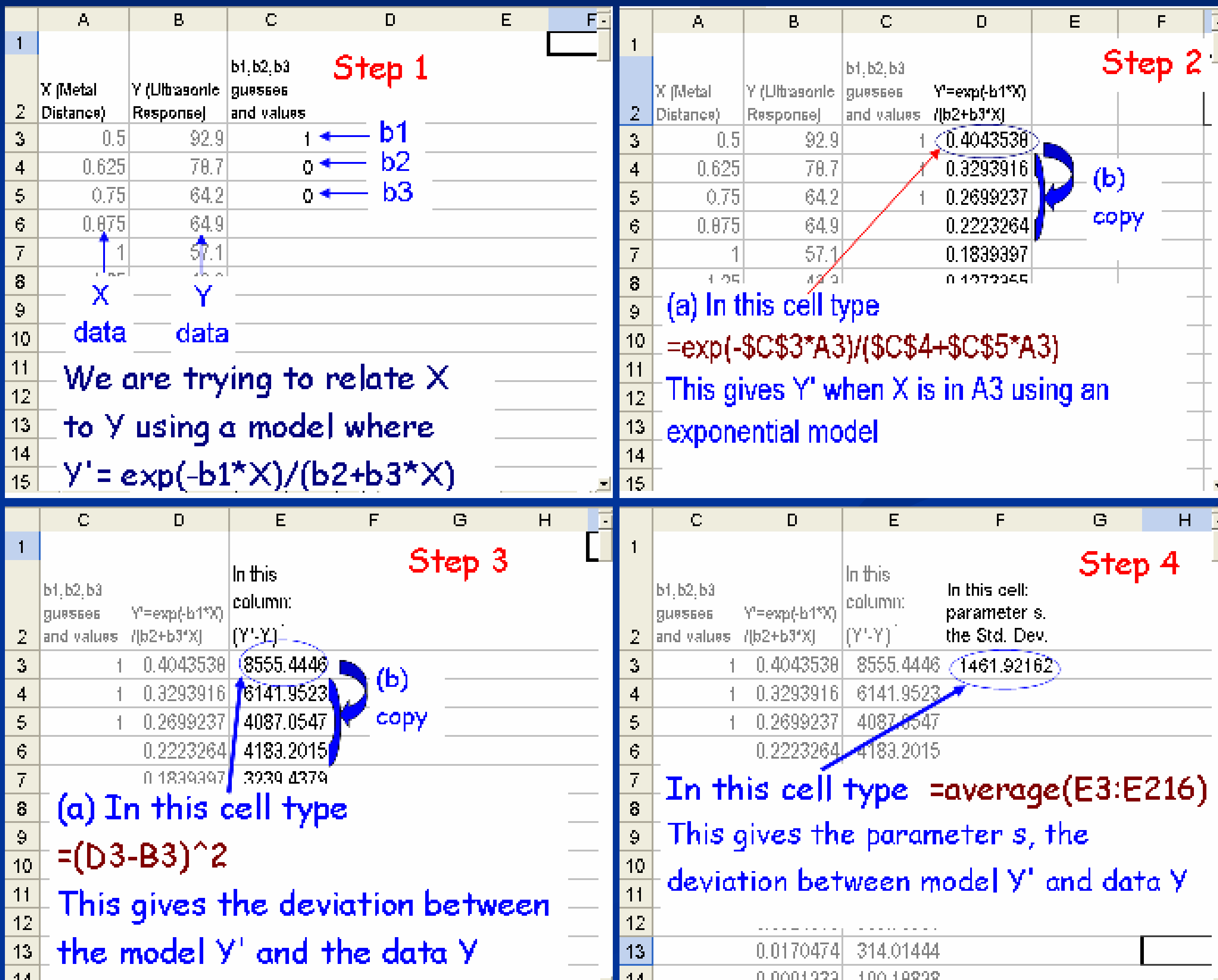


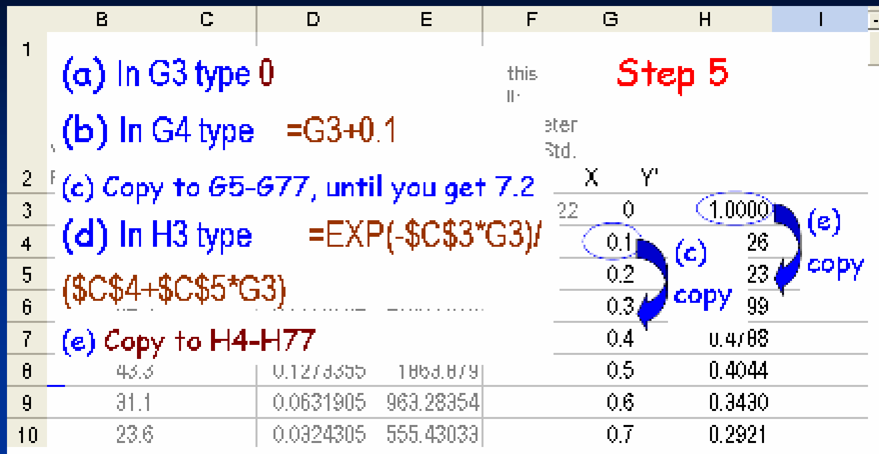


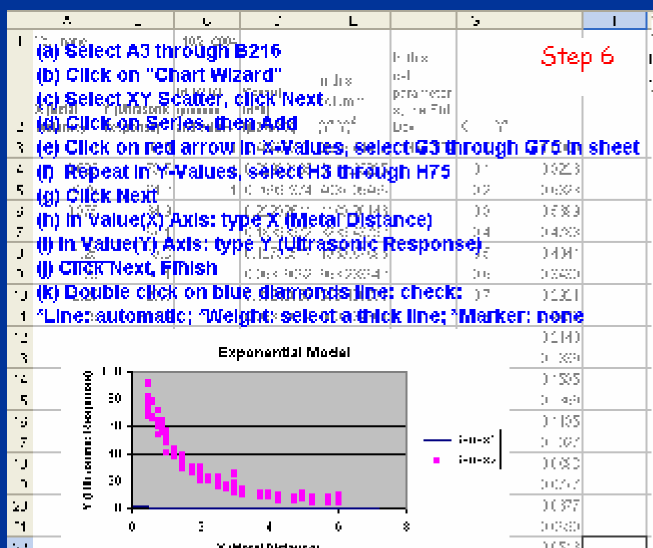


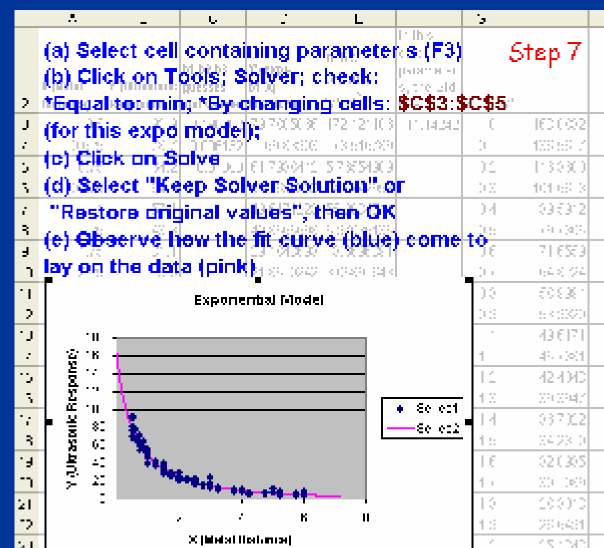


In CW5 we apply our curve-fitting process to a set of data (Ultrasonic Response versus the Metal Distance) from the National Institute of Standard website using a variable-amplitude exponential model: Y'=exp(-B1*X)/(B2+B3*X). The steps are indicated below, note a complete similarity with those used in a polynomial model (CW3 and CW4)

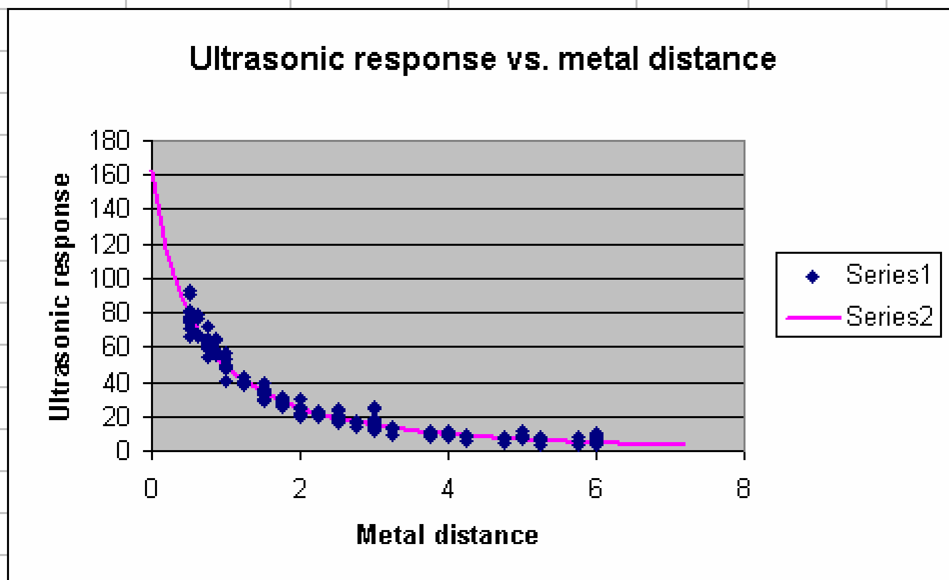



Step 5
(a) In G3 type 0
(b) In G4 type =G3+0.1
(c) Copy to G5-G77, until you get 7.2
(d) In H3 type =EXP(-$C$3*G3)/($C$4+$C$5*G3)
(e) Copy to H4-H77
X
Y'
0
1.0000
0.1
0.2
0.3
0.4
0.5
0.4044
0.6
0.3430
0.7
0.2921
(c) copy
(e) copy


Step 6
(a) Select A3 through B216
(b) Click on "Chart Wizard"
(c) Select XY Scatter, click Next
(d) Click on Series, then Add
(e) Click on red arrow in X-Values; select G3 through G75 in sheet
(f) Repeat in Y-Values, select H3 through H75
(g) Click Next
(h) In Value(X) Axis: type X (Metal Distance)
(i) In Value(Y) Axis: type Y (Ultrasonic Response)
(j) Click Next, Finish
(k) Double click on blue diamonds line: check:
*Line: automatic; *Weight: select a thick line; *Marker: none
Exponential Model
X (Metal Distance)


Step 7
(a) Select cell containing parameters (F3)
(b) Click on Tools; Solver; check:
*Equal to: min; *By changing cells: $C$3:$C$5
(for this expo model);
(c) Click on Solve
(d) Select "Keep Solver Solution" or
"Restore original values", then OK
(e) Observe how the fit curve (blue) come to
lay on the data (pink)
Exponential Model

	A	B	C	D	E	F	G	H	I
1	Tomas Materdey								
2	Data	http://www.itl.nist.gov/div898/handbook/pmd/section6/pmd631.htm							
3	Results	http://www.itl.nist.gov/div898/handbook/pmd/section6/pmd632.htm							
4	X (Metal Distance)	Y(Ultrasonic Response)	Guesses for b1, b2, b3	Y'=exp(-b1*X) /(b2+b3*X)	(Y'-Y)^2	"Standard Deviation" or s parameter		X	Y'
5	0.5	92.9	0.19029299	79.78061626	172.118	11.142417		0	163.09
6	0.625	78.7	0.00613155	69.83903537	78.5167			0.1	136.56
7	0.75	64.2	0.0105304	61.79879688	5.76578			0.2	116.86
8								0.3	101.66
9								0.4	89.591
10								0.5	79.781
11								0.6	71.656
12								0.7	64.822
13								0.8	58.999
14								0.9	53.982
15								1	49.617
16								1.1	45.788
17								1.2	42.404
18								1.3	39.395
19								1.4	36.702
20								1.5	34.281
21								1.6	32.094



Our results agree with those published in the NIST website. **This data modeling tool can be used with any model, not just polynomial and exponential models.**