Meeting #23:

**What is the difference between an analytical solution and a numerical solution? Give an example.**

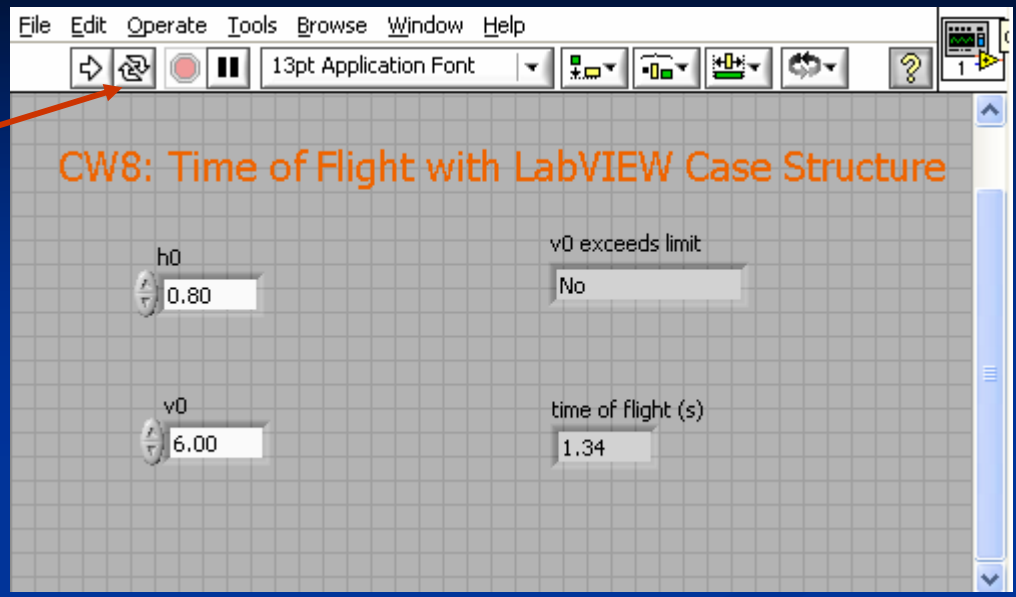
CW#9: When you launch a coin vertically up, if there is a maximum height (e.g. a ceiling you Do not want to touch) there is an upper limit to the maximum initial speed v0 with which you can launch the coin. Once the initial height h0 is specified, the RHS of equation (1) in the link (the square root) indicates this maximum v0 (this provide the analytical solution, which you can obtain by plugging the numbers). However we are going to obtain this max. v0 by Using the VI we created in CW8, i.e. numerically.

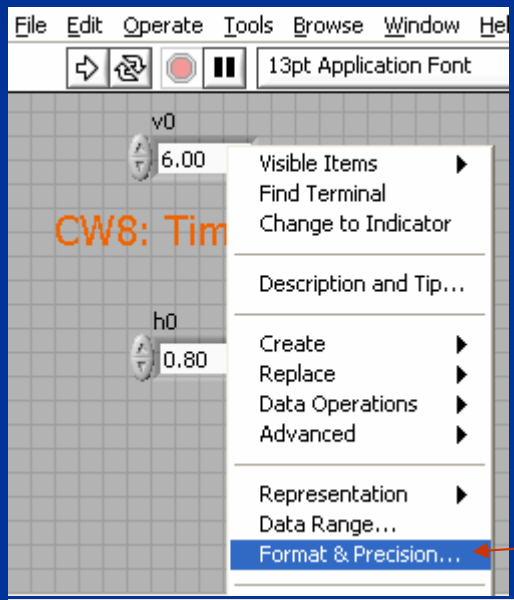
We can approach v0 max from below or above. E.g. from below, enter the given value for h0, Enter a value for v0, suppose the string indicator "v0 exceeds limit" shows "No", then enter A larger value for v0, if it say No, enter a larger value until it say Yes, then try a value $v0_1$ for v0 That is midway between the one for Yes and the one of the last No (i.e. $v0_1=(v0_{Yes}-v0_{No})/2$). If this gives Yes, then try $v0_2=(v0_1-v0_{No})/2$; if it gives No, then try $v0_2=(v0_{Yes}-v0_1)/2$, etc… Repeat this process until your trial value for v0 has three decimal digits.

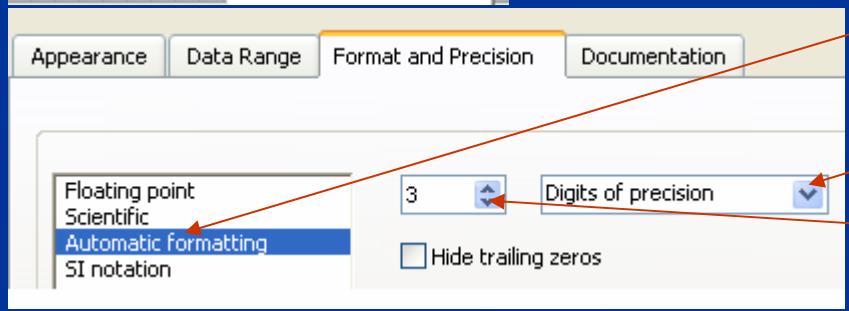
**What are the numerical v0 obtained from the VI and the analytical v0 from equation (1) in the link to "Time-of-Flight with LabVIEW –Case Structure"?**

# LabVIEW elements: **What is "Run Continuously" and How to change the digits of precision?**

When we need to run a VI repeatedly for different inputs, "Run Continuously" (button next to "Run" button) saves repeated clicks on the "Run" button;



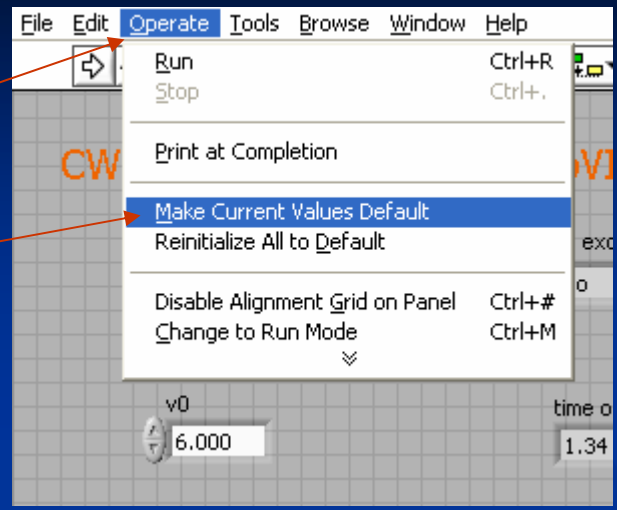



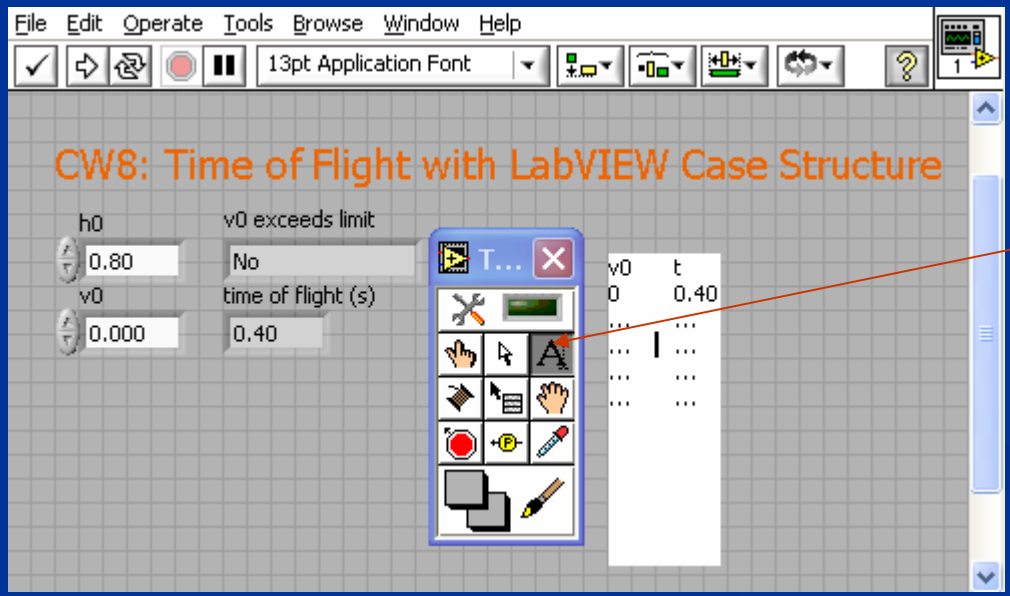




Digits of precision in a Control or Indicator numeric box can be set by right-clicking inside the box, Format & Precision/ Automatic Formatting/Digits of Precision/
and select desired Number of Digits of Precision

## Why should I use "Make Current Values Default? How to insert a text box?

Current numbers in numeric Controls and Indicators will be there next time you open the VI if before saving the VI, you click on Operate/Make Current Values Default




The Text Tool (button with an A on it, in the Tools Palette) can be used to enter or edit text and labels on the Front Panel or Block Diagram.

**What are the steps to plot a function using a computer? What is the N? What is the Interval ($t_a$, $t_b$)? What is the increment Δ? How to obtain the series $t_i$? How to obtain The series $f(t_i)$?**

CW10:

To plot a function f(t) between $t_a$ and $t_b$ using N points we will generate a time series

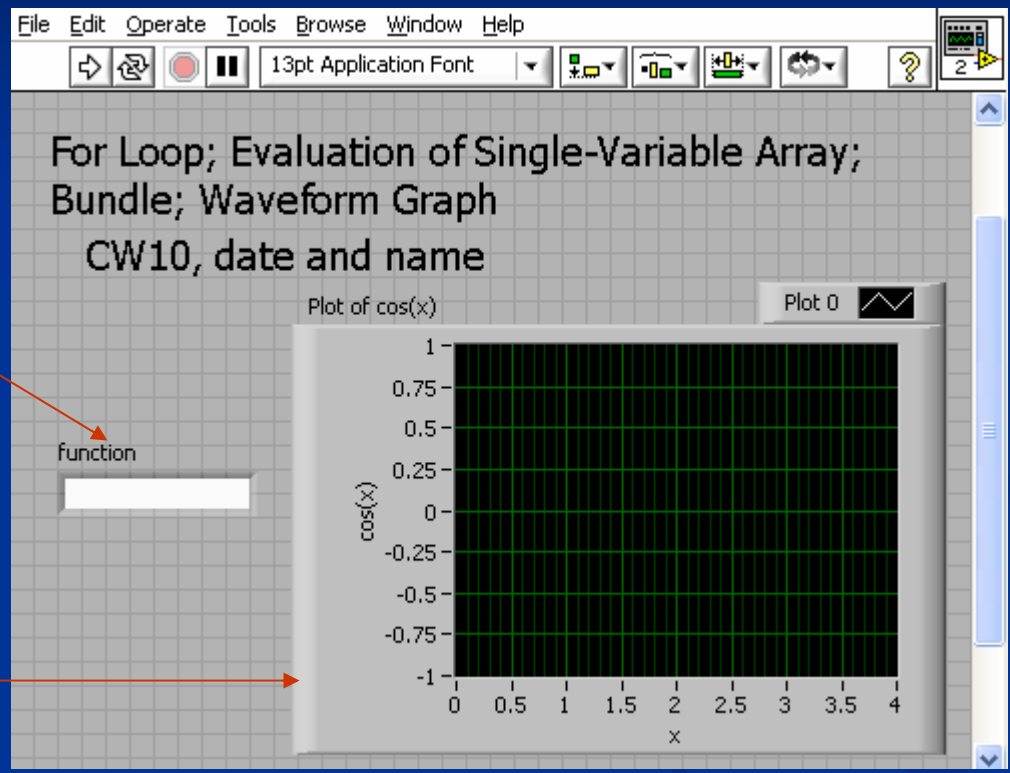
$t_i = t_a + i*\Delta$ where i =0, 2, …, N-1 (with Δ the increment; $\Delta=(t_b-t_a)/(N-1)$; $t_1=t_a$ and $t_N=t_b$) Then evaluate f(t) at $t_i$, i.e. obtaining $f(t_i)$. Then plot the points ($t_i$, $f(t_i)$), LabVIEW automatically connect these points with lines. If the number of points is large or the increment Δ is small, then the lines are so short that the overall curve looks smooth which resembles the function we are trying to plot.

In part c) we do an XY plot of two series of data by plotting pairs ($X_i$, $Y_i$)

**What is a String Control for in this example?**
**What are the inputs needed for a Waveform graph?**

String Control (under Text Ctrls) to input the function to be plotted e.g. cos(t) or cos(x)

Waveform Graph (Graphs Inds/ Graph). This graph requires as inputs the starting point $t_a$, the increment $\Delta=(t_b-t_a)/(N-1)$, and the series $f(t_i)$.



**What are the elements in a For Loop? What is a For Loop for?**

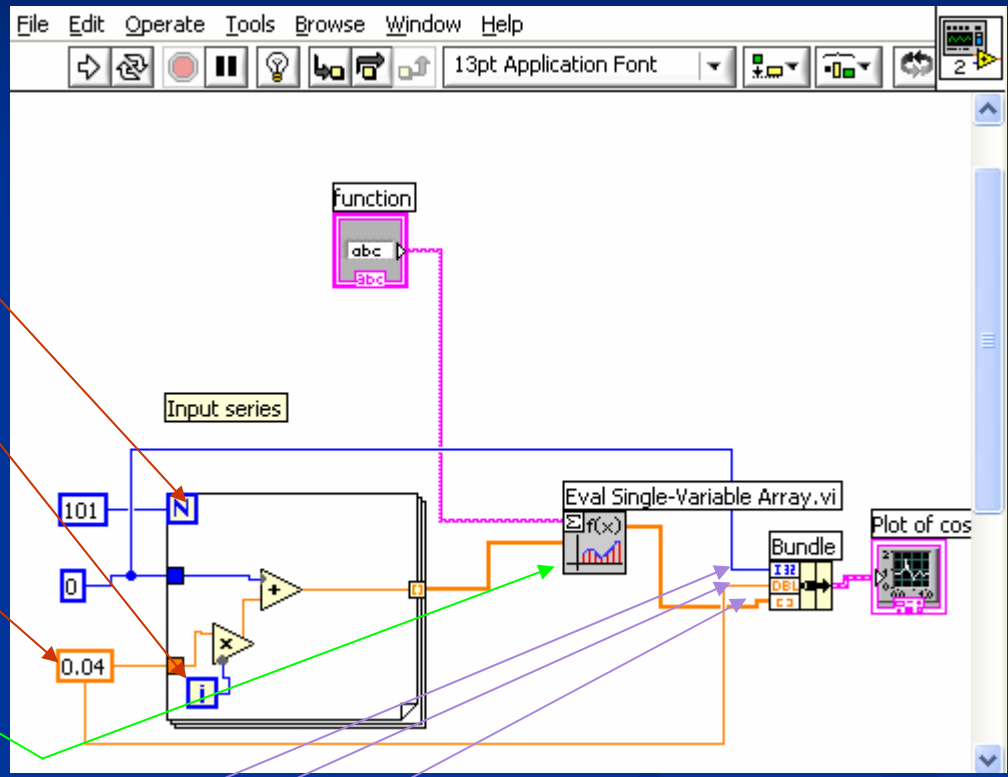
For Loop: has a count N (=number Of points) and an iteration index i Which runs from 0 to N-1. The Increment Δ whose value is $(t_b-t_a)/(N-1)$. The formula within the For Loop Generates the input series $t_i=t_a + i*\Delta$

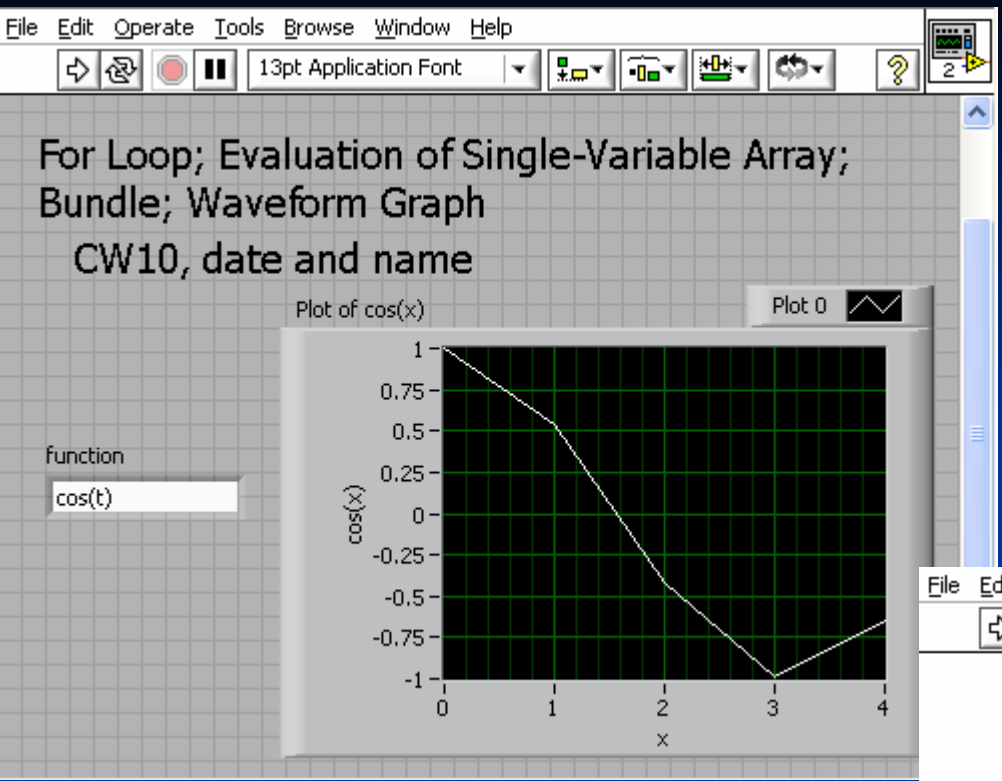
Eval. Single Variable Array (under Analyze/Mathematics/Formula/ Advanced Formula Parsing) takes as inputs The function f(t) and the input series $t_i$ , and produces the output series $f(t_i)$

Bundle (under Cluster, then right-click on its left side to "Add Input" to have three input terminals, since the Waveform Graph requires three inputs in this order: $t_a$, Δ, and $f(t_i)$

**What is an Eval Single-Variable Array for? What are its inputs?**

**What is a Bundle for? How many inputs do we Need? Why? How to add one more input?**



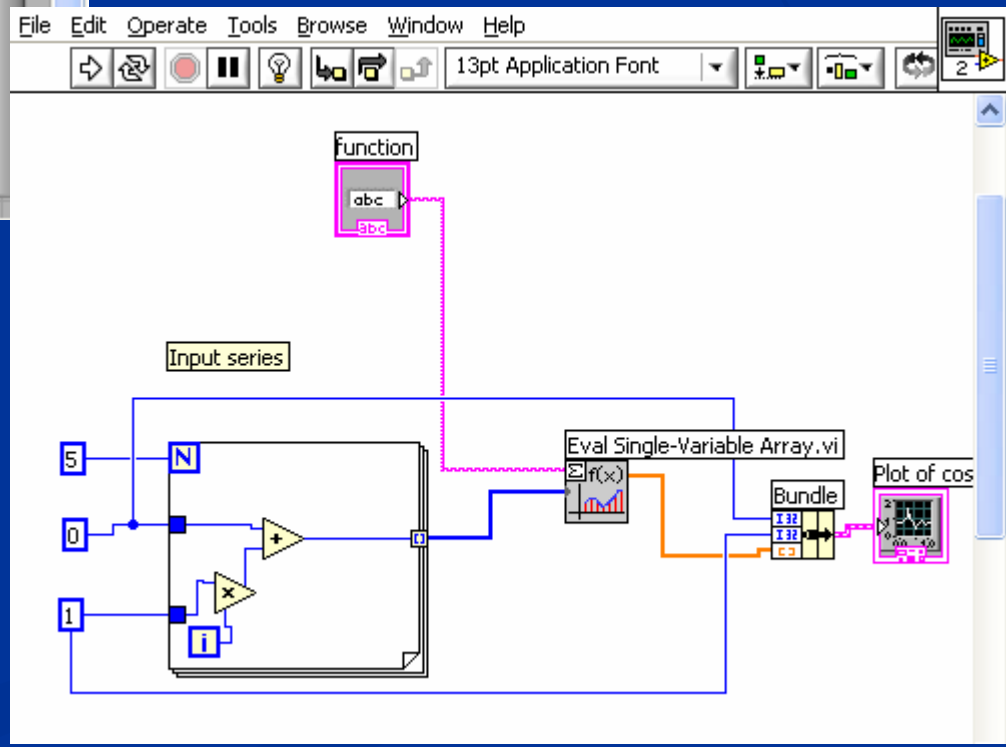



**What is the effect of using a small N Or large Δ?**

If to plot a function between 0 and 4 we use a reduced number of points such as N=5, The lines connecting the points are not short Enough and we get a broken curve.

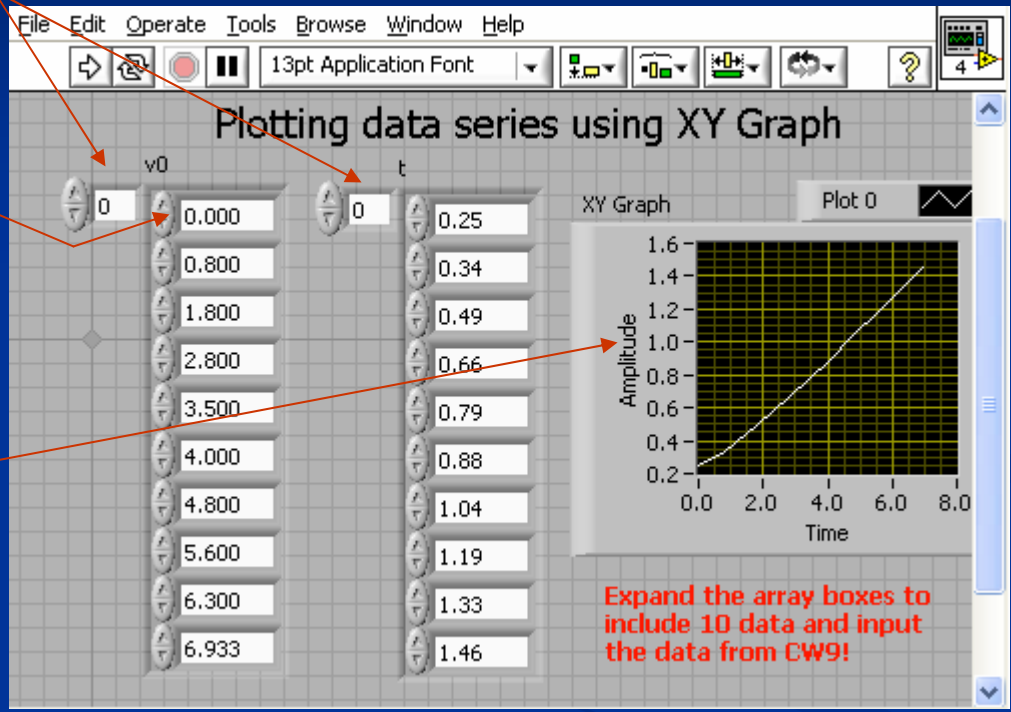
For N=5; and $t_a$=0 and $t_b$=4:

$T_i = t_a + i*\Delta$, where $\Delta=(4-0)/(5-1)=1$



**What is an Array for? How to insert an Array of Numeric Controls?**
**What is an XY graph for? What are its inputs? Is order of connection important?**

Arrays:
All Controls/Array & Cluster/Array;
Insert one Numeric Ctrl inside Array,
Then you can vertically resize the Array box for it to show ten Numeric Ctrls automatically. Enter the values carefully not to exceed the number of data points you have (10 in this case), and note the Num. Ctrls in v0 should have its Digits of Precision set to 3.




XY Graph (under Graph Inds). This graph requires as inputs two series in this order: $t_i$ to be plotted along the horizontal axis and $f(t_i)$ to be plotted along the vertical axis

Bundle (under Cluster)
Note the array with the series along the horizontal axis is connected to the upper terminal of Bundle; and the array for the series along the vertical axis is ccnnected to the lower terminal of Bundle.