College of Natural Resources

Department of Forest Resources
Forest Measurements and Inventory
Laboratory 3

Part 1: Introduction to Excel

The objectives of this laboratory exercise are to:

- Become familiar with using the Excel software package to analyze plot and stand level data
- Become familiar with using equations and graphing data with the Excel software package
- Know how to use Excel to calculate growth rates

Location: This lab is to be completed using University computer labs in your own time.

Expectations
We expect students to have a basic knowledge of computing using Microsoft Word and Excel (or equivalent packages if working from home computers). All students should have the following basic skills:

***Word-processing*:** Entering and formatting text using Microsoft Word for Windows. Simple editing using cut, copy and paste. Use of the spell-checker and Thesaurus. Printing text. Formatting paragraphs, text and page layouts. Producing simple tables. Use of the Draw and chart features to produce simple diagrams within the text.

***Spreadsheets*:** Using Excel to enter and format tabular data. Using the chart functions to illustrate data. Copying charts into Word for production of reports. Use of basic descriptive statistics using analysis tools.

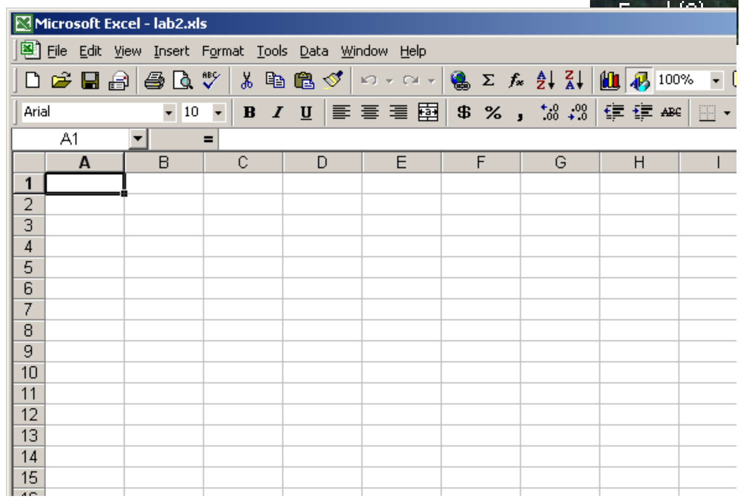
These skills are essential for success in your undergraduate degree.

Note the importance of backing up your work at regular intervals. The loss of data, essays etc. due to faulty computers or disks is NOT considered a valid excuse for not handing in work.

Part 1: Starting the Software

Once the computer has started up, double click the left mouse button on the Excel icon (as shown on the right):

This will open the Excel program, which depending on the software version will look something like this:

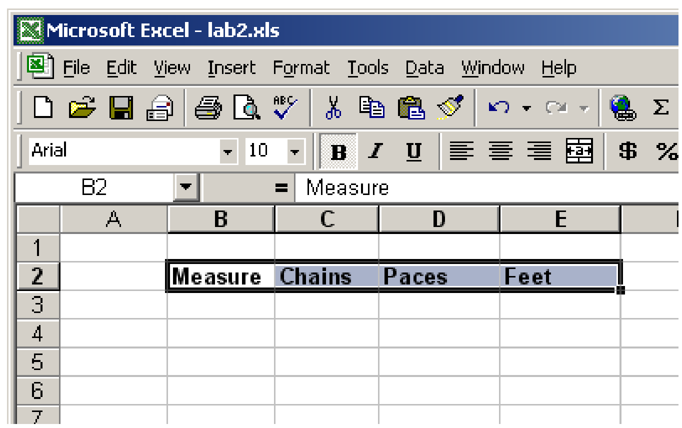


You are now ready to start doing forestry and natural resource data analysis in excel.

Part 2: Creating a Table

The first step before entering any of our data into excel is to create a basic table:

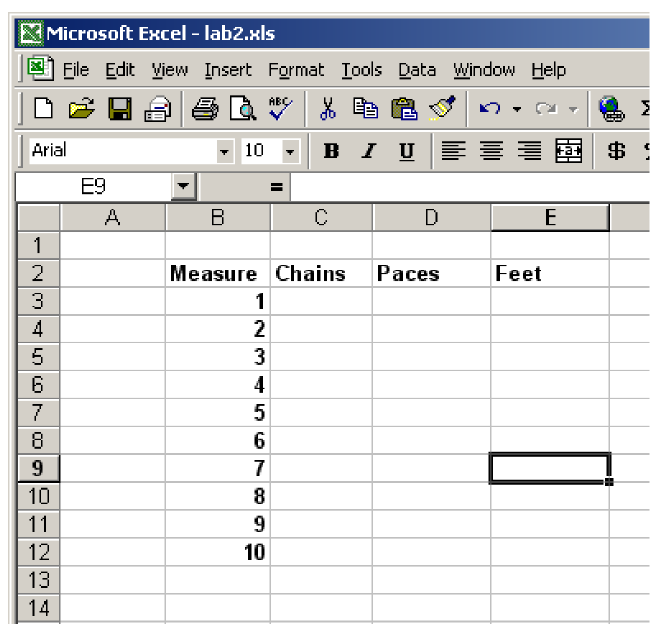
Left mouse click on cell B2.
Then type on the keyboard the word "Measure" and press Enter.



Next left mouse click on cell C2.
Now type on the keyboard the word "Chains" and press Enter.

Next left mouse click on cell D2.
Now type on the keyboard the word "Paces" and press Enter.

Next left mouse click on cell E2.
Now type on the keyboard the word "Feet" and press Enter.



To make these table headings appear clearer, left mouse click B2 and while still holding down on the left mouse button move the cursor right 3 cells to E2. This will highlight these three cells. Let go of the mouse button and left mouse click the **B** button beside the 10. The text is now "bold". Next left mouse click on cell B3.

Type the number "1" and press Enter. This will cause the cell to jump to B4. In B4 type "2" and press Enter.

Repeat this for all 10 measurements.

You have now created a basic table in which you can enter measurements.

Part 3: Create Table

Next, enter the following data into excel:

	A	B	C	D	E	F	G	H	I	J	K
1			Distance 1				Distance 2				
2		Measure	Chains	Paces	Feet		Chains	Paces	Feet	Area	
3		1		5				11			
4		2		4.5				10.5			
5		3		4				12			
6		4		6.5				11			
7		5		6				10.5			
8		6		4.5				11.5			
9		7		5				11			
10		8		6.5				10			
11		9		5				10.5			
12		10		4.5				11			
13											
14				Average				Average			
15				Std Dev				Std Dev			
16											
17											

Before the next bit you will need the **conversion factor** from paces to feet as you will need to enter this number (i.e. "factor" into Excel. **For this lab we will assume a conversion factor of 5.**

Next left click on cell E3 and then type: "=", then type in this conversion factor of 5, then type "*", then click D4, which represents that persons' paces, and finally press Enter.

Repeat this process for each measure listed in the two distances.

Step 4: Introducing Excel Shortcuts

To work out the average measure of feet for each distance, select cell E14 and type: =AVERAGE(E3:E12) and press Enter.

To calculate the standard deviation of feet for each distance, select cell E15 and type: =STDEV(E3:E12) and press Enter.

We could repeat this process for column I, by writing into cell E14 and typing: =AVERAGE(I3:I12) and pressing Enter. The standard deviation calculation will look like: =STDEV(I3:I12).

SHORTCUT #1: Copying Similar Formulas

Click you left mouse button on Cell E14 to select it and then let go. Now click your left mouse button on that cell and when the mini-menu appears select **Copy**. Next, click you right mouse button on Cell I14 and when the mini-menu appears select **Paste.**

This will "**COPY and PASTE**" your equation associated with Column E into a new equation that is associated with the values in Column I. Caution: This only works if the number of data values in each column are the same AND the location of your answer are at the same relative location (in this case the average is exactly 2 cells below the last data entry).

	A	B	C	D	E	F	G	H	I	J
1			Distance 1				Distance 2			
2		Measure	Chains	Paces	Feet		Chains	Paces	Feet	
3		1		5	55			11	121	
4		2		4.5	49.5			10.5	115.5	
5		3		4	44			12	132	
6		4		6.5	71.5			11	121	
7		5		6	66			10.5	115.5	
8		6		4.5	49.5			11.5	126.5	
9		7		5	55			11	121	
10		8		6.5	71.5			10	110	
11		9		5	55			10.5	115.5	
12		10		4.5	49.5			11	121	
13										
14				Average	57			Average	120	
15										
16										

You have now calculated the **average** or **standard deviation** of these distance measurements.

Question: Based on your analysis, if these two average distances represent two sides of a rectangle, what would be the total area and combined error (assuming the standard deviation represents the independent error):

- square feet________________ ± ____________ sq feet
- square meters______________ ± ____________ sq meters
- acres______________________ ± ____________ acres
- hectares___________________ ± ____________ hectares

SHORTCUT #2: Filling out Data or Formulas

Although you could have answered this question with a calculator, an alternative is to simply create an extra column and use an equation.

For Example in J2 you can type in the word Area and then in J4 type: **=I3*E3**

SUM | =I3*E3

	A	B	C	D	E	F	G	H	I	J	K
1			Distance 1				Distance 2				
2		Measure	Chains	Paces	Feet		Chains	Paces	Feet	Area	
3		1		5	25			11	55	=I3*E3	
4		2		4.5	22.5			10.5	52.5		
5		3		4	20			12	60		
6		4		6.5	32.5			11	55		
7		5		6	30			10.5	52.5		
8		6		4.5	22.5			11.5	57.5		
9		7		5	25			11	55		
10		8		6.5	32.5			10	50		
11		9		5	25			10.5	52.5		
12		10		4.5	22.5			11	55		
13											
14				Average	26			Average	55		
15				Std Dev	4.417453			Std Dev	2.838231		
16											
17											

This will produce an area estimate (in square feet) in Cell J3. Instead of repeating this process multiple times, a useful shortcut is the "data fill". To use this, click your left mouse button on J3 and let go.

Next move your mouse pointer to the bottom right of Cell J3 until a black cross appears.

When it does double click your left mouse button:

This will cause all the formulas to be inserted from the first cell right down to where the last data of that column is available.

J3 fx =I3*E3

	A	B	C	D	E	F	G	H	I	J	K
1			Distance 1				Distance 2				
2		Measure	Chains	Paces	Feet		Chains	Paces	Feet	Area	
3		1		5	25			11	55	1375	
4		2		4.5	22.5			10.5	52.5	1181.25	
5		3		4	20			12	60	1200	
6		4		6.5	32.5			11	55	1787.5	
7		5		6	30			10.5	52.5	1575	
8		6		4.5	22.5			11.5	57.5	1293.75	
9		7		5	25			11	55	1375	
10		8		6.5	32.5			10	50	1625	
11		9		5	25			10.5	52.5	1312.5	
12		10		4.5	22.5			11	55	1237.5	
13											
14				Average	26			Average	55		
15				Std Dev	4.417453			Std Dev	2.838231		
16											
17											

Part 5: Presenting Data in a Bar Chart

Next click your left mouse button on cell E3 and while still pressing down on the left mouse button, move your mouse cursor down the page (slowly!) until you have highlighted all the cells from E3 to E12.

Next let go of your mouse and move the cursor to the Insert Tab and select **Column**. When the Wizard appears simply select the top left option to produce a graph.

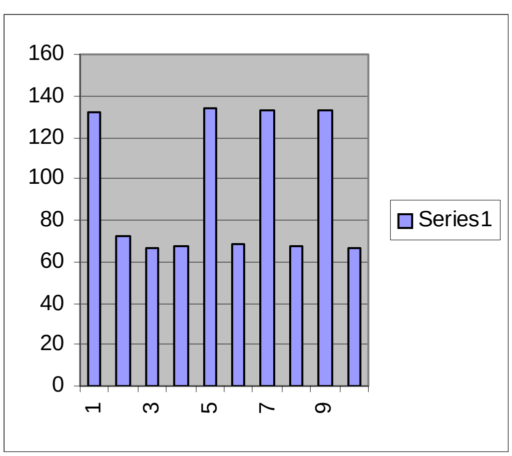
Microsoft Excel - lab2.xls

File Edit View Insert Format Tools Data Window Help

Arial 10

E3 = =(C3*66)+(D3/66*20)

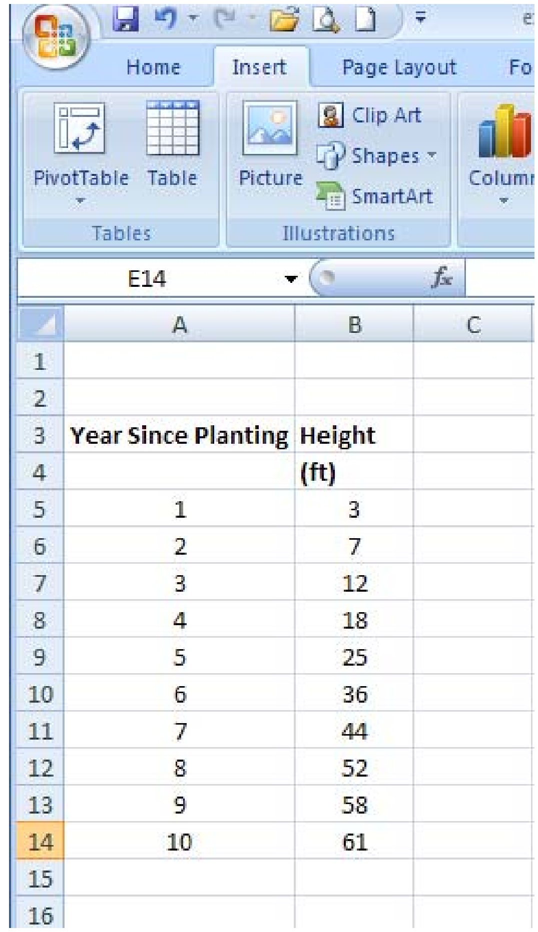
	A	B	C	D	E
1			Distance 1		
2		Measure	Chains	Paces	Feet
3		1	2	0	132
4		2	1	20	72
5		3	1	2	67
6		4	1	6	68
7		5	2	5	134
8		6	1	8	68
9		7	2	3	133
10		8	1	4	67
11		9	2	2	133
12		10	1	3	67
13					
14				Average	94



Finally, try displaying your data on different types of graphs.

Part 6 Evaluating Growth Rates

For this part of the assignment, go to the bottom of the excel page and click the Sheet 2 Tab. This will give you a new page to work with. Next type in the following information into your spreadsheet:



	A	B	C
1			
2			
3	Year Since Planting	Height	
4		(ft)	
5	1	3	
6	2	7	
7	3	12	
8	4	18	
9	5	25	
10	6	36	
11	7	44	
12	8	52	
13	9	58	
14	10	61	
15			
16			

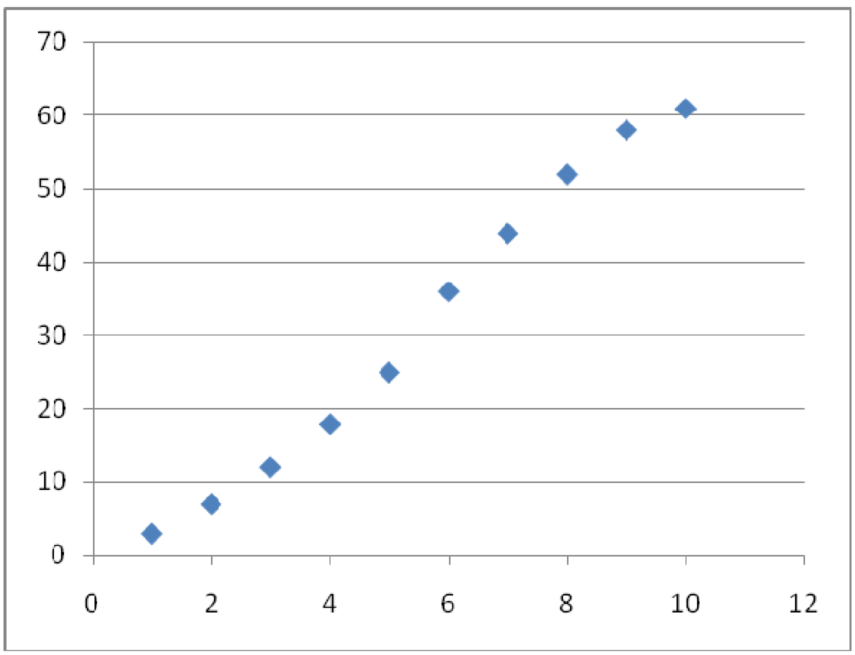
You are asked to use this data to calculate what the average growth in height was for these trees in the last 10 years.

To do this we use **Rise over Run**.

Before we do this, let's look at what the data looks like.

Click your left mouse button on cell A5 and while still pressing down on the left mouse button, move your mouse cursor down the page (slowly!) until you have highlighted all the cells from A5 to B14.

Next let go of your mouse and move the cursor to the Insert Tab and select **Scatter**. Choose the graph that appears as the top left hand option. It should look like this:



We can clearly see that the growth is not constant. By visual assessment the main growth seems to occur between years 4 and 8.

The average growth over the last 10 years is calculated by Rise over Run (often called the slope or gradient). The Rise values are the heights, while the Run values are the years since planting.

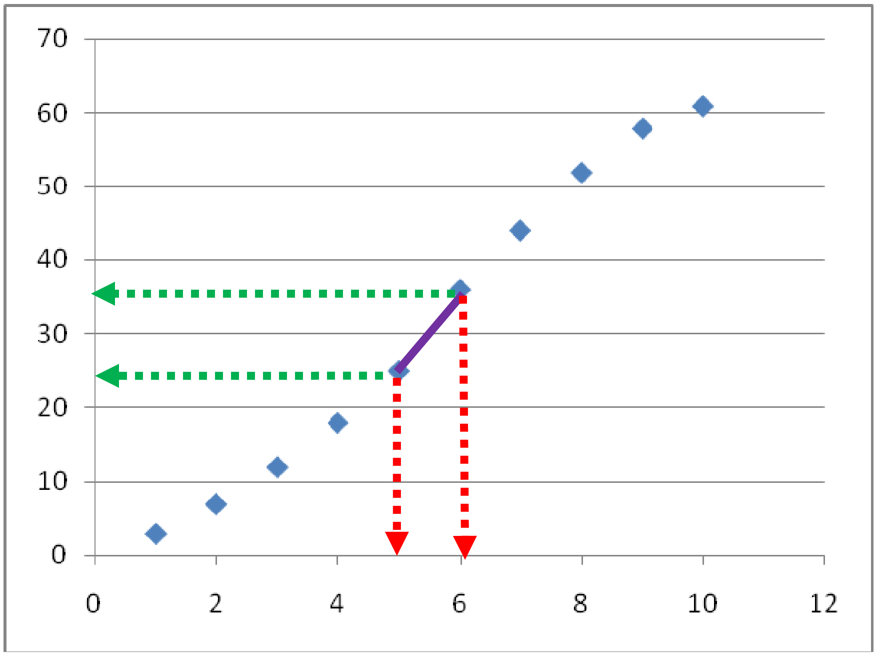
For the full 10 years the average growth in height is calculated as:

(Last Rise Value – First Rise Value) / (Last Run Value – Last Run Value)

= (61 – 3) / (10-1)

<u>= 6.44 feet per year</u>

In forestry we commonly are asked to evaluate when during the lifecycle of a stand the maximum increase in growth occurred. To do this we need to calculate the **Rise** over **Run** (**slope**) over shorter timesteps. In this example, we will calculate them every year. Doing this allows us to zone in on how the growth is changing with time. In the graph below we have the example of the **Rise** over **Run** being calculated between years 5 and 6.



If we wanted to work this out by hand we would:

1. Calculate the size of the Rise for this segment of slope – we do this by subtracting the Rise value from year 5 (=25) from the rise value at year 6 (=36) = 11
2. Calculate the size of the Run for this segment of slope – we do this by subtracting the Run value from year 5 (=5) from the Run value at year 6 (=6). =1

In this case the Rise/Run = 11/1 = **11 feet**

To do this calculation in excel for each of the years. Follow these steps:

Left mouse click on cell C3.
Now type on the keyboard the words "Growth Change" and press Enter.

Next left click on cell C6 and then type:
=(B6-B5)/(A6-A5) and press Enter.

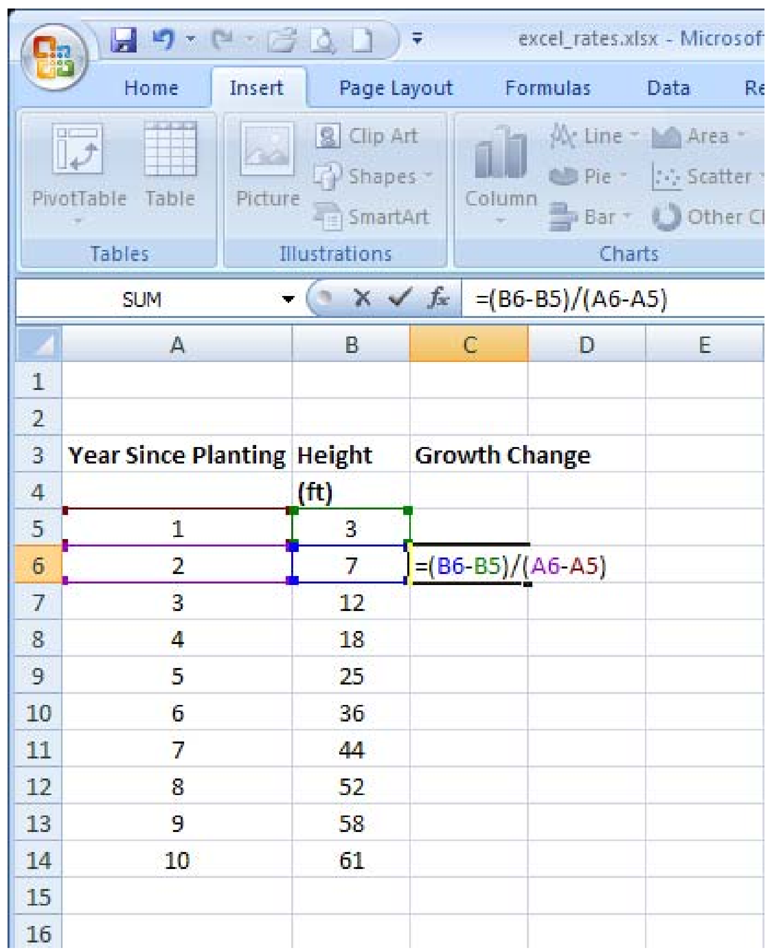
This will calculate the change in growth (height) that occurred between years 2 and 1.

Next again use SHORTCUT #2: Filling out Data or Formulas and move your mouse pointer to the bottom right of Cell C6 until a black cross appears.

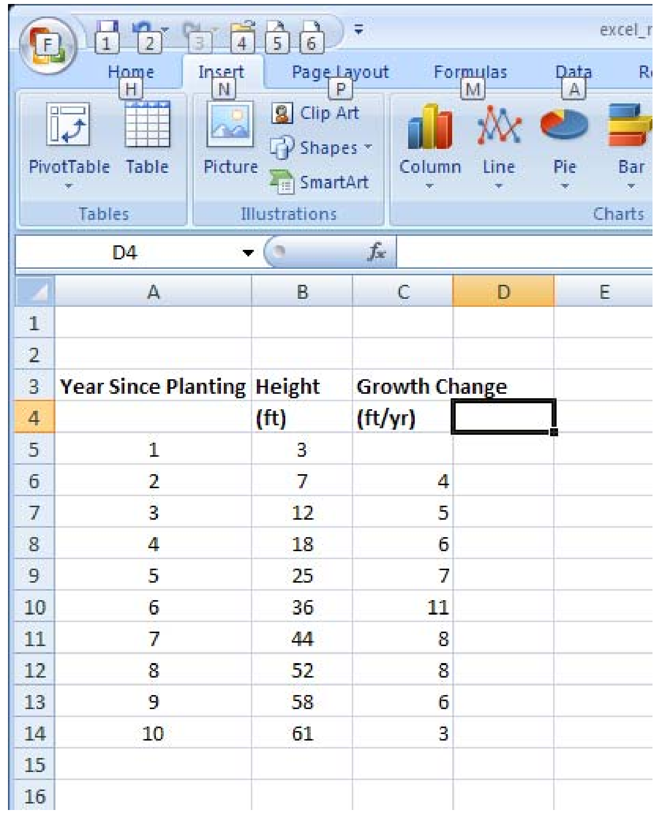
When it does double click your left mouse button:

This will cause all the formulas to be inserted from the first cell right down to where the last data of that column is available.

You will see that beside year 6 we get the same answer of 11 that we worked out by hand.

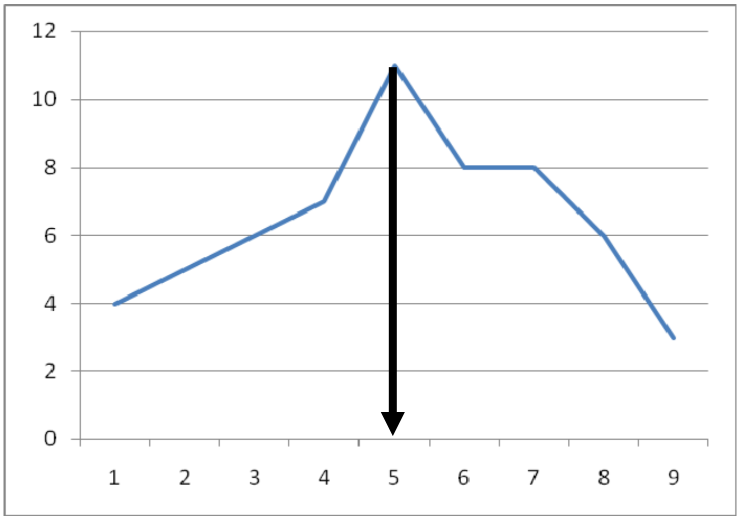


Let's look at what this new data looks like.



Click your left mouse button on cell C6 and while still pressing down on the left mouse button, move your mouse cursor down the page (slowly!) until you have highlighted all the cells from C6 to C14.

Next let go of your mouse and move the cursor to the Insert Tab and select **Line**. Choose the graph that appears as the top left hand option. It should look like this:



This graph shows you that the *peak* in growth for these trees occurred around year 5.

When we worked out the **Rise** over **Run** we are calculating a **slope**. By zoning in on differences occurring at the smallest time step – one year in this case - we are really looking at a small change in the Rise / a small change in the run. When we do this in mathematics classes we denote "a small change" by Δ or "d".

Therefore, any time you see the notation in mathematics of dy/dx this just means: small change in y / a small change in x

$$\text{Slope} = \frac{\text{Rise}_2 - \text{Rise}_1}{Run_2 - Run_1} = \frac{small\ change\ \ in\ \ Rise}{small\ \ change\ \ in\ \ Run} = \frac{\Delta Rise}{\Delta Run} = \frac{dRise}{dRun}$$

Congratulations! You have just worked out what they call in mathematics the "**First Derivative**."

In forestry we are often also asked to calculate at what years the growth was accelerating or decelerating the most. This information allows us to better evaluate when we might want to employ a different management strategy.

To work this out, we repeat the previous steps EXCEPT we now work out the Rise over Run using the Growth Change data for each year"

Acceleration =- small change in the Rise (Growth Change) / a small change in the Run (Year)

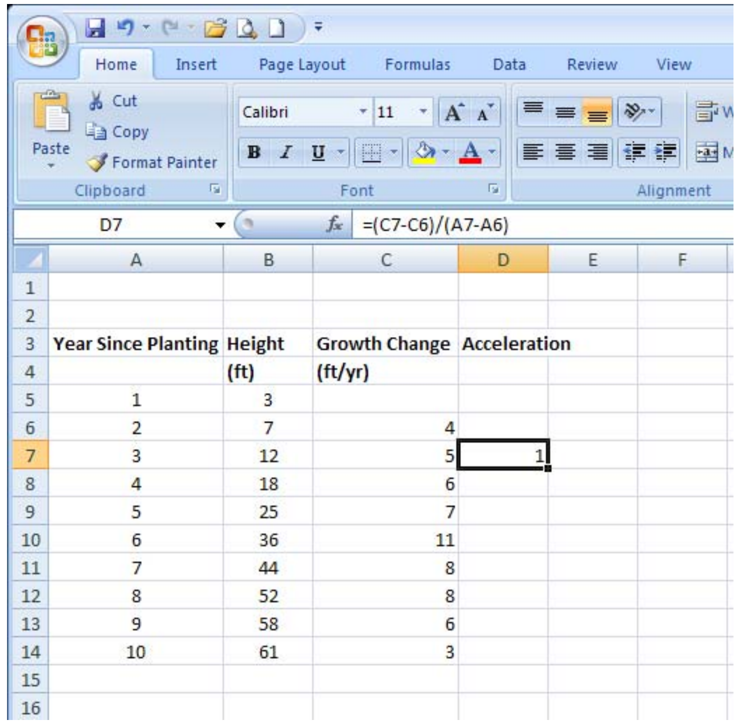
Again use SHORTCUT #2: Filling out Data or Formulas and move your mouse pointer to the bottom right of Cell D7 until a black cross appears.

When it does double click your left mouse button:

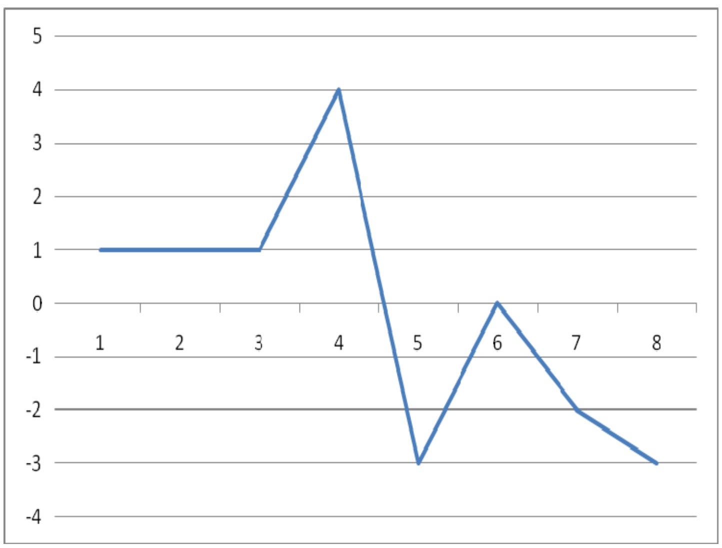
This will cause all the formulas to be inserted from the first cell right down to where the last data of that column is available.

Click your left mouse button on cell D7 and while still pressing down on the left mouse button, move your mouse cursor down the page (slowly!) until you have highlighted all the cells from D7 to C14.

Next let go of your mouse and move the cursor to the Insert Tab and select **Line**. Choose the graph that appears as the top left hand option. It should look like this:



	A	B	C	D
3	Year Since Planting	Height	Growth Change	Acceleration
4		(ft)	(ft/yr)	
5	1	3		
6	2	7	4	
7	3	12	5	1
8	4	18	6	
9	5	25	7	
10	6	36	11	
11	7	44	8	
12	8	52	8	
13	9	58	6	
14	10	61	3	



This graph shows you that the maximum growth acceleration occurred around year 4 and the maximum growth deceleration occurred around year's 5 and 8.

Question: In a real forest what may have caused the deceleration in growth around year 5?

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When we worked out the **Rise** over **Run** in this example we are calculating a **slope of a slope!** By zoning in on differences occurring at the smallest time step – one year in this case - we are really looking at a small change in the Slope of the Rise / a small change in the run. When we do this in mathematics classes we denote the 2 small changes by "d^2".

Therefore, any time you see the notation in mathematics of d^2y/d^2x this just means: small change in the slope of y / a small change in x

Congratulations! You have just worked out what they call in mathematics the "**Second Derivative**."

Part 7: Exercise – Creating Field Sheets

Using Word and Excel reproduce this table as accurately as possible:

OVERSTORY TREE DATA, UNDERSTORY TREE DATA, SITE INDEX University of Idaho Experimental Forest: Fuels Monitoring Program

Unit		Elevation			
Stand		Date			
Plot #		Collectors			
Habitat type		Slope placement			
Aspect		Fuel Model		bottom, low, mid, upper, ridge	
% slope					

Crown class code	
Dominant	D
Co-dominant	C
Intermediate	I
Suppressed	S

Plot center coordinates
x
y

Overstory 1/10ac = 37.2ft radius
Understory 1/100ac = 11.8ft radius

OVERSTORY									UNDERSTORY			
Tree #	Species code	DBH (in)	Total height (ft)	Crown base height (ft)	Crown class code	live (L) dead (D)	Damage Code	Notes	Species code	Count	Mean height (ft)	
1												0-1.9" dbh
2												
3												
4												
5												
6												
7												
8												
9												2.0 - 3.9" dbh
10												
11												
12												
13												
14												
15												
16												