

Introduction to Microsoft Excel



Microsoft Office
Excel 2003/2007

Naming cells in Excel

| | Columns | | |
|---|---------|----|----|
| | A | B | C |
| 1 | A1 | B1 | C1 |
| 2 | A2 | B2 | C2 |
| 3 | A3 | B3 | C3 |
| 4 | A4 | B4 | C4 |

Rows

this column is B1:B4

This cell is C4

Example of Excel data

The screenshot shows a Microsoft Excel window titled "Microsoft Excel - 51-marks.xls". The spreadsheet contains two main sections: a data entry section and a statistics section.

Data entered: The first section (rows 1-6) contains data for five students: Anil, Bina, Catie, Dina, and Eugene. The columns represent the student's first name (A1), exam scores (exam1 and exam2), and the calculated average (Average). The cell A1 is highlighted with a red border.

Rows: An arrow points to the horizontal axis, indicating rows.

Columns: An arrow points to the vertical axis, indicating columns.

Cell A1: An arrow points to the cell A1, which contains the value "first_name".

Charts: An arrow points to the "Chart" icon in the ribbon.

Formulas: An arrow points to the formula bar showing the formula for cell A1: =first_name.

value of cell A1: An arrow points to the value "first_name" in cell A1.

Each cell can contain text or number or formula: An arrow points to the formula bar showing the formula for cell A1: =first_name.

Sheets: An arrow points to the bottom navigation bar showing multiple sheets: mosh, Sheet3, and Sheet1.

Data computed using a formula by excel: The second section (rows 8-14) shows statistical calculations: Average, Median, Mode, and stddev. Row 14 displays frequency distributions for bins 0, 25, 50, 75, and 100, along with their respective frequencies and averages.

| | A | B | C | D |
|----|------------|------------|------------|----------|
| 1 | first_name | exam1 | exam2 | Average |
| 2 | Anil | 100 | 99 | 99.5 |
| 3 | Bina | 82 | 76 | 79 |
| 4 | Catie | 72 | 85 | 78.5 |
| 5 | Dina | 33 | 55 | 44 |
| 6 | Eugene | 22 | 10 | 16 |
| 7 | | | | |
| 8 | Statistics | | | |
| 9 | Average | 48.647059 | 54.41176 | 51.52941 |
| 10 | Median | 72 | 76 | 78.5 |
| 11 | Mode | #N/A | #N/A | #N/A |
| 12 | stddev | 33.108911 | 34.64823 | 33.15758 |
| 13 | | | | |
| 14 | bins | freq/exam1 | freq/exam2 | freq av |
| 15 | 0 | 0 | 0 | 0 |
| 16 | 25 | 1 | 1 | 1 |
| 17 | 50 | 1 | 0 | 1 |
| 18 | 75 | 1 | 1 | 0 |
| 19 | 100 | 2 | 3 | 3 |
| 20 | | | | |

Random numbers with =Rand() and =RandBetween(x, y)

1. Type these two formulas in A1 and B1 and
2. press Control-backquote/tilde [C-`] or [C ~] to see the formula

| A1 | B | C |
|---------------------|---------|---|
| =RANDBETWEEN(10,20) | | |
| =RANDBETWEEN(10,20) | =RAND() | |

| A | B |
|---|---------------|
| 1 | 19 0.47613082 |

Exercise: On new sheet create numbers 0.1 to 1.0

1. Type A1=0.1, A2=0.2
 2. Select A1 and A2 with Shift-click
 3. Drag black dot to A10.
- OR you can DOUBLE-CLICK on the black dot to fill the whole column

| A1 | f _x | 0.1 |
|-------|----------------|-----|
| 1 0.1 | | B |
| 2 0.2 | | |
| 3 | | |

| A1 | |
|-------|--|
| 1 0.1 | |
| 2 0.2 | |
| 3 0.3 | |
| 4 0.4 | |
| 5 0.5 | |
| 6 0.6 | |
| 7 0.7 | |
| 8 0.8 | |
| 9 0.9 | |
| 10 1 | |

Exercise: In B1 type =Rand(), and then drag the black dot down to make 10 Random Numbers

| | A | B | C | D | E |
|----|-----|----------|---|---|---|
| 1 | 0.1 | 0.471221 | | | |
| 2 | 0.2 | 0.915031 | | | |
| 3 | 0.3 | 0.30377 | | | |
| 4 | 0.4 | 0.394233 | | | |
| 5 | 0.5 | 0.102344 | | | |
| 6 | 0.6 | 0.15286 | | | |
| 7 | 0.7 | 0.462486 | | | |
| 8 | 0.8 | 0.562423 | | | |
| 9 | 0.9 | 0.163471 | | | |
| 10 | 1 | 0.613981 | | | |
| 11 | | | | | |

Exercise: Create 100 randoms

Create: 100 random numbers between 100 .. 200

with

1. In A1 type `=randomBetween(100,200)`,
2. drag the black-dot to J1
3. Select the Row 1 with Shift-Mouse-Click
4. Drag the black dot to J10

| A | =RANDBETWEEN(100,200) |
|---|-----------------------|
| 1 | =RANDBETWEEN(100,200) |
| 2 | |

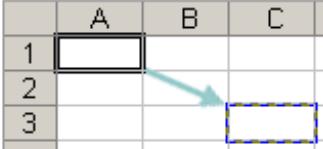


| A1 | f _x | =RANDBETWEEN(100,200) | | | | | | | |
|-----|----------------|-----------------------|-----|-----|-----|-----|-----|-----|-----|
| A | B | C | D | E | F | G | H | I | J |
| 107 | 193 | 185 | 140 | 150 | 132 | 143 | 112 | 197 | 112 |



| A1 | f _x | =RANDBETWEEN(100,200) | | | | | | | | |
|----|----------------|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| A | B | C | D | E | F | G | H | I | J | |
| 1 | 187 | 191 | 122 | 157 | 138 | 147 | 154 | 155 | 195 | 116 |
| 2 | 128 | 172 | 181 | 192 | 121 | 169 | 114 | 190 | 196 | 180 |
| 3 | 136 | 104 | 167 | 106 | 127 | 138 | 138 | 163 | 114 | 116 |
| 4 | 182 | 115 | 125 | 110 | 169 | 157 | 126 | 137 | 124 | 101 |
| 5 | 102 | 121 | 132 | 184 | 160 | 194 | 117 | 147 | 159 | 114 |
| 6 | 150 | 102 | 184 | 119 | 170 | 196 | 132 | 150 | 178 | 167 |
| 7 | 149 | 181 | 166 | 180 | 184 | 165 | 141 | 121 | 185 | 107 |
| 8 | 193 | 129 | 106 | 116 | 114 | 111 | 114 | 140 | 193 | 150 |
| 9 | 142 | 136 | 130 | 168 | 121 | 104 | 106 | 181 | 196 | 122 |
| 10 | 123 | 112 | 189 | 165 | 143 | 176 | 120 | 169 | 104 | 200 |

Absolute versus Relative Cell

| FOR A FORMULA BEING COPIED: | IF THE REFERENCE IS: | IT CHANGES TO: |
|---|--|---------------------------------------|
|  | \$A\$1 (absolute column and absolute row) | \$A\$1 (the reference is absolute) |
| | A\$1 (relative column and absolute row) | C\$1 (the reference is mixed) |
| | \$A1 (absolute column and relative row) | \$A3 (the reference is mixed) |
| | A1 (relative column and relative row) | C3 (the reference is relative) |

Exercise: Make a Multiplication Table

| | A | B | C | D | E |
|----|----|----|----|----|----|
| 1 | 1 | 2 | 3 | 4 | 5 |
| 2 | 2 | 4 | 6 | 8 | 10 |
| 3 | 3 | 6 | 9 | 12 | 15 |
| 4 | 4 | 8 | 12 | 16 | 20 |
| 5 | 5 | 10 | 15 | 20 | 25 |
| 6 | 6 | 12 | 18 | 24 | 30 |
| 7 | 7 | 14 | 21 | 28 | 35 |
| 8 | 8 | 16 | 24 | 32 | 40 |
| 9 | 9 | 18 | 27 | 36 | 45 |
| 10 | 10 | 20 | 30 | 40 | 50 |

Hint: In B2 type = \$A2 * B\$1, and drag the DOT to copy the formula.

Multiplication Table: Solution

| | A | B | C | D |
|---|---|---------------|---------------|---------------|
| 1 | 1 | 2 | 3 | 4 |
| 2 | 2 | = $\$A2*B\1 | = $\$A2*C\1 | = $\$A2*D\1 |
| 3 | 3 | = $\$A3*B\1 | = $\$A3*C\1 | = $\$A3*D\1 |
| 4 | 4 | = $\$A4*B\1 | = $\$A4*C\1 | = $\$A4*D\1 |
| 5 | 5 | = $\$A5*B\1 | = $\$A5*C\1 | = $\$A5*D\1 |
| 6 | 6 | = $\$A6*B\1 | = $\$A6*C\1 | = $\$A6*D\1 |
| 7 | 7 | = $\$A7*B\1 | = $\$A7*C\1 | = $\$A7*D\1 |

Multiplication table easy way

- Make 2x2 table
- Pull the Black Dot down
- Excel will guess the numbers are increasing in multiplication order.

| | A | B |
|---|---|---|
| 1 | 1 | 2 |
| 2 | 2 | 4 |
| 3 | | |

| | A | B | C | D | E |
|----|----|----|----|----|----|
| 1 | 1 | 2 | 3 | 4 | 5 |
| 2 | 2 | 4 | 6 | 8 | 10 |
| 3 | 3 | 6 | 9 | 12 | 15 |
| 4 | 4 | 8 | 12 | 16 | 20 |
| 5 | 5 | 10 | 15 | 20 | 25 |
| 6 | 6 | 12 | 18 | 24 | 30 |
| 7 | 7 | 14 | 21 | 28 | 35 |
| 8 | 8 | 16 | 24 | 32 | 40 |
| 9 | 9 | 18 | 27 | 36 | 45 |
| 10 | 10 | 20 | 30 | 40 | 50 |
| 11 | 11 | 22 | 33 | 44 | 55 |
| 12 | 12 | 24 | 36 | 48 | 60 |
| 13 | | | | | |

Exercise: Make the Addition Table

| | A | B | C | D | E | F | G | H | I | J |
|----|----|----|----|----|----|----|----|----|----|----|
| 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 2 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 3 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 4 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 5 | 5 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 6 | 6 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 7 | 7 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 8 | 8 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 9 | 9 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 10 | 10 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 11 | | | | | | | | | | |

Hint: $B2 = \$A2 + B\1 , and drag the DOT to copy the formula.

Exercise: Solution for AdditionTable

A screenshot of a Microsoft Excel spreadsheet titled "AdditionTable". The spreadsheet displays a 10x10 grid of numbers from 1 to 20. The first row and column are labeled with integers from 1 to 10. The formula bar at the top shows the cell reference "B2" and the formula " $=\$A2+B\1 ". A red oval highlights the formula bar and the cell B2. A black rectangle highlights the value "4" in cell B2.

| | A | B | C | D | E | F | G | H | I | J |
|----|----|----|----|----|----|----|----|----|----|----|
| 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 2 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 3 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 4 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 5 | 5 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 6 | 6 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 7 | 7 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 8 | 8 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 9 | 9 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 10 | 10 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |

Microsoft Office
Excel 2003/2007



Printing from Microsoft Excel

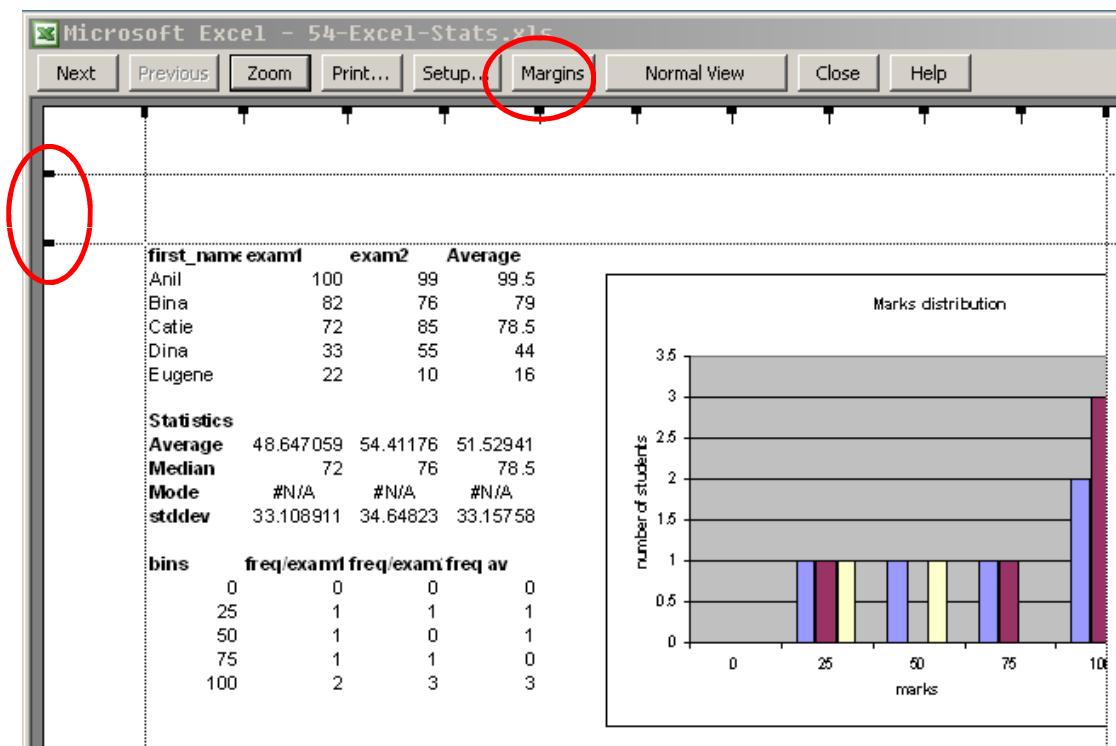


Compact Printing

- File > page setup
 - > Page > fit to 1 page
 - > Paper size A4 (depending on printer).
 - > margins > Reduce margins to 0.1 inch.
 - > sheet > select [Gridlines]
 - Finally click on [Print Preview] to see it.
 - [Install from Google *doPdf virtual pdf printer* driver].
 - Always exchange **pdf files** for easier printing on different computers.

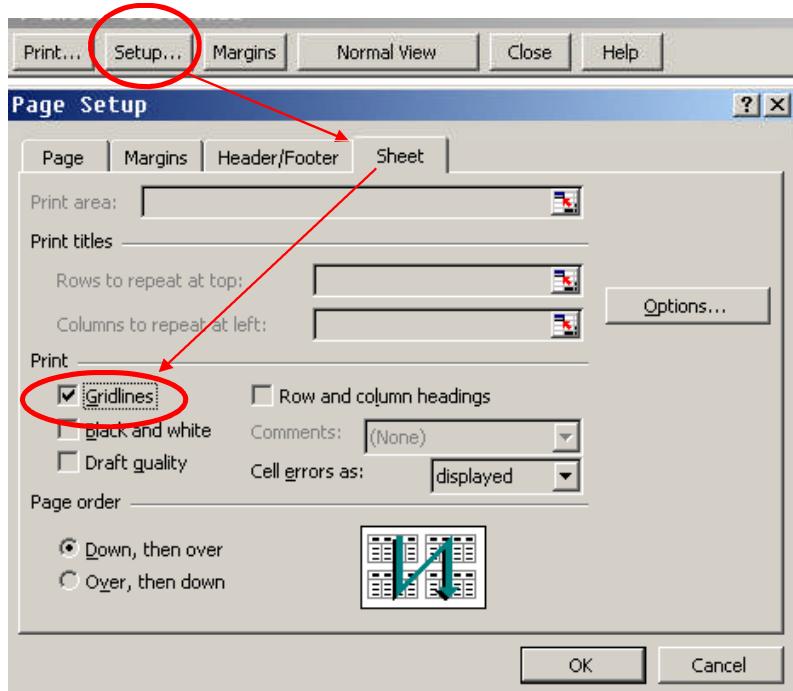
File > Print Preview

- Drag the black dots to adjust margin



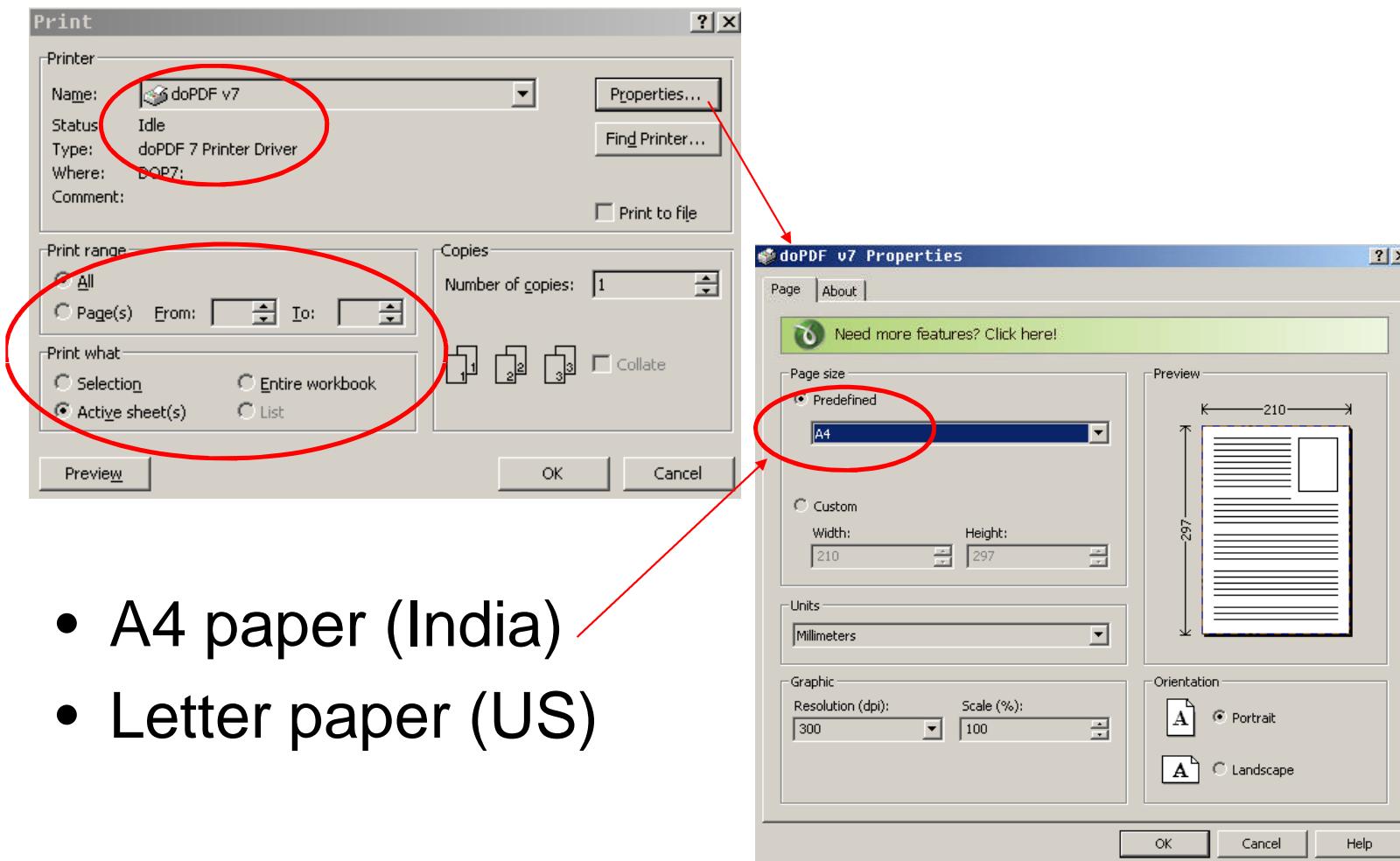
Add Grid lines

- File > Print Preview > Setup > Sheet > Gridlines

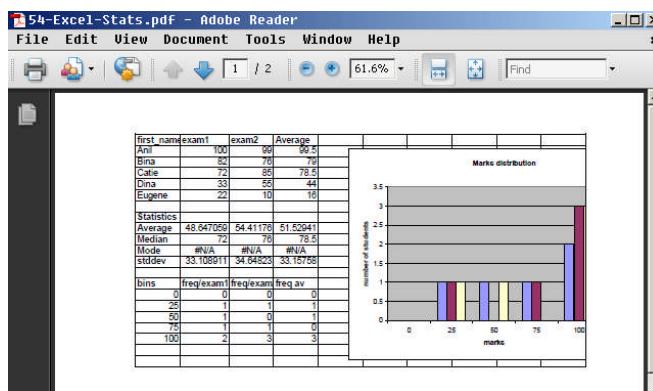
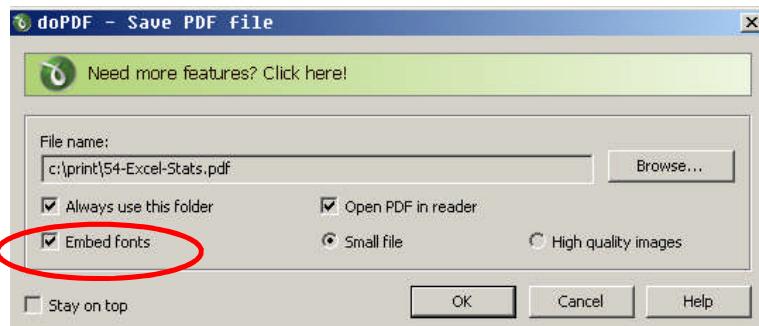


| first_name | exam1 | exam2 | Average |
|------------|------------|------------|----------|
| Anil | 100 | 99 | 99.5 |
| Bina | 82 | 76 | 79 |
| Catie | 72 | 85 | 78.5 |
| Dina | 33 | 55 | 44 |
| Eugene | 22 | 10 | 16 |
| <hr/> | | | |
| Statistics | | | |
| Average | 48.647059 | 54.41176 | 51.52941 |
| Median | 72 | 76 | 78.5 |
| Mode | #N/A | #N/A | #N/A |
| stddev | 33.108911 | 34.64823 | 33.15758 |
| <hr/> | | | |
| bins | freq/exam1 | freq/exam2 | freq av |
| 0 | 0 | 0 | 0 |
| 25 | 1 | 1 | 1 |
| 50 | 1 | 0 | 1 |
| 75 | 1 | 1 | 0 |
| 100 | 2 | 3 | 3 |

File > Print



Install doPDF virtual Printer



Save as CSV file (for Email, SPSS, R, Excel)

1. To freeze the formula and only save the numbers use **csv** (comma separated values) or **tsv** (tab separated values) in a text file):

file > save-as > csv (file.csv)

2. If you are giving an xls file to someone having only Excel 2003, do this:

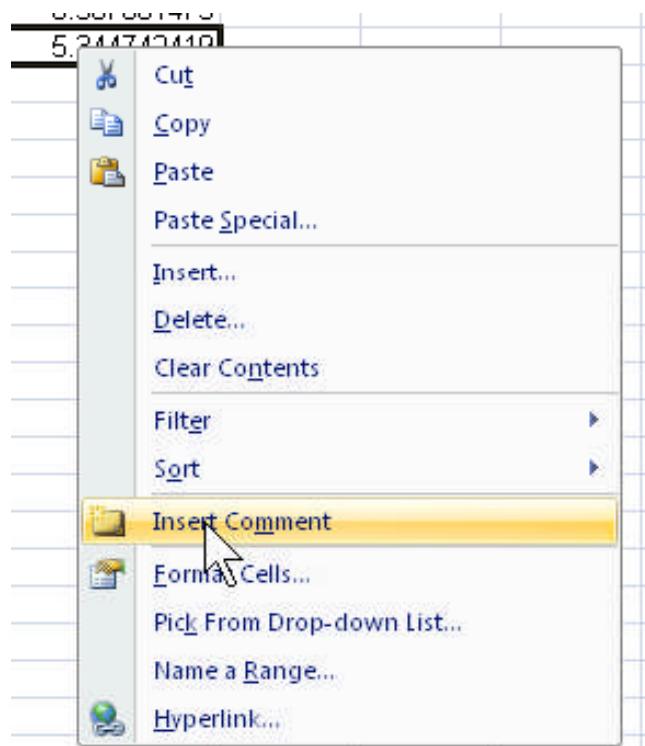
file > save-as > excel 2003

Commenting / Name

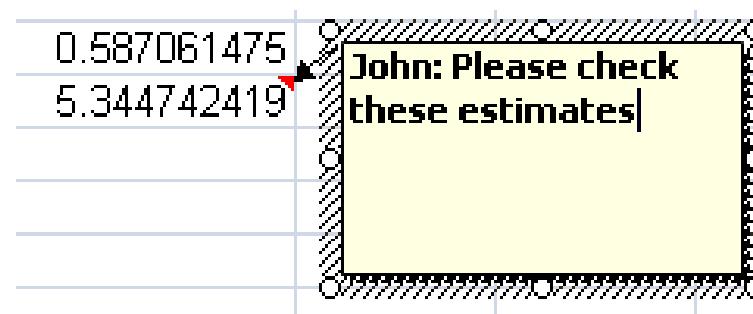
1. Add notes in a blank cell as plain text,
works for csv also.
2. Right click on a cell and add comment
3. =Formula + N("my comment")
(value of N("string") is zero).
4. Name the cells.

2. Excel comments

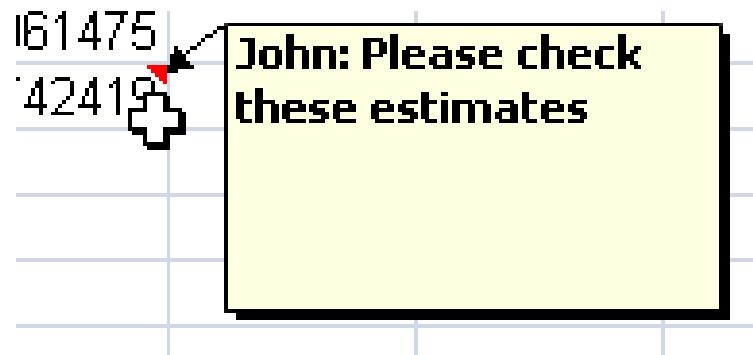
1. Right click cell > Insert Comment



2. Type the comment

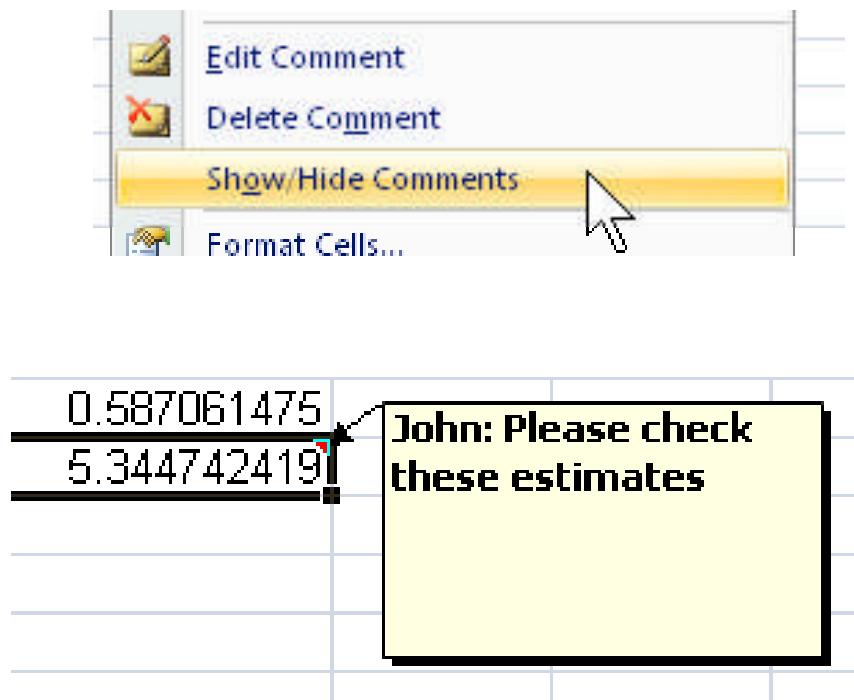


3. Hover on red triangle to see comment



2. Viewing comments

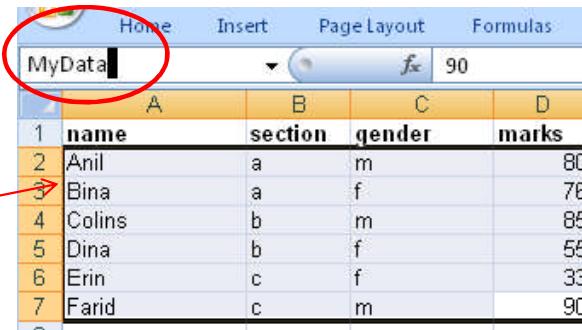
1. Right click cell > Show/hide/edit/delete comments



3. Formula + N("Comment")

4. Name the cells

- Select block of cells (cell/column/row/matrix),
- e.g. A2:D7 is named "MyData"
- You can then use "MyData" instead of A2:D7



A screenshot of Microsoft Excel showing a table of student data. The table has columns labeled 'name', 'section', 'gender', and 'marks'. The first row contains headers. Rows 2 through 7 contain data for Anil, Bina, Colins, Dina, Erin, and Farid respectively. The entire table is selected. In the formula bar at the top, the name 'MyData' is entered. A red circle highlights the formula bar, and a red arrow points from the text 'instead of A2:D7' to the word 'MyData'.

| | A | B | C | D |
|---|--------|---------|--------|-------|
| 1 | name | section | gender | marks |
| 2 | Anil | a | m | 80 |
| 3 | Bina | a | f | 76 |
| 4 | Colins | b | m | 85 |
| 5 | Dina | b | f | 55 |
| 6 | Erin | c | f | 33 |
| 7 | Farid | c | m | 90 |

Full name of it is:

'sheetname':MyData and

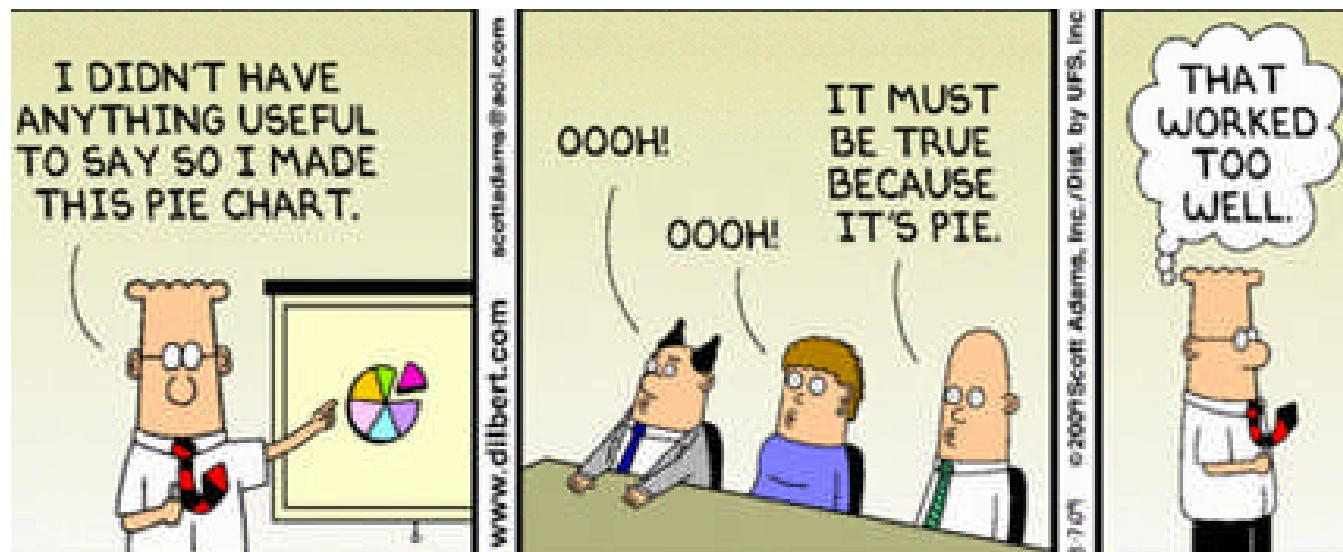
'[filename.xls]sheetname'!MyData

Graphing with Microsoft Excel



Microsoft Office
Excel 2003/2007

Dilbert on Graphs in Presentations



Create the x-data to be plotted

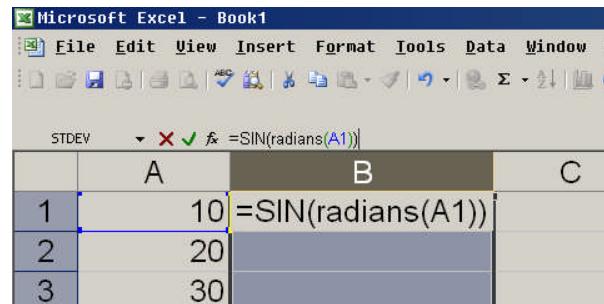
- In Excel, column A, type 10, 20
- Select A1 and A2 with Shift-mouse-click
- Drag the small dot in A2 to A9, to generate remaining x3,...x9 values

| | | | |
|----|----|---|---|
| A1 | A | B | C |
| 1 | 10 | | |
| 2 | 20 | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |

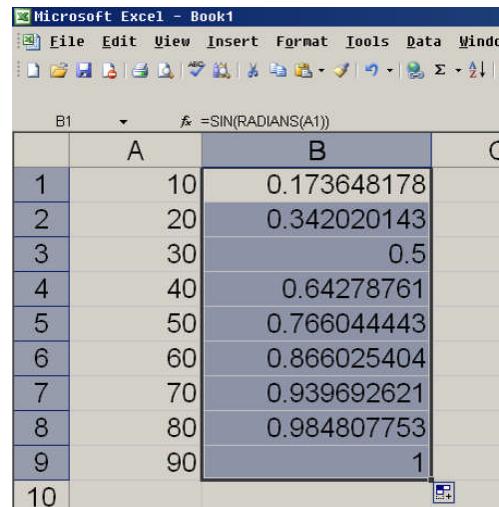
| | | |
|----|----|---|
| A1 | A | B |
| 1 | 10 | |
| 2 | 20 | |
| 3 | 30 | |
| 4 | 40 | |
| 5 | 50 | |
| 6 | 60 | |
| 7 | 70 | |
| 8 | 80 | |
| 9 | 90 | |
| 10 | | |
| 11 | | |
| 12 | | |

Create the y-data, e.g. $y=\sin(x)$

- In Cell B1, type
fx=sin(radians(A1))
- Drag the black dot
in bottom-right
corner of B1 to fill
B2..B9 with y1..y9.



| | A | B | C |
|---|----|-------------------|---|
| 1 | 10 | =SIN(radians(A1)) | |
| 2 | 20 | | |
| 3 | 30 | | |



| | A | B | C |
|----|----|-------------|---|
| 1 | 10 | 0.173648178 | |
| 2 | 20 | 0.342020143 | |
| 3 | 30 | 0.5 | |
| 4 | 40 | 0.64278761 | |
| 5 | 50 | 0.766044443 | |
| 6 | 60 | 0.866025404 | |
| 7 | 70 | 0.939692621 | |
| 8 | 80 | 0.984807753 | |
| 9 | 90 | 1 | |
| 10 | | | |

Exercise: Make this table

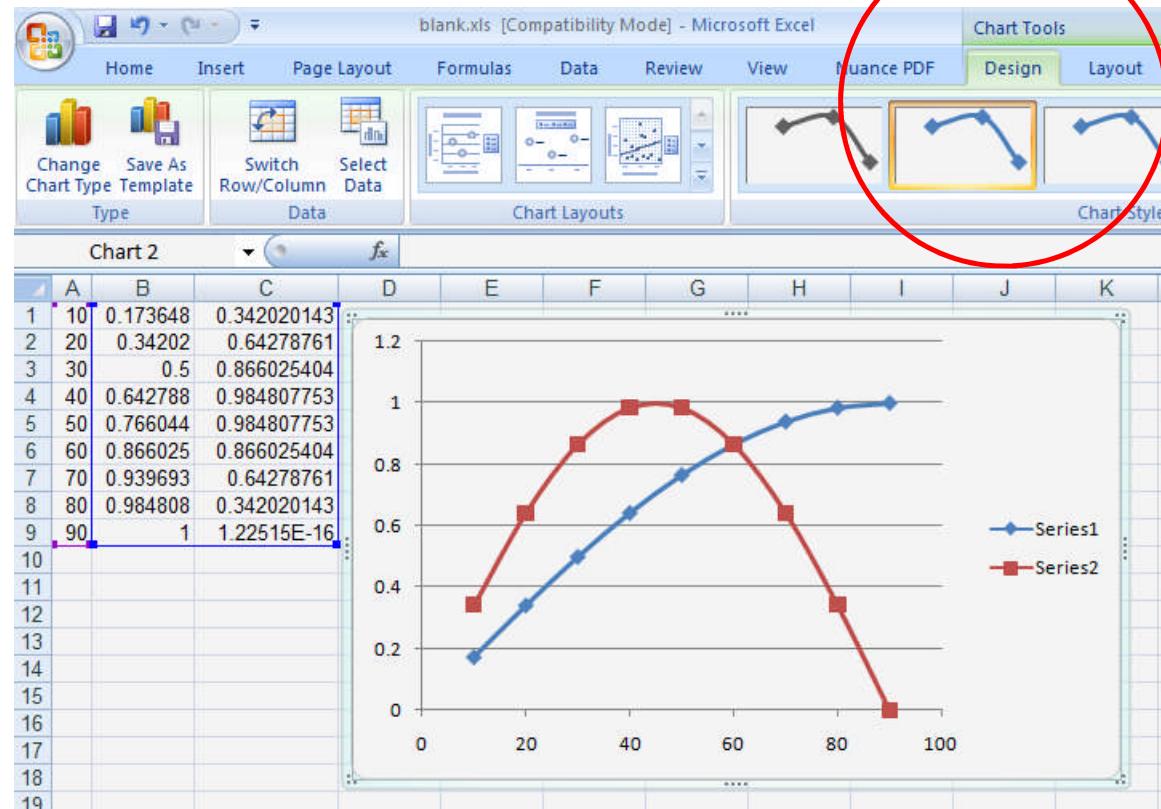
| | A | B | C |
|---|----|-------------------|-----------------------|
| 1 | 10 | =SIN(RADIANS(A1)) | =SIN(2*(RADIANS(A1))) |
| 2 | 20 | =SIN(RADIANS(A2)) | =SIN(2*(RADIANS(A2))) |
| 3 | 30 | =SIN(RADIANS(A3)) | =SIN(2*(RADIANS(A3))) |
| 4 | 40 | =SIN(RADIANS(A4)) | =SIN(2*(RADIANS(A4))) |
| 5 | 50 | =SIN(RADIANS(A5)) | =SIN(2*(RADIANS(A5))) |
| 6 | 60 | =SIN(RADIANS(A6)) | =SIN(2*(RADIANS(A6))) |
| 7 | 70 | =SIN(RADIANS(A7)) | =SIN(2*(RADIANS(A7))) |
| 8 | 80 | =SIN(RADIANS(A8)) | =SIN(2*(RADIANS(A8))) |
| 9 | 90 | =SIN(RADIANS(A9)) | =SIN(2*(RADIANS(A9))) |

Exercise: Plot $\sin(x)$ and $\sin(2x)$

The screenshot shows a Microsoft Excel window titled "blank.xls [Compatibility Mode] - Microsoft Excel". The ribbon is visible at the top, with the "Insert" tab selected. In the "Charts" section of the ribbon, the "Scatter" icon is highlighted with a red circle. A dropdown menu for "Scatter" is open, showing four chart options: "Scatter with Smooth Lines and Markers" (selected), "Scatter with只 Smooth Lines", "Scatter with只 Markers", and "All Chart Types...". The "Scatter with Smooth Lines and Markers" option is highlighted with a yellow box. Below the dropdown, a tooltip provides the following information: "Compare pairs of values, Use it when there are a few data points in x-axis order and the data represents a function." The Excel spreadsheet contains two columns of data. Column A has values from 10 to 90. Column B contains formulas that calculate the sine of the values in Column A and twice the value of Column A. For example, B1 contains the formula $=\text{SIN}(\text{RADIANS}(A1))$. The formula in B2 is $=\text{SIN}(\text{RADIANS}(A2))$, in B3 is $=\text{SIN}(\text{RADIANS}(A3))$, in B4 is $=\text{SIN}(\text{RADIANS}(A4))$, in B5 is $=\text{SIN}(\text{RADIANS}(A5))$, in B6 is $=\text{SIN}(\text{RADIANS}(A6))$, in B7 is $=\text{SIN}(\text{RADIANS}(A7))$, in B8 is $=\text{SIN}(\text{RADIANS}(A8))$, and in B9 is $=\text{SIN}(\text{RADIANS}(A9))$. Column C contains the formulas $=\text{SIN}(2 * \text{RADIANS}(A1))$ through $=\text{SIN}(2 * \text{RADIANS}(A9))$.

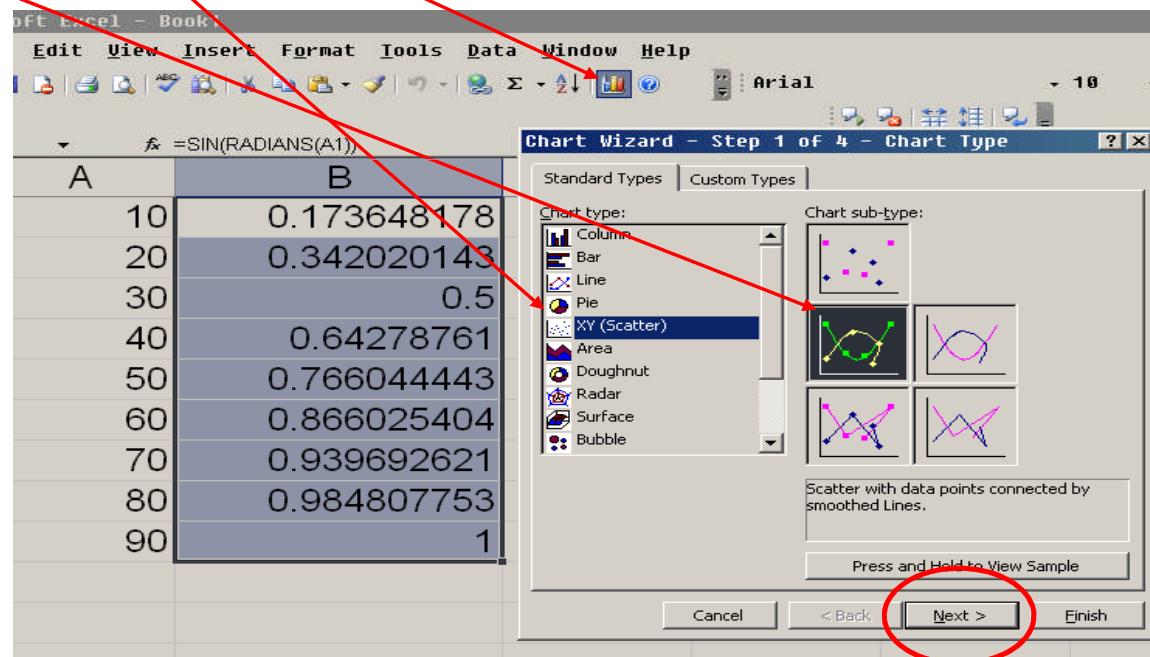
| | A | B | C | D |
|----|----|-----------------------------------|---------------------------------------|---|
| 1 | 10 | $=\text{SIN}(\text{RADIANS}(A1))$ | $=\text{SIN}(2 * \text{RADIANS}(A1))$ | |
| 2 | 20 | $=\text{SIN}(\text{RADIANS}(A2))$ | $=\text{SIN}(2 * \text{RADIANS}(A2))$ | |
| 3 | 30 | $=\text{SIN}(\text{RADIANS}(A3))$ | $=\text{SIN}(2 * \text{RADIANS}(A3))$ | |
| 4 | 40 | $=\text{SIN}(\text{RADIANS}(A4))$ | $=\text{SIN}(2 * \text{RADIANS}(A4))$ | |
| 5 | 50 | $=\text{SIN}(\text{RADIANS}(A5))$ | $=\text{SIN}(2 * \text{RADIANS}(A5))$ | |
| 6 | 60 | $=\text{SIN}(\text{RADIANS}(A6))$ | $=\text{SIN}(2 * \text{RADIANS}(A6))$ | |
| 7 | 70 | $=\text{SIN}(\text{RADIANS}(A7))$ | $=\text{SIN}(2 * \text{RADIANS}(A7))$ | |
| 8 | 80 | $=\text{SIN}(\text{RADIANS}(A8))$ | $=\text{SIN}(2 * \text{RADIANS}(A8))$ | |
| 9 | 90 | $=\text{SIN}(\text{RADIANS}(A9))$ | $=\text{SIN}(2 * \text{RADIANS}(A9))$ | |
| 10 | | | | |
| 11 | | | | |

Graphs of $\sin(x)$ and $\sin(2x)$

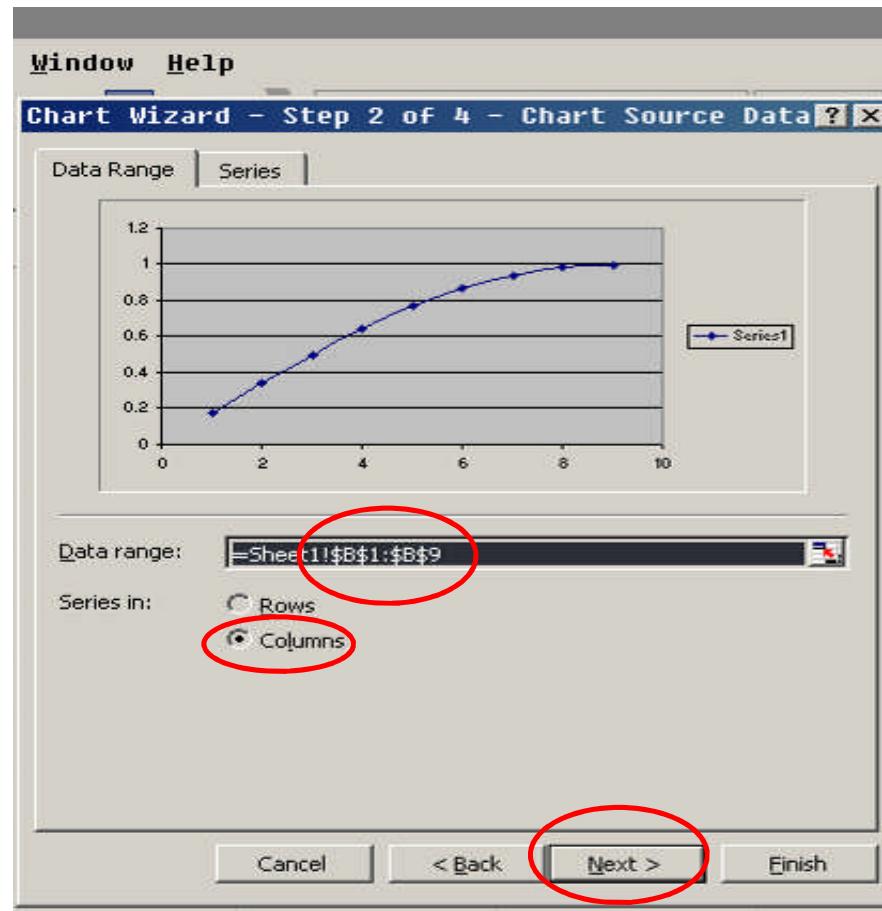


Excel 2003: Graph the xy-data (chart scatter)

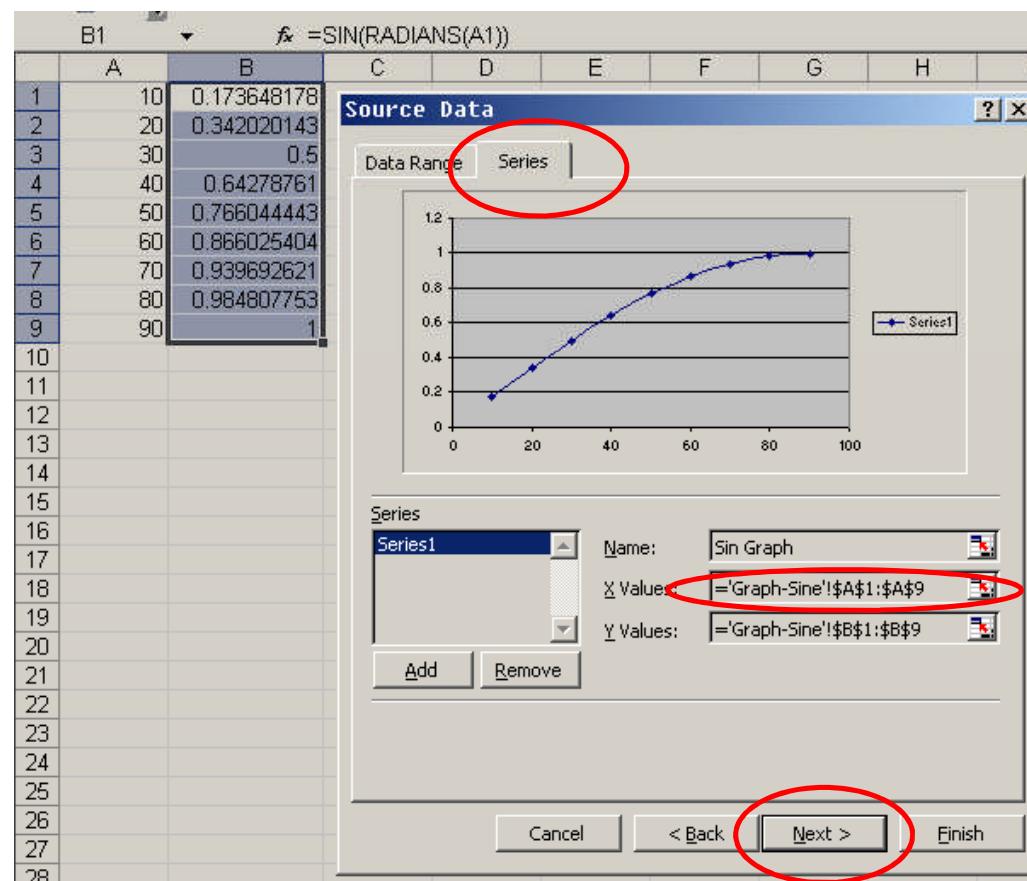
Select Chart >
XY (Scatter) >
connected by smooth lines



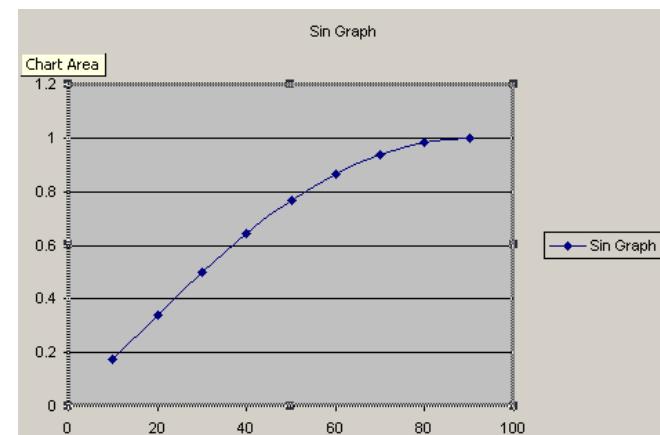
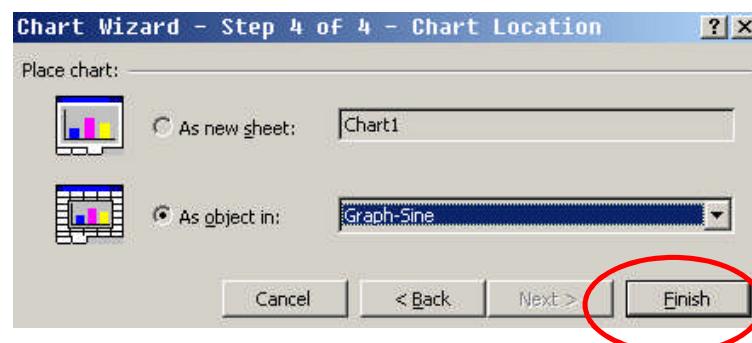
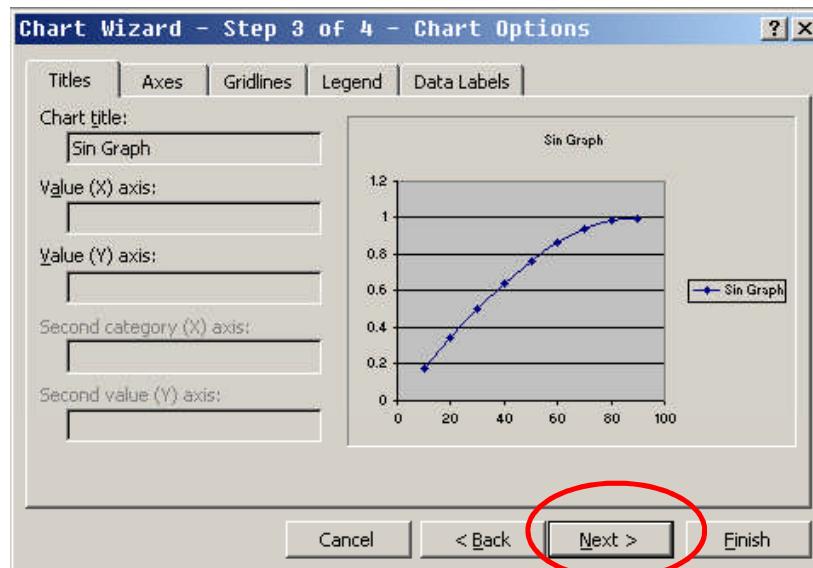
Next > data range is B1 .. B9



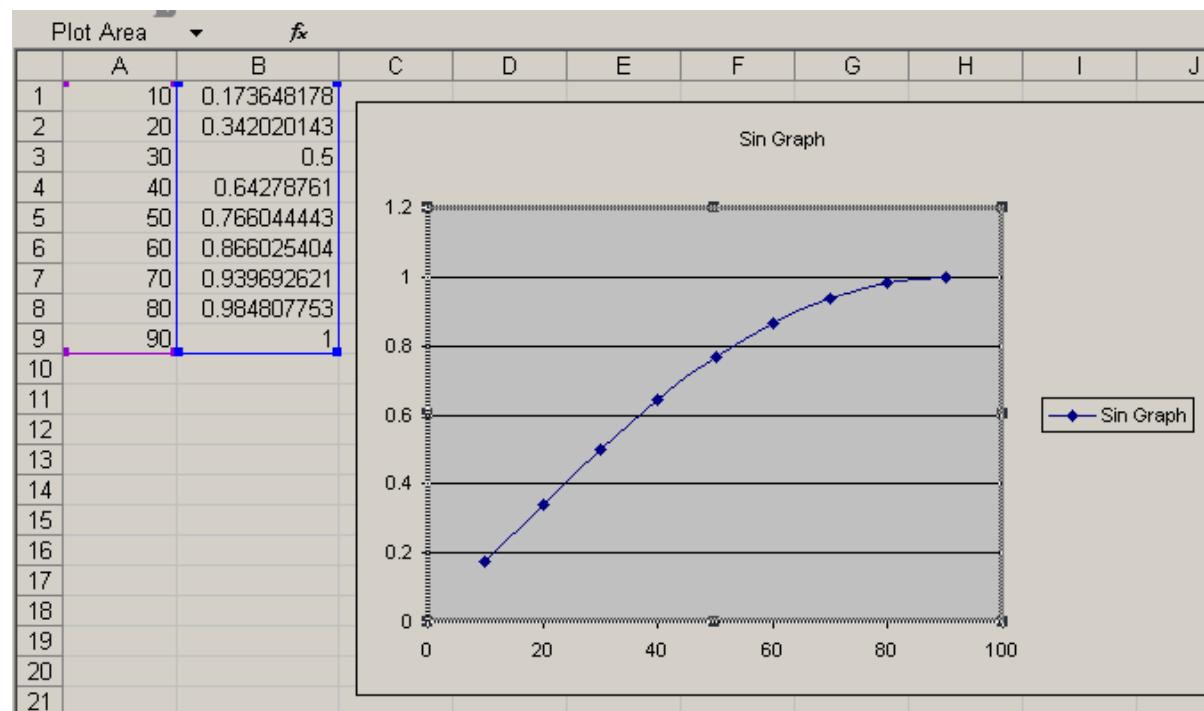
Put x values for the series



Next > next > finish

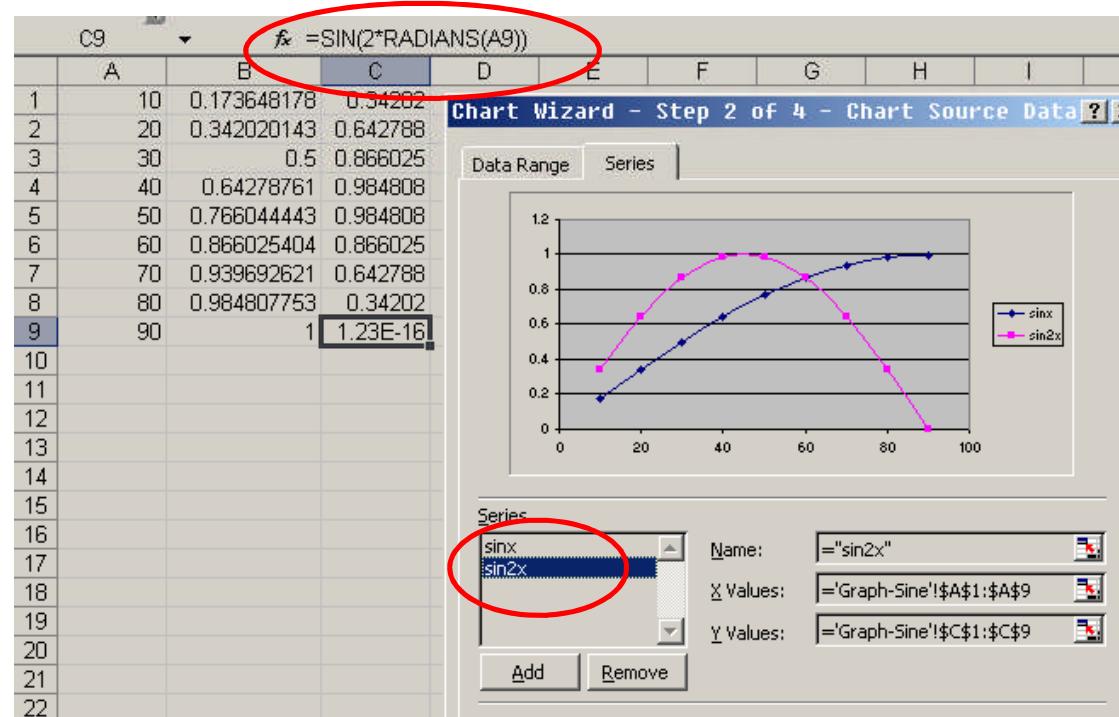


Next > Finish to see the graph.

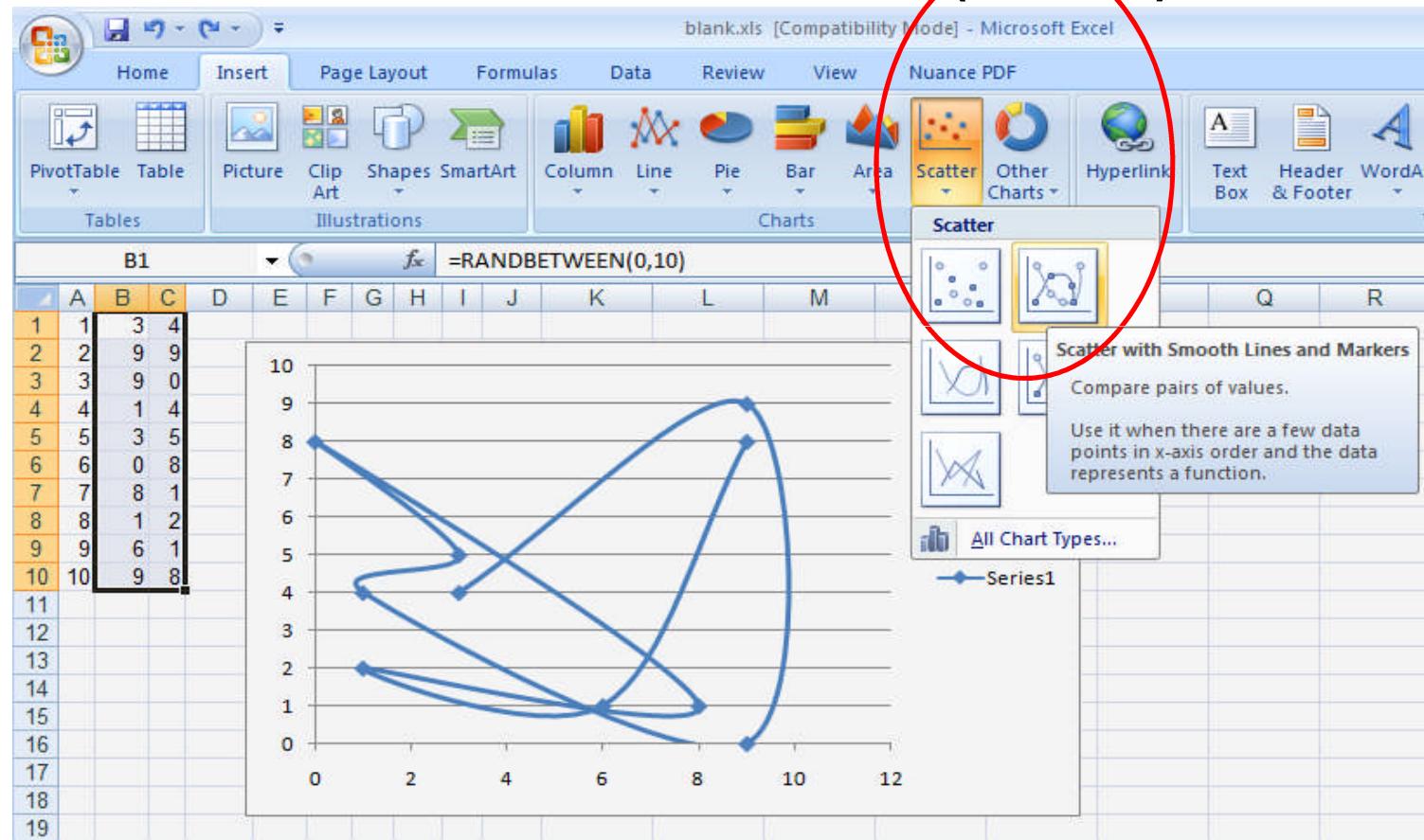


Plot $\sin(x)$ and $\sin(2x)$ together

- Add to column C1, $f_x = \sin(2*\text{Radian}(A1))$ and drag the black-dot down to c9.
- Repeat graph procedure with two series



Exercise: Make the plot of randombetween(0,10)



Exercise: create this table, and make a pie chart out of it.

| B1 | | |
|----|---|----|
| | A | B |
| 1 | A | 30 |
| 2 | B | 40 |
| 3 | C | 24 |
| | | |

Pie chart

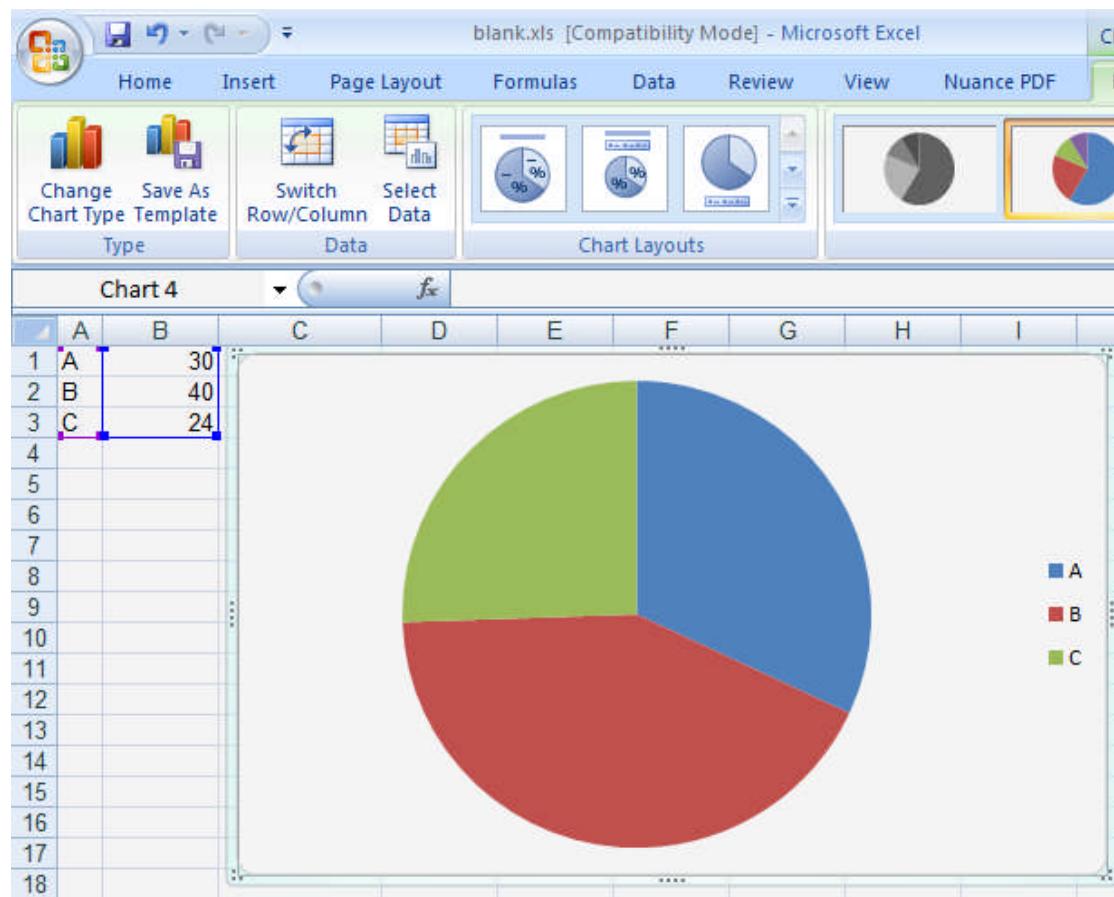
A screenshot of Microsoft Excel showing the ribbon and a pie chart context menu. The ribbon tabs visible are Home, Insert, Page Layout, Formulas, Data, Review, View, and Nuance PDF. The Insert tab is selected. A red circle highlights the Pie icon in the Charts group. A context menu is open over a pie chart icon, containing the following text:

Pie
Display the contribution of each value to a total.
Use it when the values can be added together or when you have only one data series and all values are positive.

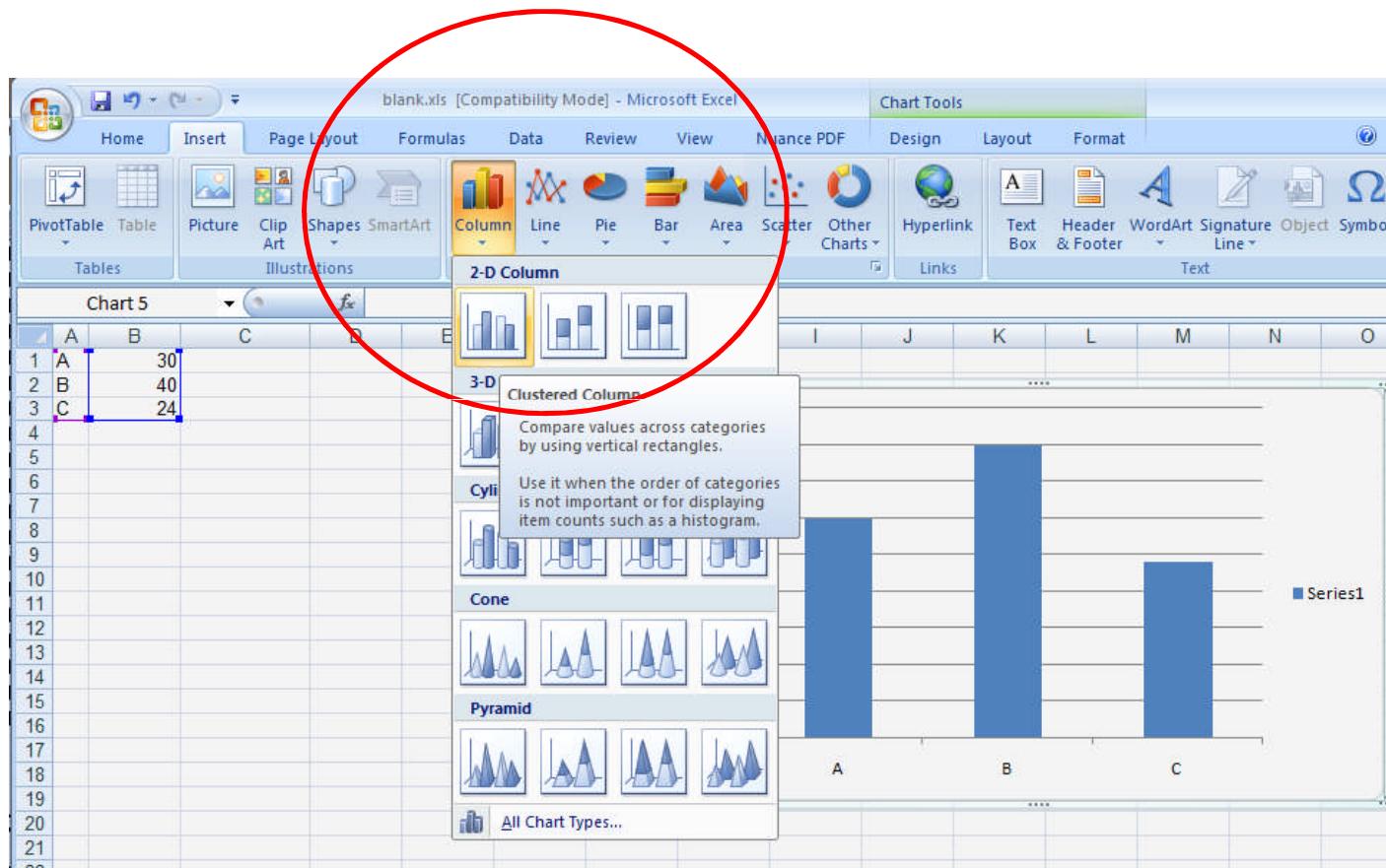
The Excel worksheet contains the following data:

| | A | B |
|----|---|----|
| 1 | A | 30 |
| 2 | B | 40 |
| 3 | C | 24 |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |

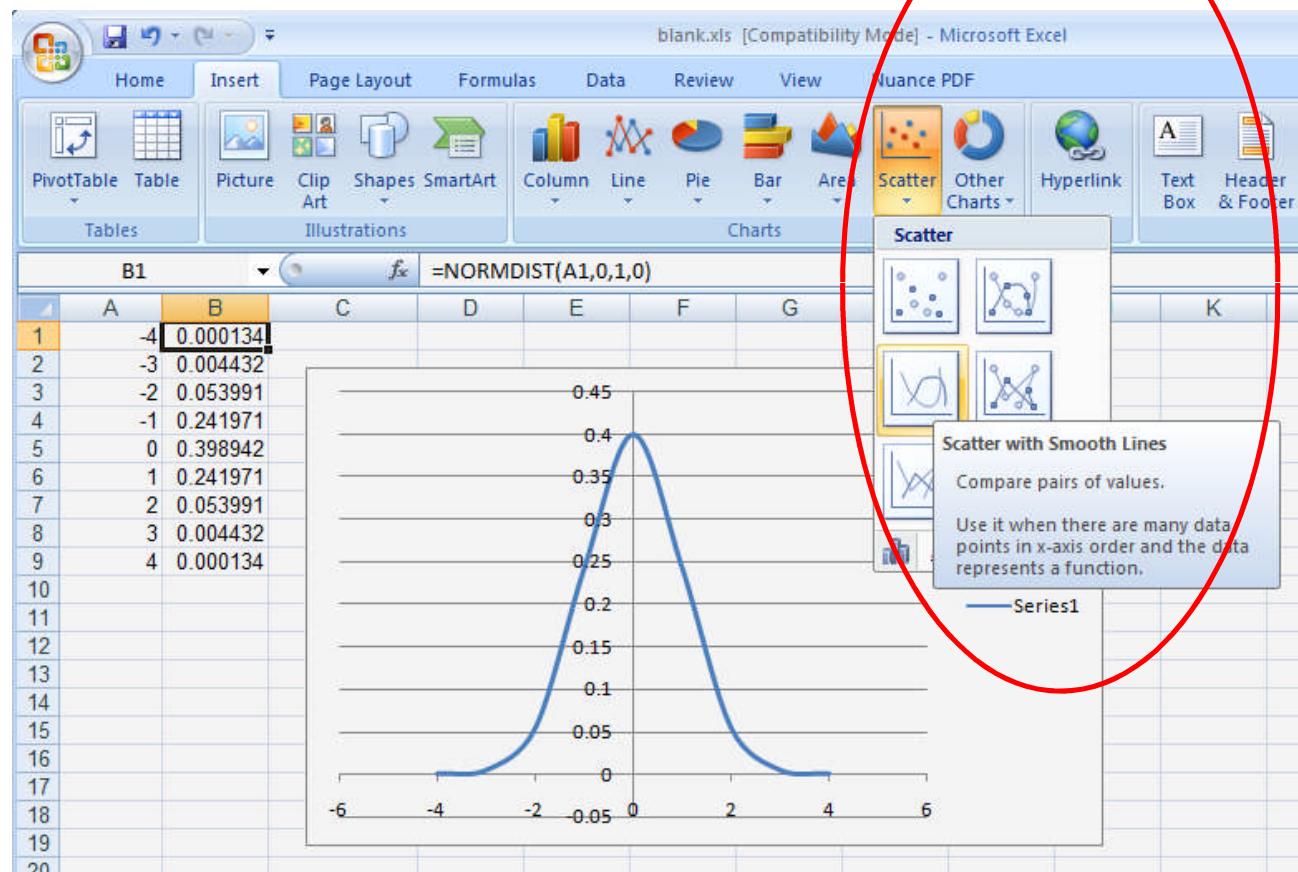
Exercise: make this pie chart



Make this bar chart



Exercise: Draw the graph of Std Normal Distribution with: A1:A9=-4,-3,...,4
B1=normdist(A1,0,1,0)



Managing Data with Microsoft Excel



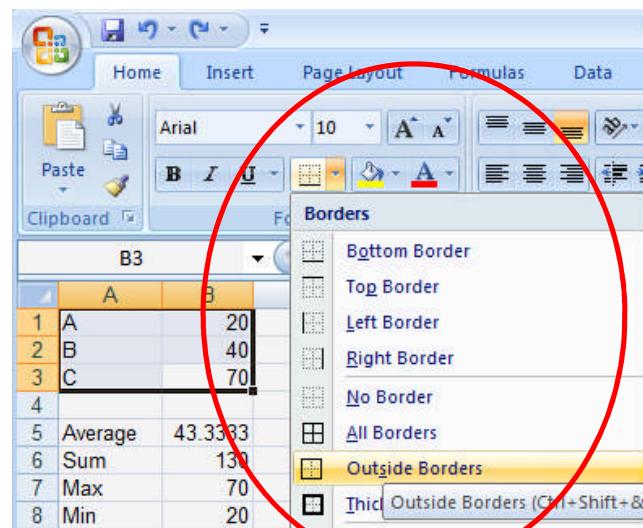
Microsoft Office
Excel 2003/2007

Border around the data

- Type this data on a new sheet

| | A | B |
|---|---|----|
| 1 | A | 20 |
| 2 | B | 90 |
| 3 | C | 60 |
| 4 | | |

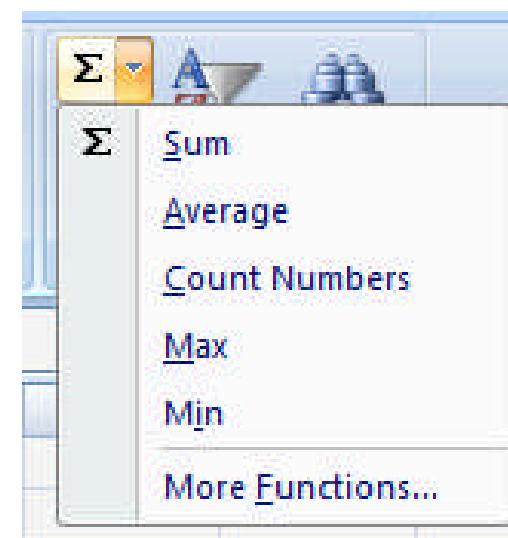
- Put a border around the data



Useful Functions

- Type this data on a new sheet
- Select the block A1:B3
- Click on Sigma sign to see some useful function

| | A | B |
|---|---|----|
| 1 | A | 20 |
| 2 | B | 90 |
| 3 | C | 60 |
| A | | |



Exercise: Compute Average, Sum, Max, Min, Stdev

| | A | B |
|---|---------|--------|
| 1 | A | 20 |
| 2 | B | 90 |
| 3 | C | 60 |
| 4 | | |
| 5 | Average | 56.667 |
| 6 | Sum | 170 |
| 7 | Max | 90 |
| 8 | Min | 20 |
| 9 | Stdev | 35.119 |

Solution: Average, Sum, Max, Min, Stdev

| | A | B |
|---|---------|-------------------------|
| 1 | A | 20 |
| 2 | B | 90 |
| 3 | C | 60 |
| 4 | | |
| 5 | Average | =AVERAGE(\$B\$1:\$B\$3) |
| 6 | Sum | =SUM(\$B\$1:\$B\$3) |
| 7 | Max | =MAX(\$B\$1:\$B\$3) |
| 8 | Min | =MIN(\$B\$1:\$B\$3) |
| 9 | Stdev | =STDEV(\$B\$1:\$B\$3) |

Rounding numbers

| | A | B | C |
|----|-------|-------------|-------|
| 1 | A | | 20 |
| 2 | B | | 90 |
| 3 | C | | 60 |
| 4 | | | |
| 5 | Avera | 56.66666667 | 56.67 |
| 6 | Sum | 170 | 170 |
| 7 | Max | 90 | 90 |
| 8 | Min | 20 | 20 |
| 9 | Stdev | 35.1188458 | 35.12 |
| 10 | | | |

Rounding numbers with =round(value,digits)

| | A | B | C |
|----|---------|-------------------------|----------------|
| 1 | A | 20 | |
| 2 | B | 90 | |
| 3 | C | 60 | |
| 4 | | | |
| 5 | Average | =AVERAGE(\$B\$1:\$B\$3) | =ROUND(\$B5,2) |
| 6 | Sum | =SUM(\$B\$1:\$B\$3) | =ROUND(\$B6,2) |
| 7 | Max | =MAX(\$B\$1:\$B\$3) | =ROUND(\$B7,2) |
| 8 | Min | =MIN(\$B\$1:\$B\$3) | =ROUND(\$B8,2) |
| 9 | Stdev | =STDEV(\$B\$1:\$B\$3) | =ROUND(\$B9,2) |
| 10 | | | |

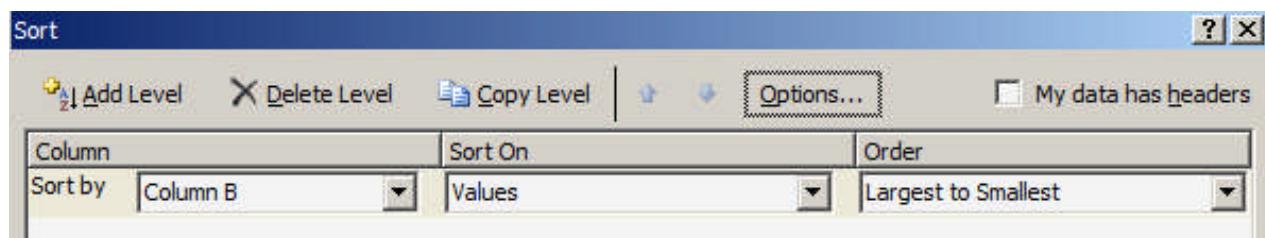
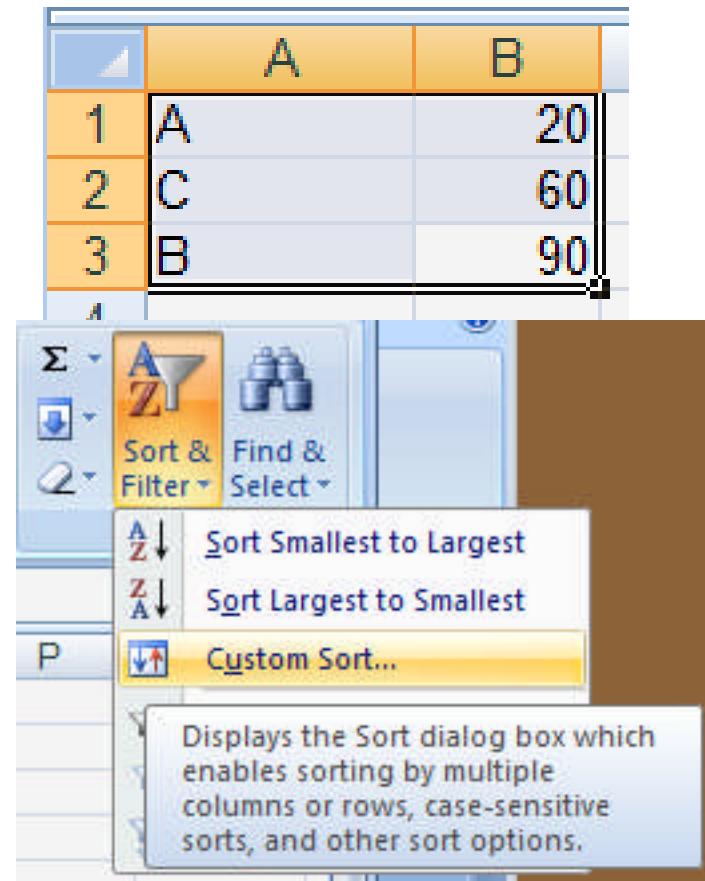
More functions: click on the blue function name to get help

The screenshot shows a Microsoft Excel interface. On the left, the formula bar displays the formula `=AVERAGE(B1:B3)`. To the right of the formula bar is a table titled "Statistical functions". The table has two columns: "Function" and "Description". The "Function" column lists several statistical functions: AVEDEV, AVERAGE, AVERAGEA, AVERAGEIF, AVERAGEIFS, BETADIST, and BETAINV. The "Description" column provides a brief explanation for each function. The entire screenshot is framed by a light gray border.

| Function | Description |
|------------|---|
| AVEDEV | Returns the average of the absolute deviations of data points from their mean |
| AVERAGE | Returns the average of its arguments |
| AVERAGEA | Returns the average of its arguments, including numbers, text, and logical values |
| AVERAGEIF | Returns the average (arithmetic mean) of all the cells in a range that meet a given criteria |
| AVERAGEIFS | Returns the average (arithmetic mean) of all cells that meet multiple criteria. |
| BETADIST | Returns the beta cumulative distribution function |
| BETAINV | Returns the inverse of the cumulative distribution function for a specified beta distribution |

Sort the table

- Select the block A1:B3 and click [Custom Sort]
- Sort by column B



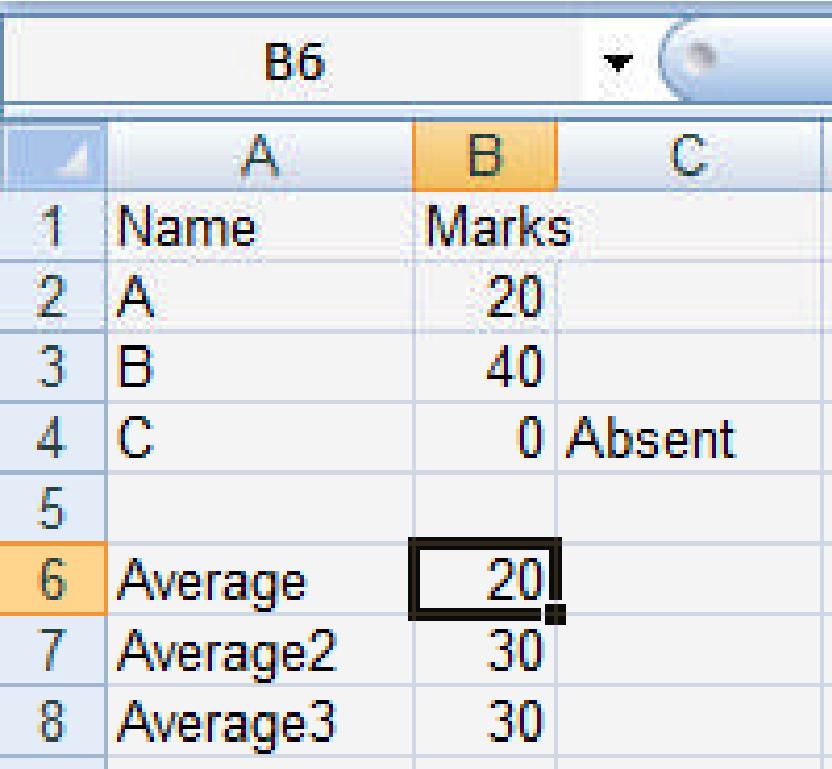
Sort the table

- Select the block A1:B3 and click [Custom Sort]
- Sort by column B

| | A | B |
|---|---|----|
| 1 | A | 20 |
| 2 | C | 60 |
| 3 | B | 90 |
| 4 | | |

| | A | B |
|---|---|----|
| 1 | B | 90 |
| 2 | C | 60 |
| 3 | A | 20 |
| 4 | | |

What is the Class Average?



| | A | B | C |
|---|----------|-------|--------|
| 1 | Name | Marks | |
| 2 | A | 20 | |
| 3 | B | 40 | |
| 4 | C | 0 | Absent |
| 5 | | | |
| 6 | Average | 20! | |
| 7 | Average2 | 30 | |
| 8 | Average3 | 30 | |
| - | | | |

Exercise: Compute the average marks

Class average ignoring '0'

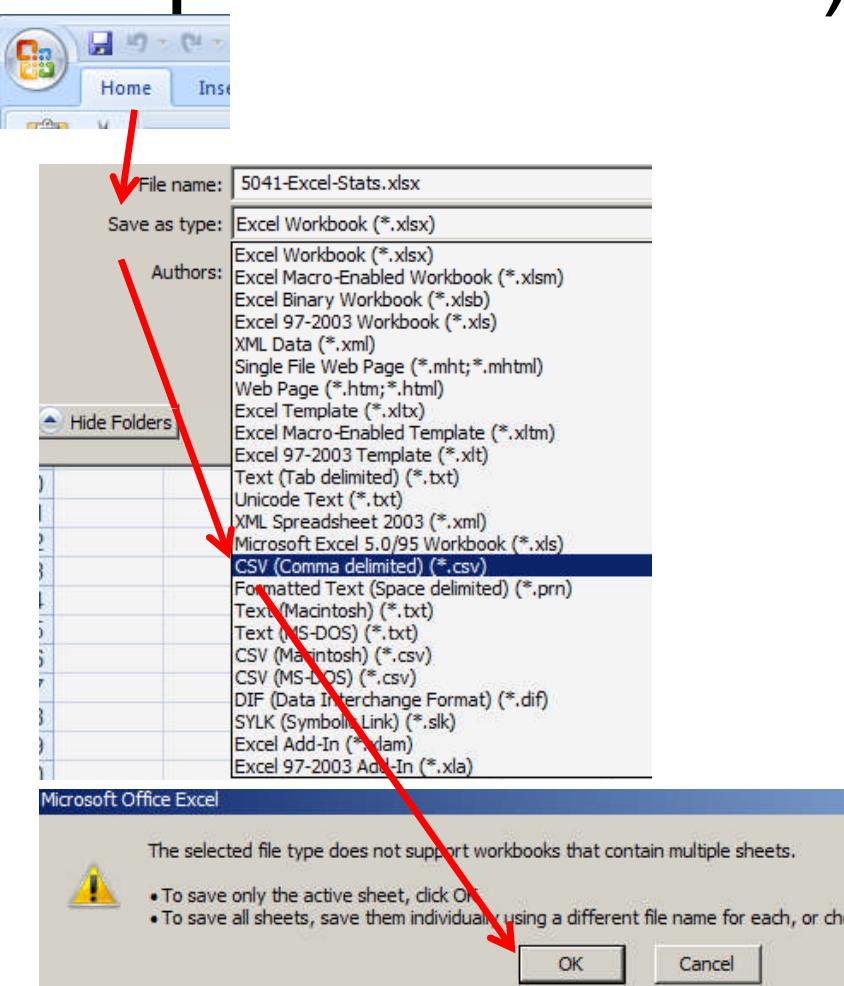
| | A | B |
|---|----------|--------------------------------------|
| 1 | Name | Marks |
| 2 | A | 20 |
| 3 | B | 40 |
| 4 | C | 0 |
| 5 | | |
| 6 | Average | =AVERAGE(B2:B4) |
| 7 | Average2 | =AVERAGE(IF(B2:B4<>0,B2:B4)) |
| 8 | Average3 | = SUM(B2:B4) / COUNTIF(B2:B4, "<>0") |
| 9 | | |

In B7, type '=average(IF(B2:B4<>0,B2:B4)' and press Control-Shift-Enter, to make it into an {array}

In B8, type '=SUM(B2:B4)/COUNTIF(B2:B4, "<>0")'

Export data as CSV (comma separated values)

- To freeze the formulas as data. Export it as a CSV file.
- Office Button> Save As> Other formats> csv file> Ok to warnings

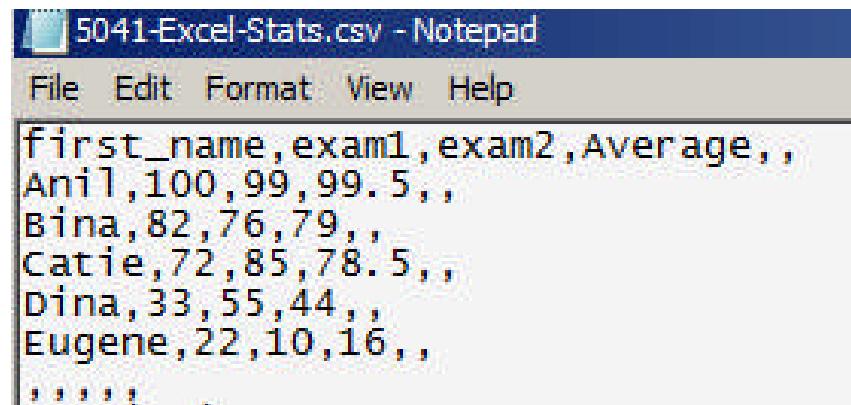


Open the saved CSV file in notepad

This CSV file can be used in R, SPSS, Excel, etc.

Find the CSV file on the desktop >

[right-click-mouse] > [open with] > notepad.



A screenshot of a Windows Notepad window titled "5041-Excel-Stats.csv - Notepad". The window displays a CSV file with the following data:

| first_name | exam1 | exam2 | Average | |
|------------|-------|-------|---------|---|
| Anil | 100 | 99 | 99.5 | , |
| Bina | 82 | 76 | 79 | , |
| Catie | 72 | 85 | 78.5 | , |
| Dina | 33 | 55 | 44 | , |
| Eugene | 22 | 10 | 16 | , |
| | | | | . |

Exercise: Shuffle Data with Microsoft Excel



Microsoft Office
Excel 2003/2007

Exercise: Shuffle Student List

1. New sheet
2. Type 2 roll numbers
3. Select A2,A3
4. Drag BlackDot to A11 or Double-Click on the BlackDot

| A |
|----------|
| 1 RollNo |
| 2 MBA001 |
| 3 MBA002 |
| 4 |
| 5 |
| 6 |
| 7 |
| 8 |
| 9 |
| 10 |
| 11 |

| A | B |
|-----------|---|
| 1 RollNo | |
| 2 MBA001 | |
| 3 MBA002 | |
| 4 MBA003 | |
| 5 MBA004 | |
| 6 MBA005 | |
| 7 MBA006 | |
| 8 MBA007 | |
| 9 MBA008 | |
| 10 MBA009 | |
| 11 MBA010 | |
| 12 | |
| 13 | |

Exercise: Shuffle Student List

1. In B1 type Random.
2. In B2, write =Rand().
3. Drag the BlackDot to B11 or DoubleClick on it.

| | A | B | C | D |
|----|--------|-----------|---|---|
| 1 | RollNo | Random | | |
| 2 | MBA001 | 0.7598865 | | |
| 3 | MBA002 | 0.0353166 | | |
| 4 | MBA003 | 0.4022008 | | |
| 5 | MBA004 | 0.311469 | | |
| 6 | MBA005 | 0.4316834 | | |
| 7 | MBA006 | 0.470749 | | |
| 8 | MBA007 | 0.9824384 | | |
| 9 | MBA008 | 0.8908466 | | |
| 10 | MBA009 | 0.5804362 | | |
| 11 | MBA010 | 0.3223183 | | |
| 12 | | | | |

Exercise: Shuffle Student List

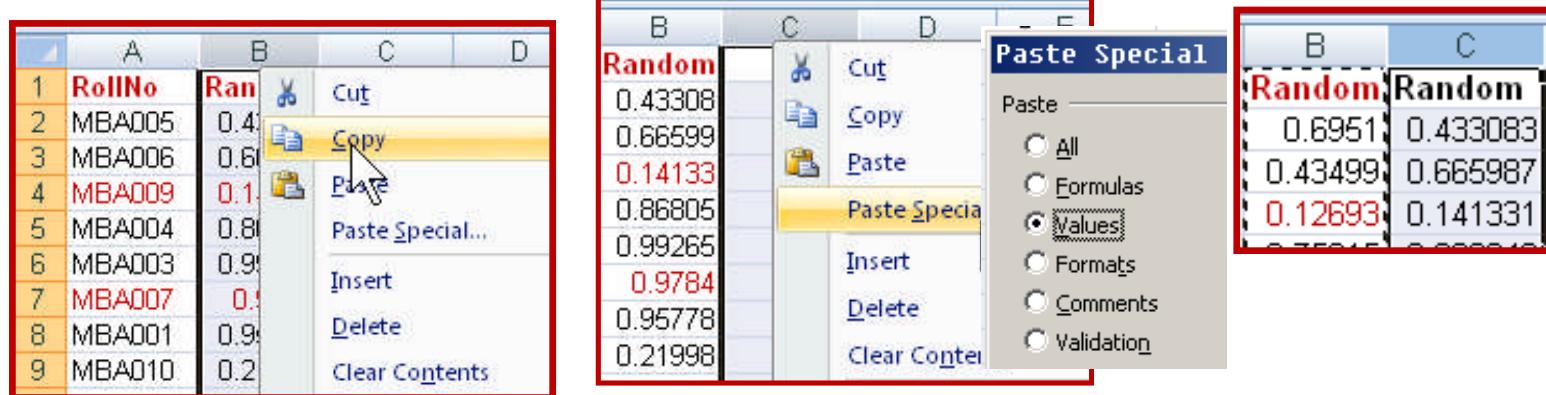
1. Control-A to select All
2. Sort
3. Custom Sort
4. Sort on Random (data has headers)
5. You get students shuffled

The screenshot shows the Microsoft Excel ribbon with the 'Sort & Filter' tab selected. A context menu is open over a range of data, with the 'Sort' option highlighted. Below the ribbon, the 'Sort' dialog box is displayed, showing the 'Sort On' dropdown set to 'Values' and the 'Order' dropdown set to 'Smallest to Largest'. A red arrow points from the 'Sort' button in the context menu to the 'Sort' button in the dialog box. Another red arrow points from the 'Sort' button in the dialog box to the 'Sort' button in the ribbon. The data in the worksheet consists of two columns: 'RollNo' and 'Random'. The rows are numbered 1 through 12. The data is currently sorted by 'Random' values in ascending order.

| | A | B |
|----|--------|-----------|
| 1 | RollNo | Random |
| 2 | MBA004 | 0.2692261 |
| 3 | MBA010 | 0.5127882 |
| 4 | MBA003 | 0.3608772 |
| 5 | MBA005 | 0.0007163 |
| 6 | MBA006 | 0.1294583 |
| 7 | MBA009 | 0.263669 |
| 8 | MBA002 | 0.9069466 |
| 9 | MBA001 | 0.4795143 |
| 10 | MBA008 | 0.6302409 |
| 11 | MBA007 | 0.4208918 |
| 12 | | |

Freezing the data (change formula to numbers)

- Everytime you sort by data, the random numbers keep changing.
- To keep the numbers fixed. Right click on column B > Copy > Goto Column C > Paste Special > Values.



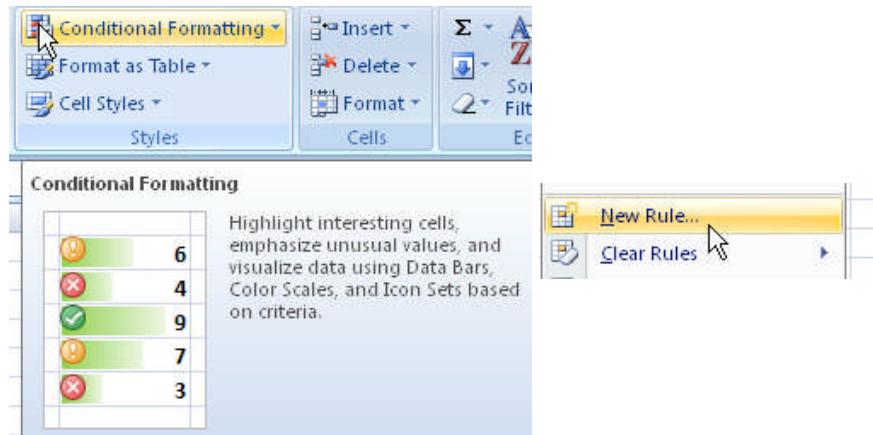
Freezing the data (change formula to numbers)

- Everytime you sort by data, the random numbers keep changing.
- To keep the numbers fixed. Right click on column B > Copy > Goto Column C > Paste Special > Values.

| B | C |
|---------|----------|
| Random | Random |
| 0.6951 | 0.433083 |
| 0.43499 | 0.665987 |
| 0.12593 | 0.141331 |

Exercise: Shuffle into Groups

1. Home
2. Select All (Control-A)
3. Conditional Formatting
4. New Rule
5. Formula
6. $=\text{Mod}(\text{ROW}(),3)=1$



Screenshot illustrating the steps to apply conditional formatting based on the formula $=\text{MOD}(\text{ROW}(),3)=1$.

The screenshot shows the 'New Formatting Rule' dialog box open over a spreadsheet. The formula $=\text{MOD}(\text{ROW}(),3)=1$ is entered in the 'Format values where this formula is true:' field. The preview shows the text 'AaBbCcYyZz' in red.

The spreadsheet table has columns A and B. Column A contains RollNo values (MBA001 to MBA011) and column B contains Random values. The rows are colored in groups of three: Row 1 (orange), Row 2 (light blue), Row 3 (orange), Row 4 (light blue), Row 5 (orange), Row 6 (light blue), Row 7 (orange), Row 8 (light blue), Row 9 (orange), Row 10 (light blue), and Row 11 (orange). The formula applied in step 6 ensures that every third row (rows 1, 4, 7, 10) is colored orange, while the other rows are light blue.

| A | B |
|----|--------|
| 1 | RollNo |
| 2 | MBA005 |
| 3 | MBA006 |
| 4 | MBA009 |
| 5 | MBA004 |
| 6 | MBA003 |
| 7 | MBA007 |
| 8 | MBA001 |
| 9 | MBA010 |
| 10 | MBA008 |
| 11 | MBA002 |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

Microsoft Office
Excel 2003/2007



Data Analysis with Microsoft Excel



"All I'm saying is we plug these into Excel, let it do its thing, and then we can all play until lunch!"

Agenda

1. Sort column
2. Average of 2 columns
3. Stddev of a column
4. Descriptive statistics
5. Histogram of average with a chart
6. Frequency computation

Naming cells in Excel

| | Columns | | |
|---|---------|----|----|
| | A | B | C |
| 1 | A1 | B1 | C1 |
| 2 | A2 | B2 | C2 |
| 3 | A3 | B3 | C3 |
| 4 | A4 | B4 | C4 |

Rows

Columns

this column is B1:B4

This cell is C4

Example of Excel data

The screenshot shows a Microsoft Excel window titled "Microsoft Excel - 51-marks.xls". The spreadsheet contains two main sections: a data entry section and a statistics section.

Data entered: The first section (rows 1-6) contains data for five students: Anil, Bina, Catie, Dina, and Eugene. The columns represent the student's first name (A1), exam scores (exam1 and exam2), and the calculated average (Average). The cell A1 is highlighted with a red border.

Rows: An arrow points to the horizontal axis, indicating rows.

Columns: An arrow points to the vertical axis, indicating columns.

Cell A1: An arrow points to the cell A1, which contains the value "first_name".

Charts: An arrow points to the "Chart" icon in the ribbon.

Formulas: An arrow points to the formula bar showing the formula for cell A1: =first_name.

value of cell A1: An arrow points to the value "first_name" in cell A1.

Each cell can contain text or number or formula: An arrow points to the formula bar showing the formula for cell A1: =first_name.

Sheets: An arrow points to the bottom navigation bar showing multiple sheets: mosh, Sheet3, and Sheet1.

Statistics: The second section (rows 8-14) provides statistical analysis of the data. It includes rows for Average, Median, Mode, and stddev. Row 14 shows frequency distributions for bins of 0, 25, 50, 75, and 100, along with their respective frequencies and averages.

| | A | B | C | D |
|----|------------|------------|------------|----------|
| 1 | first_name | exam1 | exam2 | Average |
| 2 | Anil | 100 | 99 | 99.5 |
| 3 | Bina | 82 | 76 | 79 |
| 4 | Catie | 72 | 85 | 78.5 |
| 5 | Dina | 33 | 55 | 44 |
| 6 | Eugene | 22 | 10 | 16 |
| 7 | | | | |
| 8 | Statistics | | | |
| 9 | Average | 48.647059 | 54.41176 | 51.52941 |
| 10 | Median | 72 | 76 | 78.5 |
| 11 | Mode | #N/A | #N/A | #N/A |
| 12 | stddev | 33.108911 | 34.64823 | 33.15758 |
| 13 | | | | |
| 14 | bins | freq/exam1 | freq/exam2 | freq av |
| 15 | 0 | 0 | 0 | 0 |
| 16 | 25 | 1 | 1 | 1 |
| 17 | 50 | 1 | 0 | 1 |
| 18 | 75 | 1 | 1 | 0 |
| 19 | 100 | 2 | 3 | 3 |
| 20 | | | | |

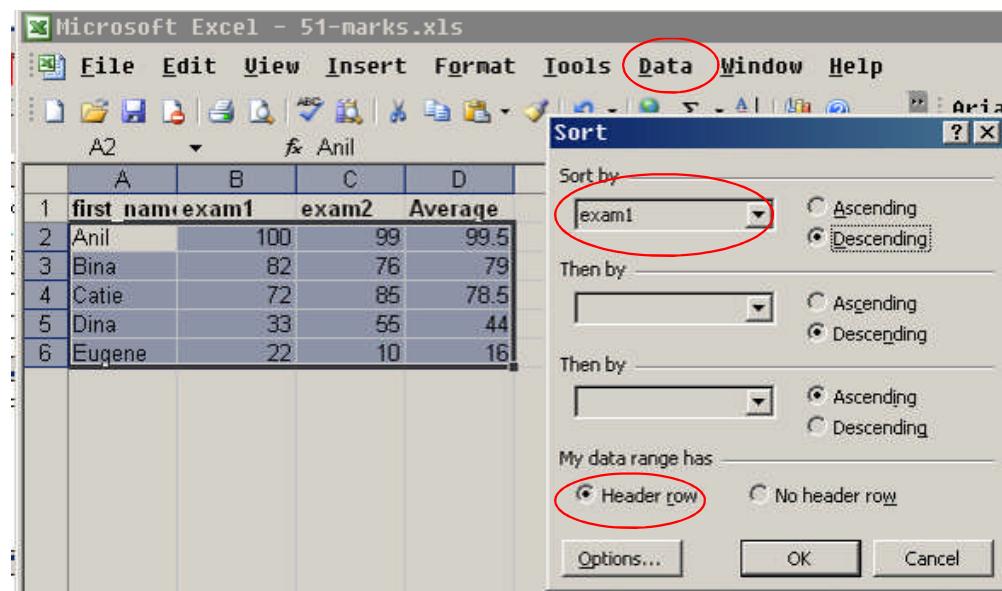
Create some data in Excel

Start > Excel > Enter data as below

| | Columns | | |
|---|---------|-------|-------|
| | A | B | C |
| 1 | Name | exam1 | exam2 |
| 2 | Anil | 10 | 15 |
| 3 | Bina | 70 | 80 |
| 4 | Catie | 90 | 60 |

Sort data by exam1

- Select cells [A1..D6]
- Menu > Data > Sort



Average of two columns in 3rd column (exam1 and exam2)

- Put cursor in D2
- fx=Average(B2,C2)
- Drag black dot from D2 to D6 with mouse.

| | A | B | C | D | E |
|---|------------|-------|-------|---------|---|
| 1 | first_name | exam1 | exam2 | Average | |
| 2 | Anil | 100 | 99 | 99.5 | |
| 3 | Bina | 82 | 76 | 79 | |
| 4 | Catie | 72 | 85 | 78.5 | |
| 5 | Dina | 33 | 55 | 44 | |
| 6 | Eugene | 22 | 10 | 16 | |

Three ways to find Average

| | A | B |
|---|------|-------|
| 1 | name | marks |
| 2 | Anil | 20 |
| 3 | Ball | 40 |
| 4 | Cat | 0 |

| | | |
|----------|----------------------------------|----|
| Average1 | =AVERAGE(B2:B4) | 20 |
| Average2 | =AVERAGE(IF(B2:B4<>0,B2:B4)) | 30 |
| Average3 | =SUM(B2:B4)/COUNTIF(B2:B4,"<>0") | 30 |

Column Statistics: standard deviation (stddev)

1. Select B11

2. After fx=, type:
STDDEV(B2:B6)

3. Drag black square
in B11 to D11, to
get stddev of each
column

Refer to the 2nd column as B2:B6

The screenshot shows a Microsoft Excel window titled "Microsoft Excel - 51-marks.xls". The formula bar displays the formula =STDEV(B2:B6). The data table has columns A, B, C, D, and E. Column A contains names: Anil, Bina, Catie, Dina, and Eugene. Column B contains exam scores: 100, 82, 72, 72, and 22. Column C contains exam2 scores: 99, 99, 85, 10, and 10. Column D contains Average scores: 99.5, 90.5, 78.5, 41, and 16. Row 8 is labeled "Statistics". Rows 9, 10, and 11 are labeled "Median", "Mode", and "stddev" respectively. The cell B11 contains the value 28.962044, which is highlighted with a red border. The cell D11 contains the value 46.54353, and the cell E11 contains the value 35.35428. Red arrows point from the numbered steps to the corresponding actions in the Excel interface.

| | A | B | C | D | E |
|----|------------|-----------|----------|----------|---|
| 1 | first_name | exam1 | exam2 | Average | |
| 2 | Anil | 100 | 99 | 99.5 | |
| 3 | Bina | 82 | 99 | 90.5 | |
| 4 | Catie | 72 | 85 | 78.5 | |
| 5 | Dina | 72 | 10 | 41 | |
| 6 | Eugene | 22 | 10 | 16 | |
| 7 | | | | | |
| 8 | Statistics | | | | |
| 9 | Median | 72 | 85 | 78.5 | |
| 10 | Mode | 72 | 99 | #N/A | |
| 11 | stddev | 28.962044 | 46.54353 | 35.35428 | |
| 12 | | | | | |

Help on the statistical functions

The screenshot shows an Excel spreadsheet with data in columns A, B, and C. The formula bar displays the formula `=STDEV(B2:B6)`. A red circle highlights the function name `STDEV` in the formula. The help window on the right is titled "HELP on STDEV". It contains the following information:

STDEV
See Also

Estimates standard deviation based on a sample. The standard deviation is a measure of how widely values are dispersed from the average value (the mean).

Syntax

`STDEV(number1, number2, ...)`

Number1, number2, ... are 1 to 30 number arguments corresponding to a sample population. You can also use a single array or a reference to an array instead of arguments separated by commas.

Remarks

- STDEV assumes that its arguments are a sample of the population. If you represents the entire population, then compute the standard deviation using STDEVP.
- The standard deviation is calculated using the "unbiased" or "n-1" method.
- STDEV uses the following formula:

$$\sqrt{\frac{\sum(x - \bar{x})^2}{n-1}}$$

Click here
to see the
selected
cells B2:B6
and help
on function
STDEV

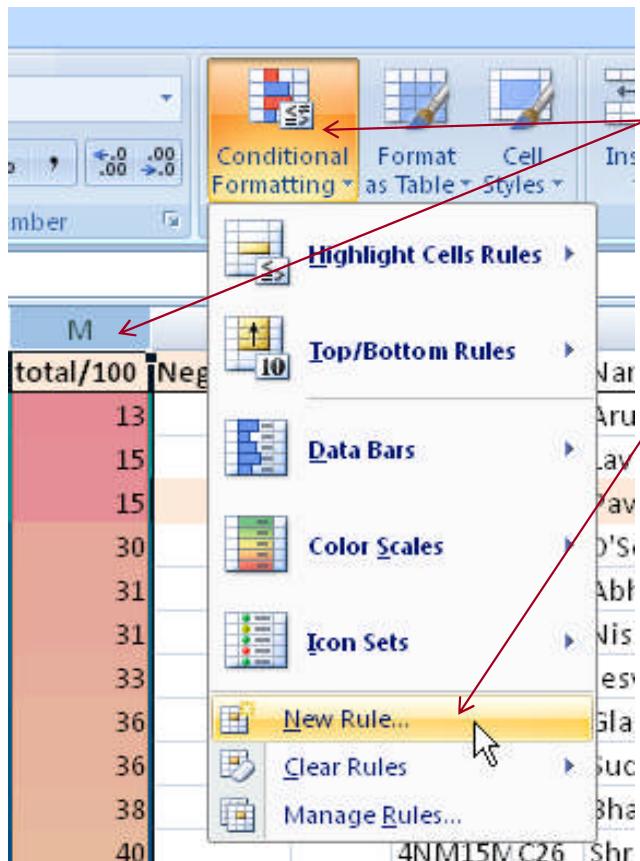
Click on
See Also
to get
help on
all other
functions



Excel 2007

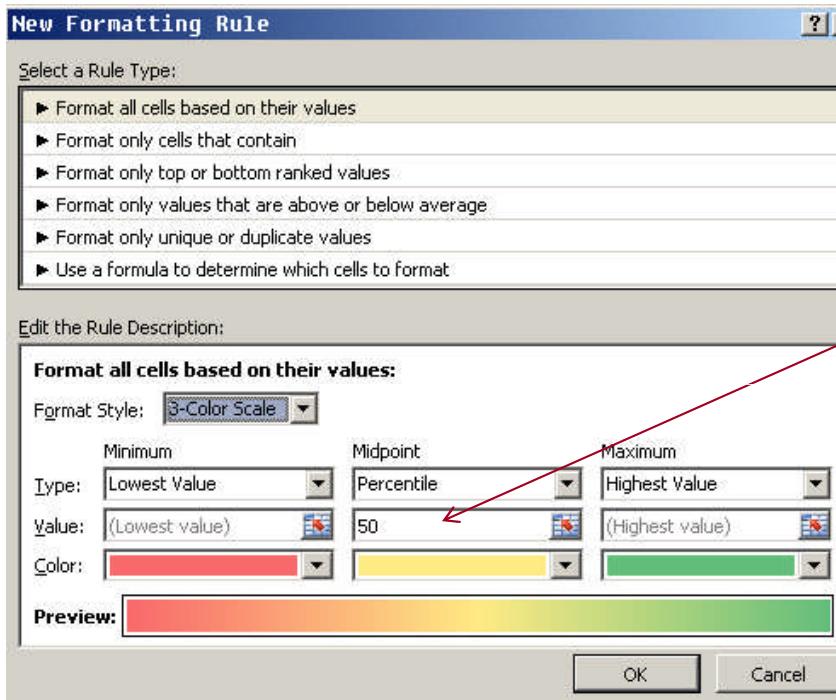
Grading in Excel

Coloring the marks



1. Select Marks Column
2. Home > Conditional Formatting
3. New Formatting Rule

Coloring the marks



1. Select Marks Column
2. Home > Conditional Formatting
3. New Formatting Rule
4. "3 color scale"
Red: Lowest,
Yellow: 50% percentile,
Green: Highest

Advanced: Calculate =PERCENTILE(\$B\$3:\$B\$20,0.25), then use a formula to determine which cells to color $B3 \leq \text{PERCENTILE}(\$B\$3:\$B\$20,0.25)$

See <http://www.dummies.com/how-to/content/how-to-highlight-data-based-on-percentile-rank-in-.html>

Insert Pivot Table

The screenshot shows a Microsoft Excel spreadsheet with a PivotTable Field List dialog box open. The spreadsheet contains a table of student marks and grades. The PivotTable Field List dialog box displays fields from the table, with 'total/100' selected in the 'Values' area.

| | A | B | C |
|----|-----------------------|-------|-------|
| 1 | Drop Page Fields Here | | |
| 2 | | | |
| 3 | Count of total/100 | | Grade |
| 4 | total/100 | Total | |
| 5 | 13-22 | 3 | F |
| 6 | 23-32 | 3 | F |
| 7 | 33-42 | 6 | D |
| 8 | 43-52 | 18 | B |
| 9 | 53-62 | 61 | A |
| 10 | 63-72 | 75 | S |
| 11 | 73-82 | 14 | S |
| 12 | Grand Total | 180 | |
| 13 | | | |
| 14 | | | |

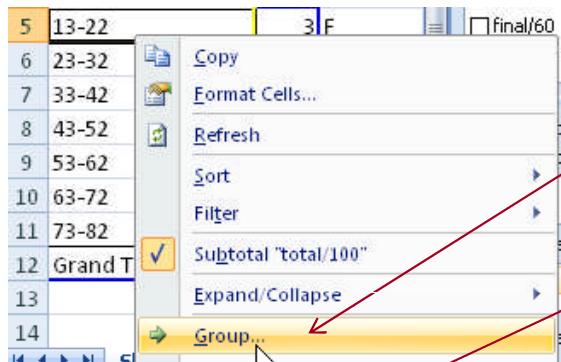
PivotTable Field List dialog box:

- Choose fields to add to report:
 - MovieQz/10
 - GroupQz/23Jan16/10
 - final/60
 - total/100
- Drag fields between areas below:
 - Report Filter
 - Column Labels
 - Row Labels
 - Values
- Fields currently assigned:
 - Report Filter: total/100
 - Column Labels: Count of total/100
- Defer Layout Update
- Update

1. Insert Pivot Table

2. Select
RowLabels=Marks
Sigma Values=
Count of Marks

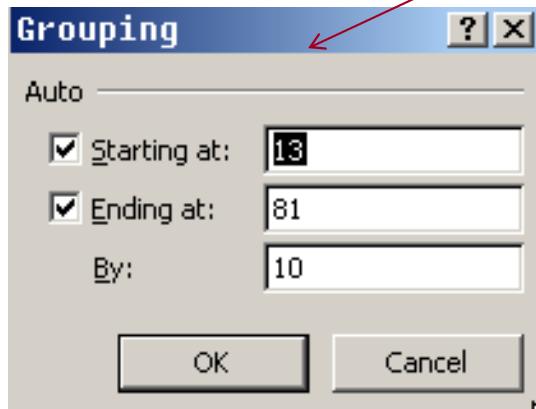
Freq/Count Histogram



Right click on any row, and click on
"Group"

Grouping from Lowest to Highest, with delta

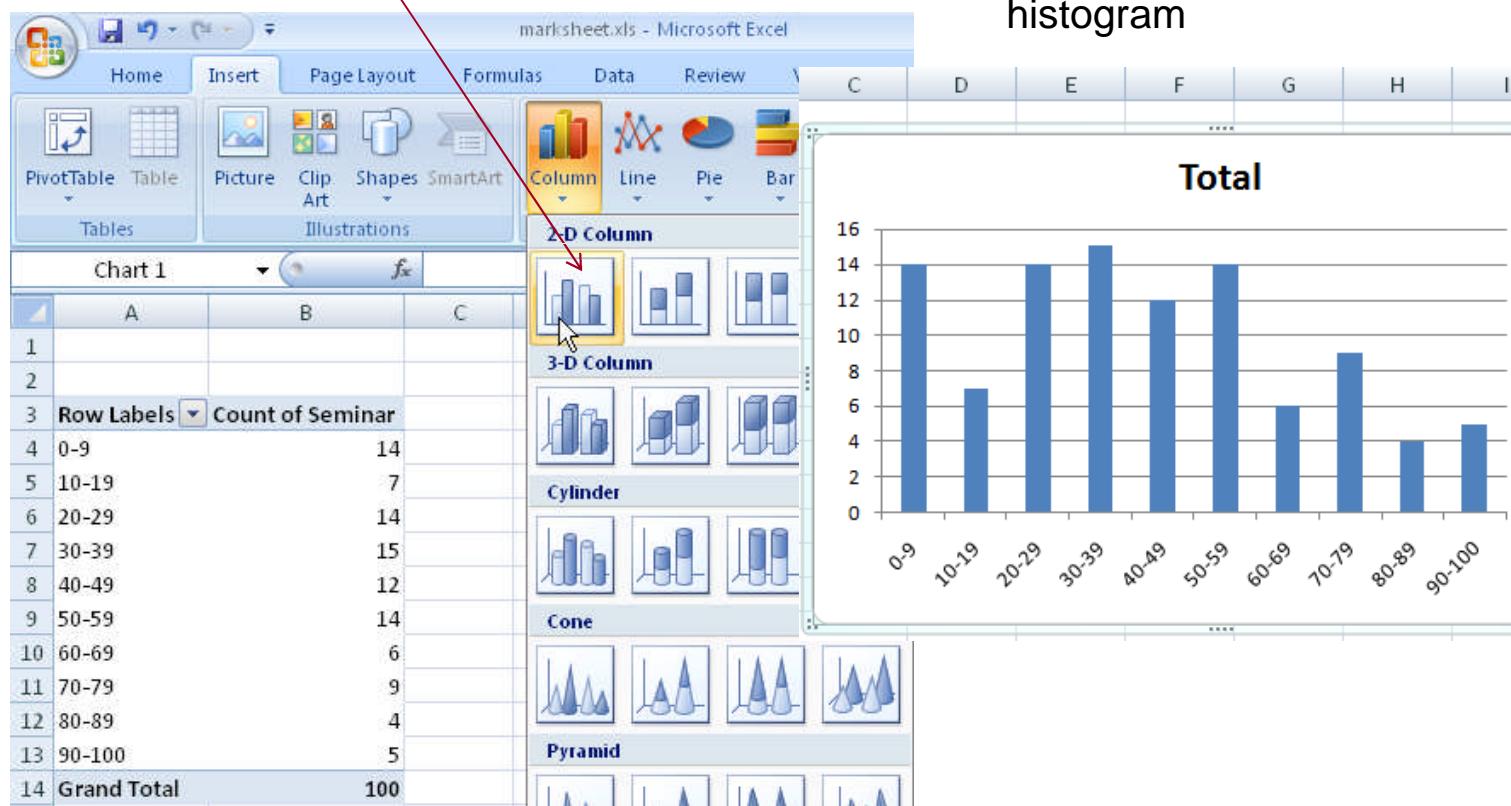
You get this table:



| | A | B |
|----|-----------------------|-------|
| 1 | Drop Page Fields Here | |
| 2 | | |
| 3 | Count of total/100 | |
| 4 | total/100 | Total |
| 5 | 13-22 | 3 |
| 6 | 23-32 | 3 |
| 7 | 33-42 | 6 |
| 8 | 43-52 | 18 |
| 9 | 53-62 | 61 |
| 10 | 63-72 | 75 |
| 11 | 73-82 | 14 |
| 12 | Grand Total | 180 |

Freq/Count Histogram

Insert > Column Chart



You get this mark distribution histogram

Summing marks

We had 3 quiz of 10, 5, 15 marks.

With weightage {30, 50, 20} out of total=100.

Suppose a student got q1,q2,q3 marks in those quizzes,
then we get weighted total % for each student as:

$\text{total} = \text{int}(\text{q1}/10 * 30 + \text{q2}/5 * 50 + \text{q3} / 15 * 20)$

Re-Scaling

Marks Range = a .. b

Want Range = c .. d

Rescale student marks=m to new with:

new = int($(m - a) * (d - c) / (b - a) + c$)

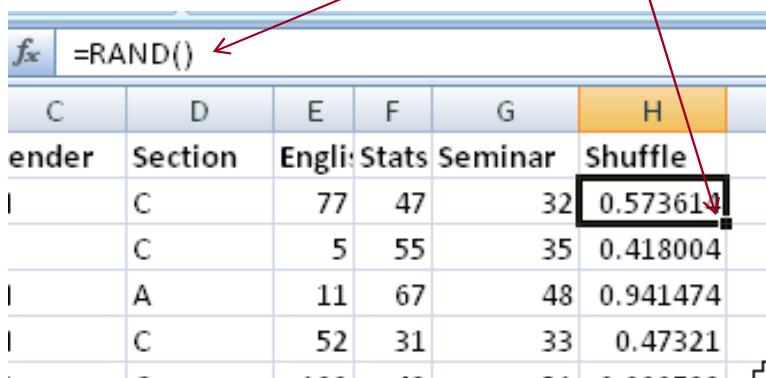
E.g. Students got marks in range: 7 to 81

We want to give marks in range: 40 to 100

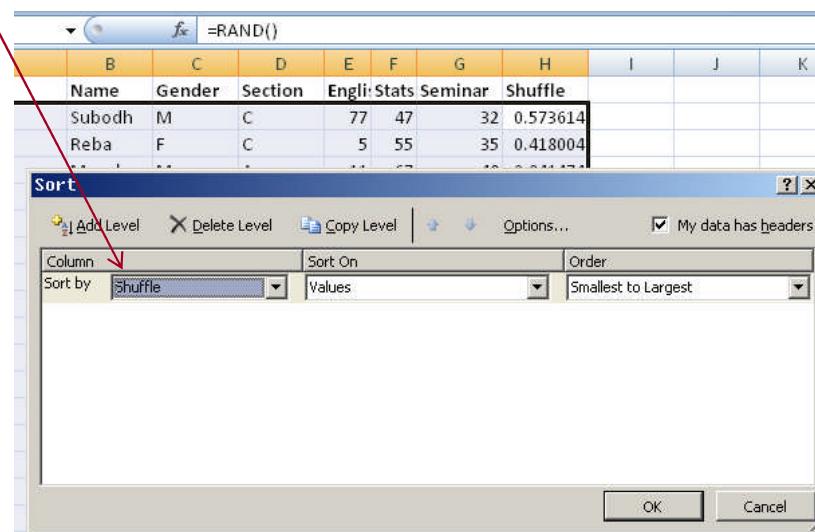
new = int ($(m - 7) * (100 - 40) / (81 - 7) + 40$)

Random shuffling

- Add a column Shuffle, =Rand(),
- drag Black Dot to all the rows.
- Sort by column shuffle.

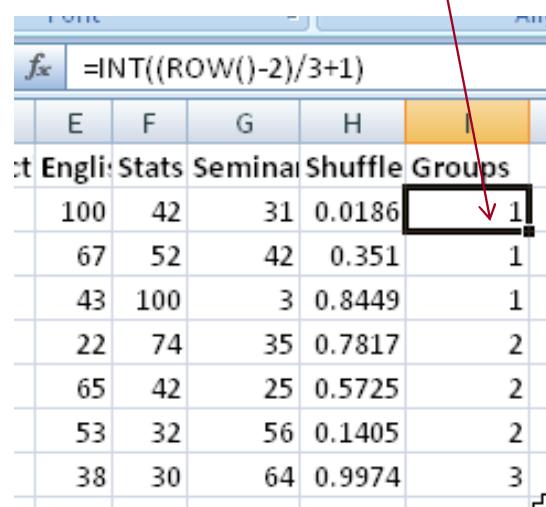


| | C | D | E | F | G | H | | | | |
|--------|---------|-------|-------|---------|---------|----------|--|--|--|--|
| Gender | Section | Engli | Stats | Seminar | Shuffle | | | | | |
| I | C | | 77 | 47 | 32 | 0.573614 | | | | |
| I | C | | 5 | 55 | 35 | 0.418004 | | | | |
| I | A | | 11 | 67 | 48 | 0.941474 | | | | |
| I | C | | 52 | 31 | 33 | 0.47321 | | | | |



Random Grouping of size=3

- Shuffle the rows (last slide).
- Add a column Groups, = int((row() - 2)/3+1)
- Drag Black Dot down to all rows
- You get group numbers, each group size is 3.



| E | F | G | H | I |
|-----|-----|----|--------|---|
| 100 | 42 | 31 | 0.0186 | 1 |
| 67 | 52 | 42 | 0.351 | 1 |
| 43 | 100 | 3 | 0.8449 | 1 |
| 22 | 74 | 35 | 0.7817 | 2 |
| 65 | 42 | 25 | 0.5725 | 2 |
| 53 | 32 | 56 | 0.1405 | 2 |
| 38 | 30 | 64 | 0.9974 | 3 |



Pivot table in Excel

Example data of class marks

- We want to find out the average for each section, and average for the gender.
- Pivot table does this for us.

| | A | B | C | D |
|---|--------|---------|--------|-------|
| 1 | name | section | gender | marks |
| 2 | Anil | a | m | 80 |
| 3 | Bina | a | f | 76 |
| 4 | Colins | b | m | 85 |
| 5 | Dina | b | f | 55 |
| 6 | Erin | c | f | 33 |
| 7 | Farid | c | m | 90 |
| n | | | | |

Data > Pivot table

The screenshot illustrates the process of creating a PivotTable in Microsoft Excel. It shows three windows:

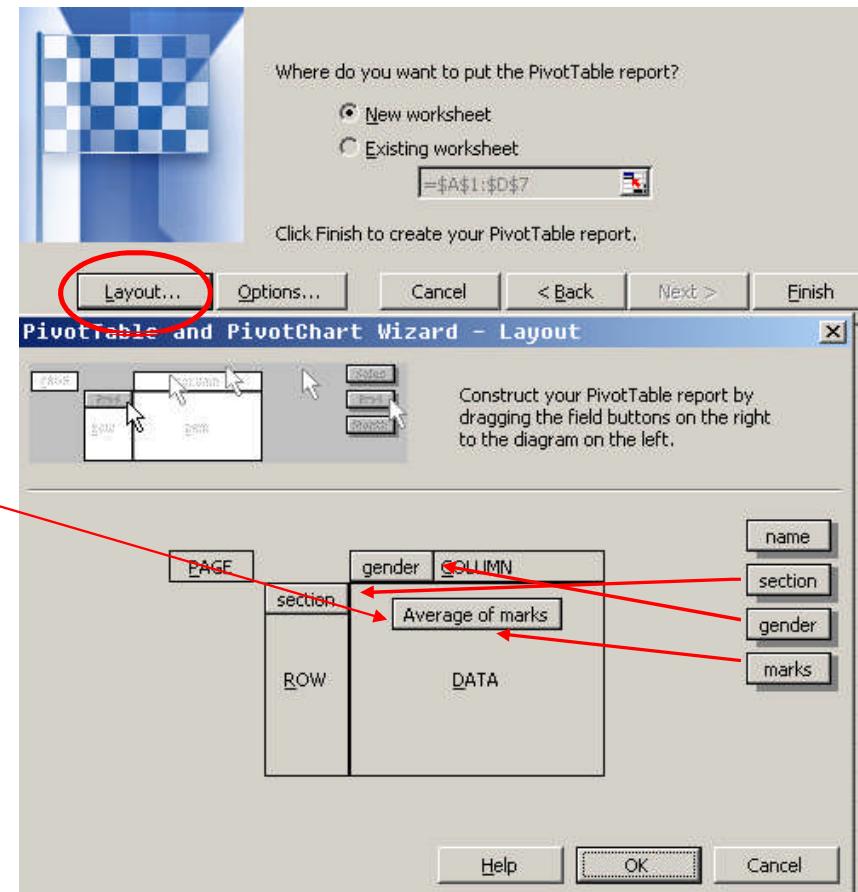
- Data Menu:** The "Data" menu is open, with the "PivotTable and PivotChart Report..." option highlighted.
- PivotTable and PivotChart Wizard - Step 2:** This dialog box asks "Where is the data that you want to use?". The range "Exam-marks!\$A\$1:\$D\$7" is selected in the "Range" field. Buttons for "Cancel", "< Back", "Next >", and "Finish" are visible.
- PivotTable and PivotChart Wizard - Step 3 of 3:** This dialog box asks "Where do you want to put the PivotTable report?". The "New worksheet" radio button is selected. A preview of the PivotTable is shown on the left. The "Finish" button is visible at the bottom.

The data used for the PivotTable is as follows:

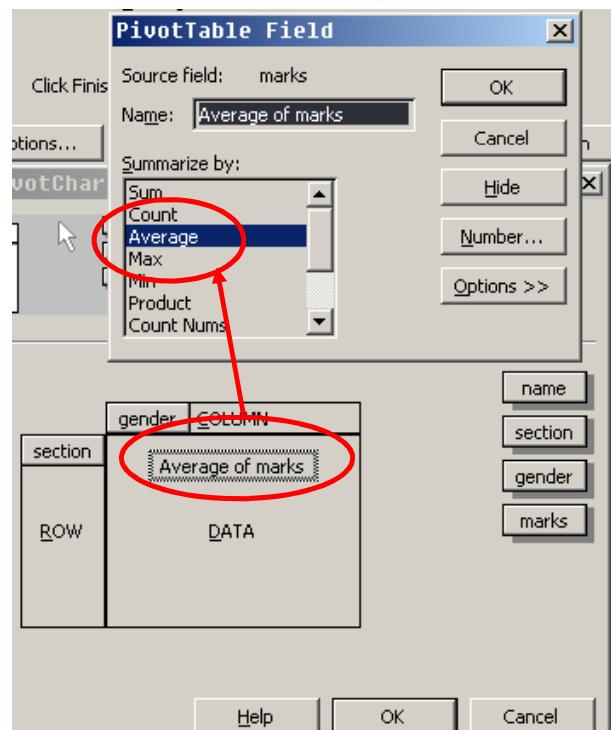
| | A | B | C | D | E |
|---|--------|---------|--------|-------|---|
| 1 | name | section | gender | marks | |
| 2 | Anil | a | m | 80 | |
| 3 | Bina | a | f | 76 | |
| 4 | Colins | b | m | 85 | |
| 5 | Dina | b | f | 55 | |
| 6 | Erin | c | f | 33 | |
| 7 | Farid | c | m | 90 | |

Layout

- Drag “section” “gender” and “marks” in the layout form.
- Click on “marks” and select average.



- Click on “marks” and select average.



Result

- We get average of each section and for each gender.

| | A | B | C | D |
|---|-----------------|----------|----|---------|
| 1 | | | | |
| 2 | | | | |
| 3 | Average of mark | gender | | |
| 4 | section | f | m | Average |
| 5 | a | 76 | 80 | 78 |
| 6 | b | 55 | 85 | 70 |
| 7 | c | 33 | 90 | 61.5 |
| 8 | Average | 54.66667 | 85 | 69.833 |
| 9 | | | | |



Excel 2007

Pivot Table in Excel

Example data of class marks

- We want to find out the average for each section, and average for the gender.
- Pivot table does this for us automatically

| | A | B | C | D | |
|---|--------|---------|--------|-------|--|
| 1 | name | section | gender | marks | |
| 2 | Anil | a | m | 80 | |
| 3 | Bina | a | f | 76 | |
| 4 | Colins | b | m | 85 | |
| 5 | Dina | b | f | 55 | |
| 6 | Erin | c | f | 77 | |
| 7 | Farid | c | m | 90 | |
| 8 | | | | | |

Excel 2007 Pivot table

Exercise: Enter this data

| | A | B | C | D | |
|---|--------|---------|--------|-------|--|
| 1 | name | section | gender | marks | |
| 2 | Anil | a | m | 80 | |
| 3 | Bina | a | f | 76 | |
| 4 | Colins | b | m | 85 | |
| 5 | Dina | b | f | 55 | |
| 6 | Erin | c | f | 77 | |
| 7 | Farid | c | m | 90 | |

Select data and Insert > Pivot Table

The screenshot shows a Microsoft Excel interface with the following details:

- Top Menu:** Home, Insert, Page Layout, Formulas.
- Insert Tab Buttons:** PivotTable (highlighted), Table, Picture, Clip Art, Shapes, SmartArt, Column.
- Submenu for PivotTable:** Shows "PivotTable" and "PivotChart".
- Contextual Menu (Open over Data):** "Insert PivotTable" is selected.
 - Description: "Summarize data using a PivotTable."
 - Text: "PivotTables make it easy to arrange and summarize complicated data and drill down on details."
 - Help: "Press F1 for more help."
- Data Table:** A table with columns "name" and "marks".

| | name | marks |
|---|-------|-------|
| 1 | Anil | 80 |
| 2 | Bina | 76 |
| 3 | Colin | 85 |
| 4 | Dina | 55 |
| 5 | Erin | 77 |
| 6 | Farid | 90 |
| 7 | c | m |
| 8 | | |
| 9 | | |

Create Pivot Table

The screenshot shows a Microsoft Excel spreadsheet with a data table and an open 'Create PivotTable' dialog box.

Data Table:

| | A | B | C | D | E | F | G |
|---|--------|---------|--------|-------|---|---|---|
| 1 | name | section | gender | marks | | | |
| 2 | Anil | a | m | 80 | | | |
| 3 | Bina | a | f | 76 | | | |
| 4 | Colins | b | m | 85 | | | |
| 5 | Dina | b | f | 55 | | | |
| 6 | Erin | c | f | 77 | | | |
| 7 | Farid | c | m | 90 | | | |

Create PivotTable Dialog Box:

Choose the data that you want to analyze

Select a table or range
Table/Range: 'Exam-marks'!\$A\$1:\$D\$7

Use an external data source
Choose Connection...
Connection name:

Choose where you want the PivotTable report to be placed

New Worksheet

Existing Worksheet
Location: [empty cell reference]

OK Cancel

Blank Pivot table

The screenshot shows a Microsoft Excel spreadsheet titled "5044-Excel-Pivot.xlsx". The PivotTable Tools ribbon tab is selected. A data table is visible in the range A1:D8, containing columns for name, section, gender, and marks. A PivotTable Field List pane is open on the right, showing fields: name, section, gender, and marks. The "marks" field is checked. The PivotTable area (A10:A16) displays the message: "To build a report, choose fields from the PivotTable Field List". The status bar at the bottom indicates "Ready".

| | A | B | C | D |
|----|--------|---|--------|-------|
| 1 | name | section | gender | marks |
| 2 | Anil | a | m | 80 |
| 3 | Bina | a | f | 76 |
| 4 | Colins | b | m | 85 |
| 5 | Dina | b | f | 55 |
| 6 | Erin | c | f | 77 |
| 7 | Fand | c | m | 90 |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | PivotTable4 | | |
| 14 | | To build a report, choose fields from the PivotTable Field List | | |
| 15 | | | | |
| 16 | | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |
| 20 | | | | |
| 21 | | | | |
| 22 | | | | |
| 23 | | | | |
| 24 | | | | |
| 25 | | | | |
| 26 | | | | |
| 27 | | | | |

Select Section and Gender

The screenshot shows a Microsoft Excel spreadsheet titled "Exam-marks". The data is organized into columns A, B, C, and D. Column A contains row numbers from 1 to 16. Columns B, C, and D contain data for "name", "section", "gender", and "marks" respectively. Row 10 is a summary row labeled "Row Labels" with a dropdown menu showing "Sum of marks". Rows 11, 12, and 13 show the sum of marks for sections "a", "b", and "c" respectively. Row 14 is a "Grand Total" row with a value of 463. The "PivotTable Field List" window is open on the right side of the screen, listing fields: "name", "section", "gender", and "marks". Under "Choose fields to add to report:", "section" and "marks" are checked. In the "Drag fields between areas below:" section, "section" is assigned to the "Row Labels" area, and "marks" is assigned to the "Values" area, with a formula bar showing "Sum of marks".

| A | B | C | D | |
|----|-------------|--------------|--------|-------|
| 1 | name | section | gender | marks |
| 2 | Anil | a | m | |
| 3 | Bina | a | f | |
| 4 | Colins | b | m | |
| 5 | Dina | b | f | |
| 6 | Erin | c | f | |
| 7 | Farid | c | m | |
| 8 | | | | |
| 9 | | | | |
| 10 | Row Labels | Sum of marks | | |
| 11 | a | 156 | | |
| 12 | b | 140 | | |
| 13 | c | 167 | | |
| 14 | Grand Total | 463 | | |
| 15 | | | | |
| 16 | | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |
| 20 | | | | |
| 21 | | | | |
| 22 | | | | |
| 23 | | | | |
| 24 | | | | |
| 25 | | | | |
| 26 | | | | |
| 27 | | | | |
| 28 | | | | |

PivotTable Field List

Choose fields to add to report:

- name
- section
- gender
- marks

Drag fields between areas below:

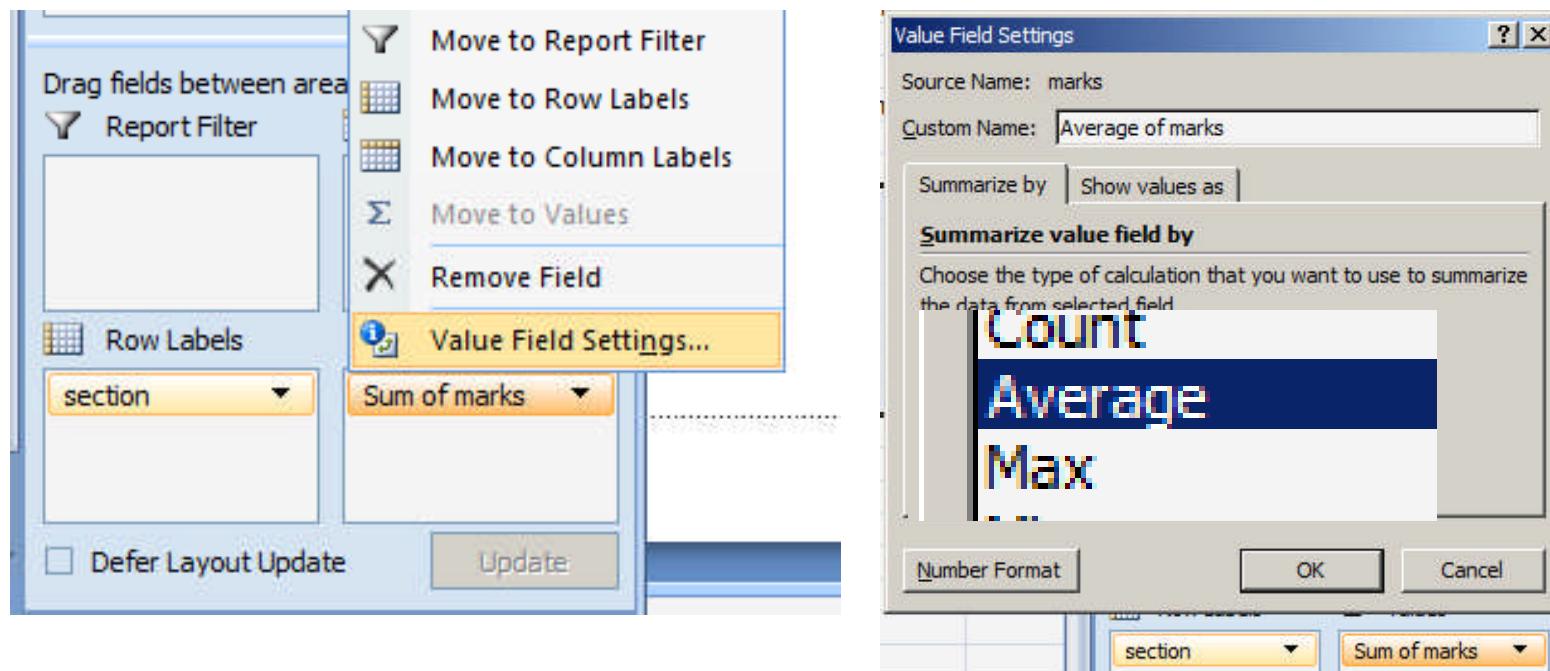
Report Filter Column Labels

Row Labels Values

section Sum of marks

Defer Layout Update Update

Change “sum of marks” > value field settings > change ‘sum’ to ‘Average’



Pivot table for average marks by section

The screenshot shows a Microsoft Excel spreadsheet titled "Exam-marks". On the left, there is a data table with columns for name, section, gender, and marks. A PivotTable is being created on the right. The "PivotTable Field List" shows fields: name, section, gender, and marks. The "Row Labels" area contains "section". The "Values" area contains "marks" with the formula "Average of marks". The PivotTable preview shows the average marks for sections a, b, and c.

| | A | B | C |
|----|-------------|------------------|--------|
| 1 | name | section | gender |
| 2 | Anil | a | m |
| 3 | Bina | a | f |
| 4 | Colins | b | m |
| 5 | Dina | b | f |
| 6 | Erin | c | f |
| 7 | Farid | c | m |
| 8 | | | |
| 9 | | | |
| 10 | Row Labels | Average of marks | |
| 11 | a | 78 | |
| 12 | b | 70 | |
| 13 | c | 83.5 | |
| 14 | Grand Total | 77.16666667 | |
| 15 | | | |
| 16 | | | |
| 17 | | | |
| 18 | | | |
| 19 | | | |
| 20 | | | |
| 21 | | | |
| 22 | | | |
| 23 | | | |
| 24 | | | |
| 25 | | | |
| 26 | | | |
| 27 | | | |
| 28 | | | |

PivotTable Field List

Choose fields to add to report:

name

section

gender

marks

Drag fields between areas below:

Report Filter Column Labels

Row Labels Values

section Average of m...

Exercise: Make the pivot table for average by gender

| | Row Labels | Average of marks |
|----|-------------|------------------|
| 10 | f | 69.33 |
| 11 | m | 85 |
| 13 | Grand Total | 77.17 |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |



Excel 2007

Histogram of Marksheets using Pivot Table

Histogram

1. File > open > marksheet.csv

| | A | B | C | D | E | F | G |
|----|----------|------------|--------|---------|---------|-------|---------|
| 1 | Roll | Name | Gender | Section | English | Stats | Seminar |
| 2 | 14MBA001 | Subodh | M | C | 77 | 47 | 32 |
| 3 | 14MBA002 | Reba | F | C | 5 | 55 | 35 |
| 4 | 14MBA003 | Mayekar | M | A | 11 | 67 | 48 |
| 5 | 14MBA004 | Kushwaha | M | C | 52 | 31 | 33 |
| 6 | 14MBA005 | Narain | M | C | 100 | 42 | 31 |
| 7 | 14MBA006 | Bhadriraju | M | C | 64 | 28 | 22 |
| 8 | 14MBA007 | Magesh | M | C | 50 | 5 | 37 |
| 9 | 14MBA008 | Naimish | M | C | 46 | 31 | 31 |
| 10 | 14MBA009 | Preetish | F | C | 39 | 79 | 26 |
| 11 | 14MBA010 | Karanam | M | B | 39 | 66 | 38 |
| 12 | 14MBA011 | Lal | F | C | 34 | 78 | 15 |

Insert > Pivot Table

The screenshot shows the Microsoft Excel ribbon with the 'Insert' tab selected. In the 'Tables' group, the 'PivotTable' icon is highlighted. Below the ribbon, a small preview window displays a table with columns labeled 'A' and 'B'. To the right of the ribbon, a larger window titled 'Create PivotTable' is open. It contains two main sections: 'Choose the data that you want to analyze' and 'Choose where you want the PivotTable report to be placed'. The 'Select a table or range' option is selected, and the range 'marksheet!\$A\$1:\$G\$101' is entered in the 'Table/Range' field. The 'New Worksheet' option is selected under 'Choose where you want the PivotTable report to be placed'. The background shows a portion of an Excel spreadsheet with data in columns A through G.

| A | B | C | D | E | F | G |
|------------|--------|--------|---------|---------|-------|---------|
| Roll | Name | Gender | Section | English | Stats | Seminar |
| 1 Roll | Subodh | M | | | 47 | 32 |
| 2 14MBA001 | Reha | F | | | 55 | 35 |
| 3 14MRA002 | | | | | 67 | 48 |
| | | | | | 31 | 33 |
| | | | | | 42 | 31 |
| | | | | | 28 | 22 |
| | | | | | 5 | 37 |
| | | | | | 31 | 31 |
| | | | | | 79 | 26 |
| | | | | | 66 | 38 |
| | | | | | 78 | 15 |
| | | | | | 62 | 12 |
| | | | | | 70 | 74 |
| | | | | | 68 | 89 |

Group the data into Histogram

1. Select English & Sum English(for row values and Sum), you get a table.
- 2 In the table on any row, Right click > Group
3. Grouping 0 to 100, by 10 (se we get 0,10,20,30,..,100).

The screenshot shows a Microsoft Excel interface with a PivotTable. On the left, there's a PivotTable Field List pane. A context menu is open over the 'English' field, with 'Group...' highlighted in yellow. The main area shows a PivotTable with data from rows 1 to 15. The first few rows of data are:

| Row | Value | Sum |
|-----|-------|-----|
| 1 | 1 | 15 |
| 2 | 2 | 6 |
| 3 | 3 | 8 |
| 4 | 0 | 33 |
| 5 | 4 | 13 |
| 6 | 5 | 15 |
| 7 | 6 | 13 |
| 8 | 8 | 30 |
| 9 | 11 | 16 |
| 10 | 13 | 19 |
| 11 | 15 | 22 |
| 12 | 16 | 66 |
| 13 | 19 | |
| 14 | 22 | |
| 15 | 22 | |

The 'PivotTable Field List' pane shows fields: Gender, Section, English (selected), Stats, Seminar. The 'Grouping' dialog box is open, showing 'Starting at: 0', 'Ending at: 100', and 'By: 10'. Buttons for 'OK' and 'Cancel' are at the bottom.

Right click and Summarize change Sum to Count

The screenshot shows a Microsoft Excel spreadsheet with a PivotTable. The PivotTable is located in the range A3:F15, with the title "Sum of English". The "Row Labels" field contains numerical ranges from 0-9 to 90-100, and the "Sum of English" field contains the sum of values for each row. A context menu is open over the "Sum of English" cell in row 3. The menu options include: Copy, Format Cells..., Number Format..., Refresh, Sort, Remove "Sum of English", Summarize Data By (which is highlighted), Value Field Settings..., PivotTable Options..., and Hide Field List. To the right of the menu, a "PivotTable" sidebar is visible, titled "Choose fields to". It lists several fields: Roll, Name, Gender, Section, English (which is checked), Stats, and Seminar. Below the sidebar is a dropdown menu for summarizing data, with "Sum" selected (indicated by a checkmark) and "Count" being the option currently being selected (indicated by a cursor).

| | A | B | C | D | E | F |
|----|-------------|----------------|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | Row Labels | Sum of English | | | | PivotTable |
| 4 | 0-9 | | | | | <input type="checkbox"/> Roll |
| 5 | 10-19 | | | | | <input type="checkbox"/> Name |
| 6 | 20-29 | | | | | <input type="checkbox"/> Gender |
| 7 | 30-39 | | | | | <input type="checkbox"/> Section |
| 8 | 40-49 | | | | | <input checked="" type="checkbox"/> English |
| 9 | 50-59 | | | | | <input type="checkbox"/> Stats |
| 10 | 60-69 | | | | | <input type="checkbox"/> Seminar |
| 11 | 70-79 | | | | | |
| 12 | 80-89 | | | | | |
| 13 | 90-100 | | | | | |
| 14 | Grand Total | | | | | |
| 15 | | | | | | |

You get a histogram of distribution of English marks

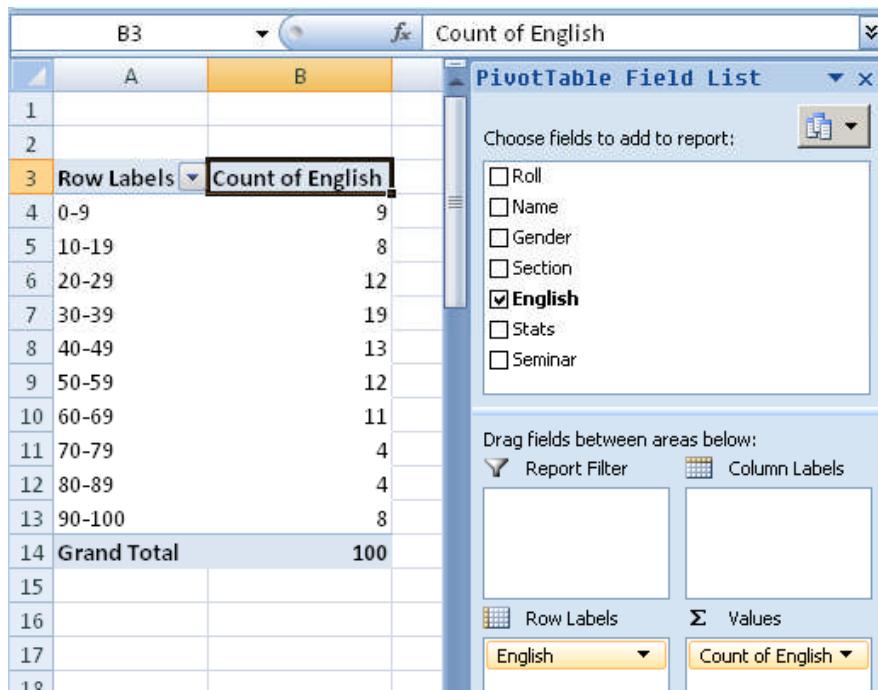
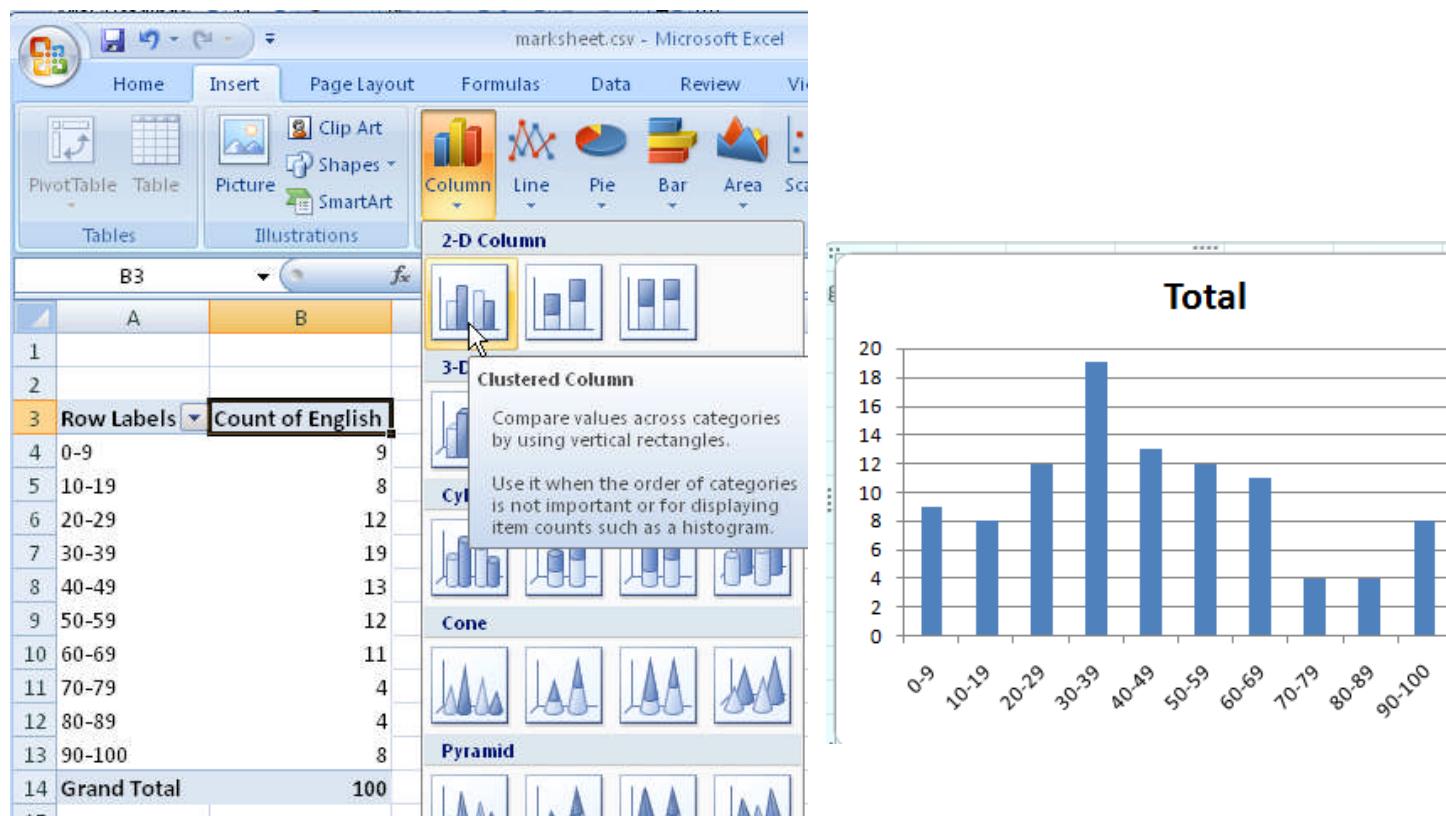


Table to Histogram

Insert > Column > 2D Column



Exercise: Find Averages for each section and gender

D4 fx Average of Seminar

| | A | B | C | D | E |
|----|-------------|--------------------|------------------|--------------------|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | Values | | | |
| 4 | Row Labels | Average of English | Average of Stats | Average of Seminar | |
| 5 | A | 51.44 | 68.96 | 48.96 | |
| 6 | F | 65.78571429 | 66.64285714 | 60.21428571 | |
| 7 | M | 33.18181818 | 71.90909091 | 34.63636364 | |
| 8 | B | 31.62962963 | 51.85185185 | 55.44444444 | |
| 9 | F | 26.14285714 | 32.71428571 | 78.78571429 | |
| 10 | M | 37.53846154 | 72.46153846 | 30.30769231 | |
| 11 | C | 48.72916667 | 53.41666667 | 30.8125 | |
| 12 | F | 29.08695652 | 81.60869565 | 31.65217391 | |
| 13 | M | 66.8 | 27.48 | 30.04 | |
| 14 | Grand Total | 44.79 | 56.88 | 42 | |
| 15 | | | | | |
| 16 | | | | | |
| 17 | | | | | |
| 18 | | | | | |
| 19 | | | | | |

PivotTable Field List

Choose fields to add to report:

- Roll
- Name
- Gender
- Section
- English
- Stats
- Seminar

Drag fields between areas below:

Report Filter

Column Labels

Σ Values

Row Labels

Σ Values

Section

Gender

Average of English

Average of Stats

Average of Seminar

Make numbers easier to read

The screenshot shows a Microsoft Excel spreadsheet titled "marksheet.csv - Microsoft Excel". The ribbon tabs visible are Home, Insert, Page Layout, Formulas, Data, Review, View, and Nuance PDF. The Home tab is selected.

The main area displays a table with columns A, B, and C. Row 4 contains the header "Values". Rows 5 through 14 show data for English, Stats, and Seminar averages. Row 14 is labeled "Grand Total".

A context menu is open over the cell containing the value "48.72916667" in row 11, column C. The menu is titled "Conditional Formating" and lists various number formats:

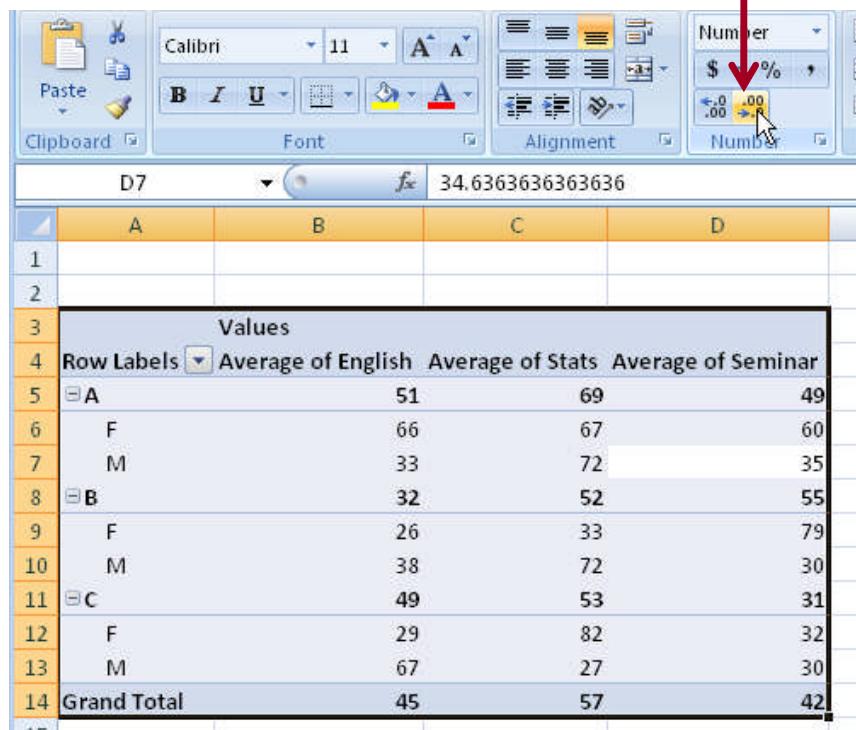
- General
- Number (highlighted)
- Currency
- Accounting
- Short Date
- Long Date
- Time
- Percentage
- Fraction
- Scientific

The "Number" format is selected, showing a dropdown with options: \$, %, ., and ,. The ".00" option is highlighted.

A tooltip for the "Decrease Decimal" button is displayed, stating: "Show less precise values by showing fewer decimal places."

| | A | B | C |
|----|-------------|--------------------|------------------|
| 1 | | | |
| 2 | | | |
| 3 | Values | | |
| 4 | Row Labels | Average of English | Average of Stats |
| 5 | A | 51.44 | 68.96 |
| 6 | F | 65.78571429 | 66.64285714 |
| 7 | M | 33.18181818 | 71.90909091 |
| 8 | B | 31.62962963 | 51.85185185 |
| 9 | F | 26.14285714 | 32.71428571 |
| 10 | M | 37.53846154 | 72.46153846 |
| 11 | C | 48.72916667 | 53.41666667 |
| 12 | F | 29.08695652 | 81.60869565 |
| 13 | M | 66.8 | 27.48 |
| 14 | Grand Total | 44.79 | 56.88 |
| 15 | | | |
| 16 | | | |
| 17 | | | |

Select All (C-a) and
click on >.00 till
all the decimals vanish



| | A | B | C | D | |
|----|-------------|--------------------|------------------|--------------------|--|
| 1 | | | | | |
| 2 | | | | | |
| 3 | Values | | | | |
| 4 | Row Labels | Average of English | Average of Stats | Average of Seminar | |
| 5 | A | 51 | 69 | 49 | |
| 6 | F | 66 | 67 | 60 | |
| 7 | M | 33 | 72 | 35 | |
| 8 | B | 32 | 52 | 55 | |
| 9 | F | 26 | 33 | 79 | |
| 10 | M | 38 | 72 | 30 | |
| 11 | C | 49 | 53 | 31 | |
| 12 | F | 29 | 82 | 32 | |
| 13 | M | 67 | 27 | 30 | |
| 14 | Grand Total | 45 | 57 | 42 | |

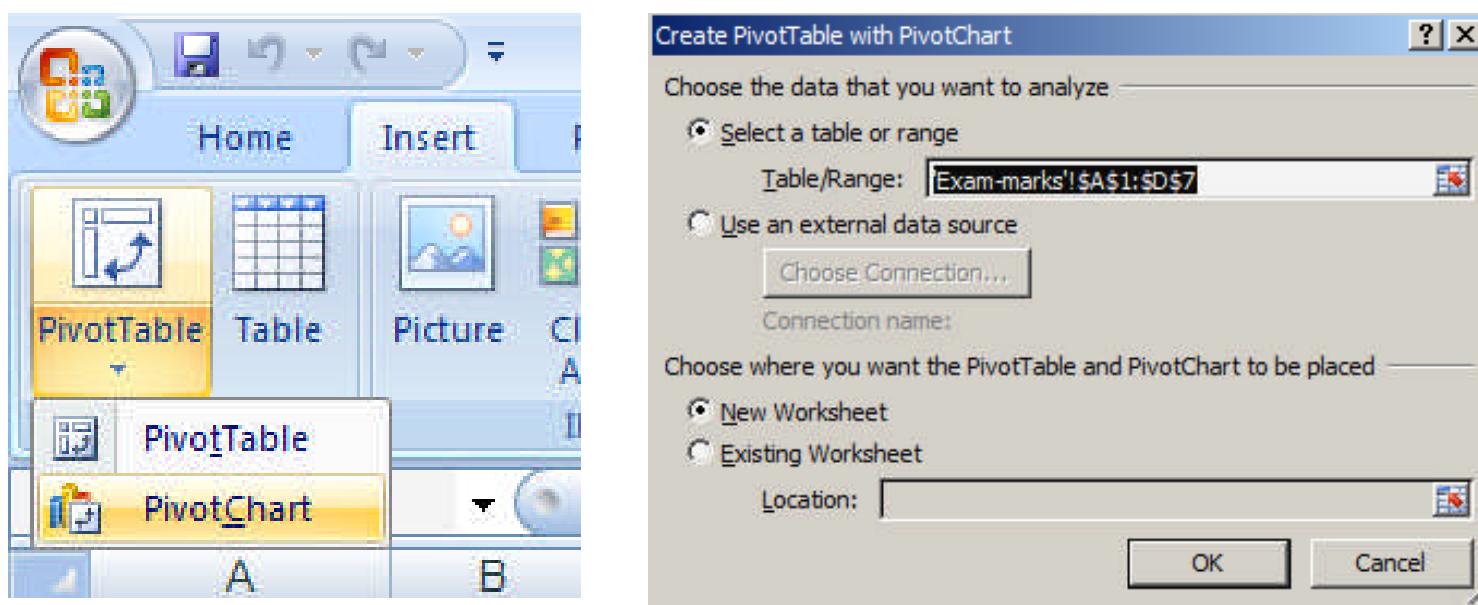


Excel 2007

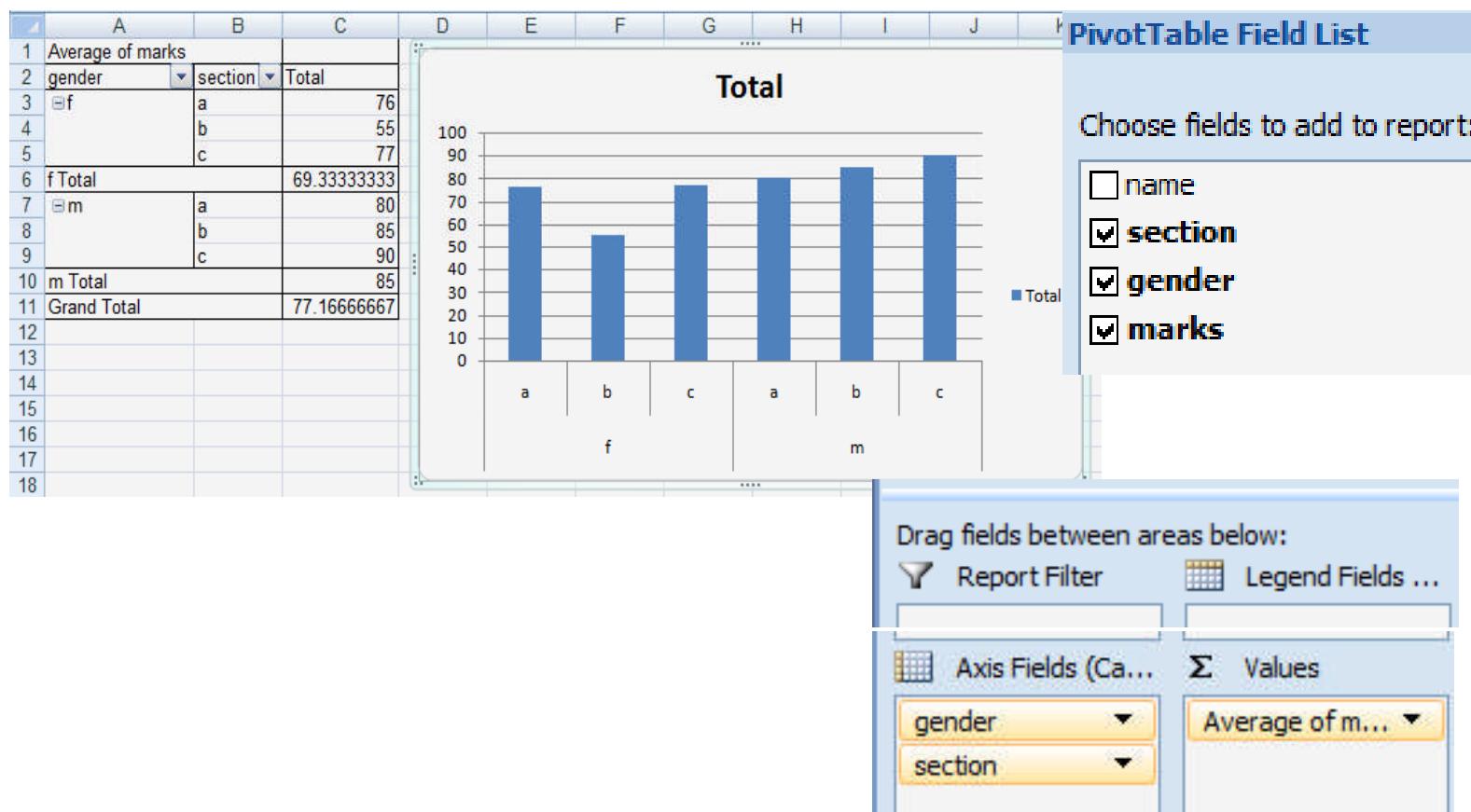
Pivot Chart in Excel

Pivot Chart

Select Data > Insert > Pivot > PivotChart >
NewWorksheet > OK



Pivot Chart to Make



Pivot table for sales data

- Google > JKSHIM Critical Thinking

Google jkshim Critical thinking

Critical Thinking - jkshim - Google Sites
<https://sites.google.com/site/jkshimcriticalthinking/notes>
15 Dec 2013 - jkshim. Search this site. Listen to the rain. **Critical Thinking**. Critical Thinking. Č. Updating... Č. ct-2013.pdf. (5827k). Mosh Mosh.,.

jkshim

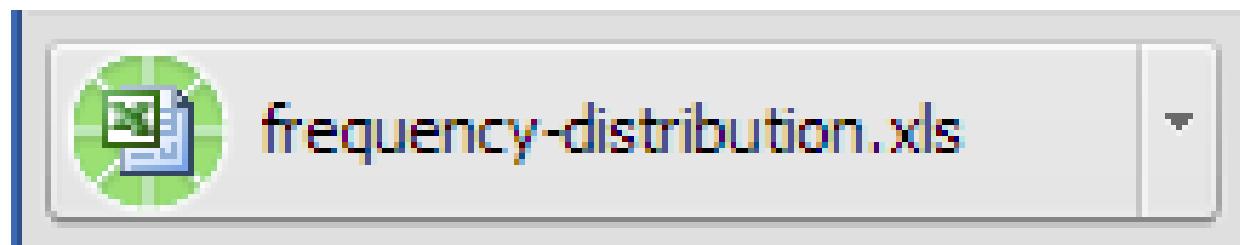
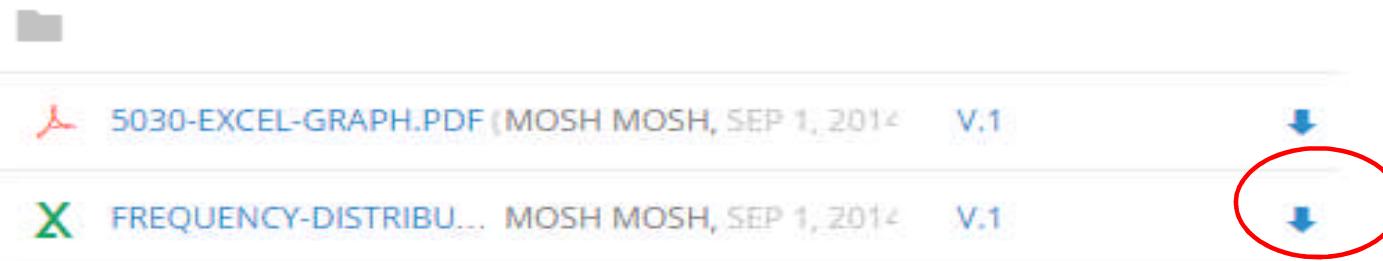
LISTEN TO THE RAIN
CRITICAL THINKING
EXCEL
SITEMAP

Critical Thinking

Download the xls file

<https://sites.google.com/site/jkshimcriticalthinking/excel>

download the xls file. and open it in excel

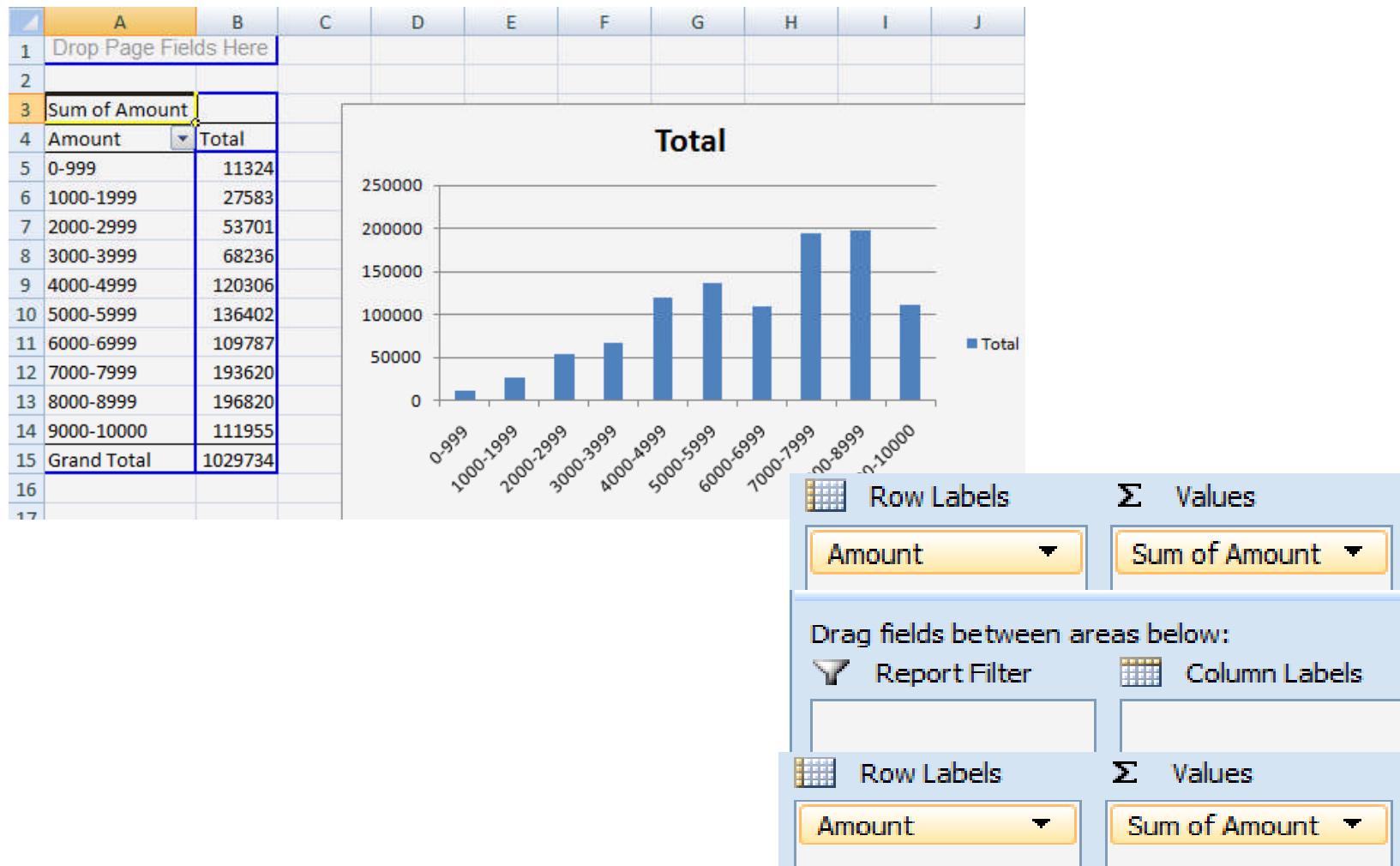


Open the pivot-table sheet

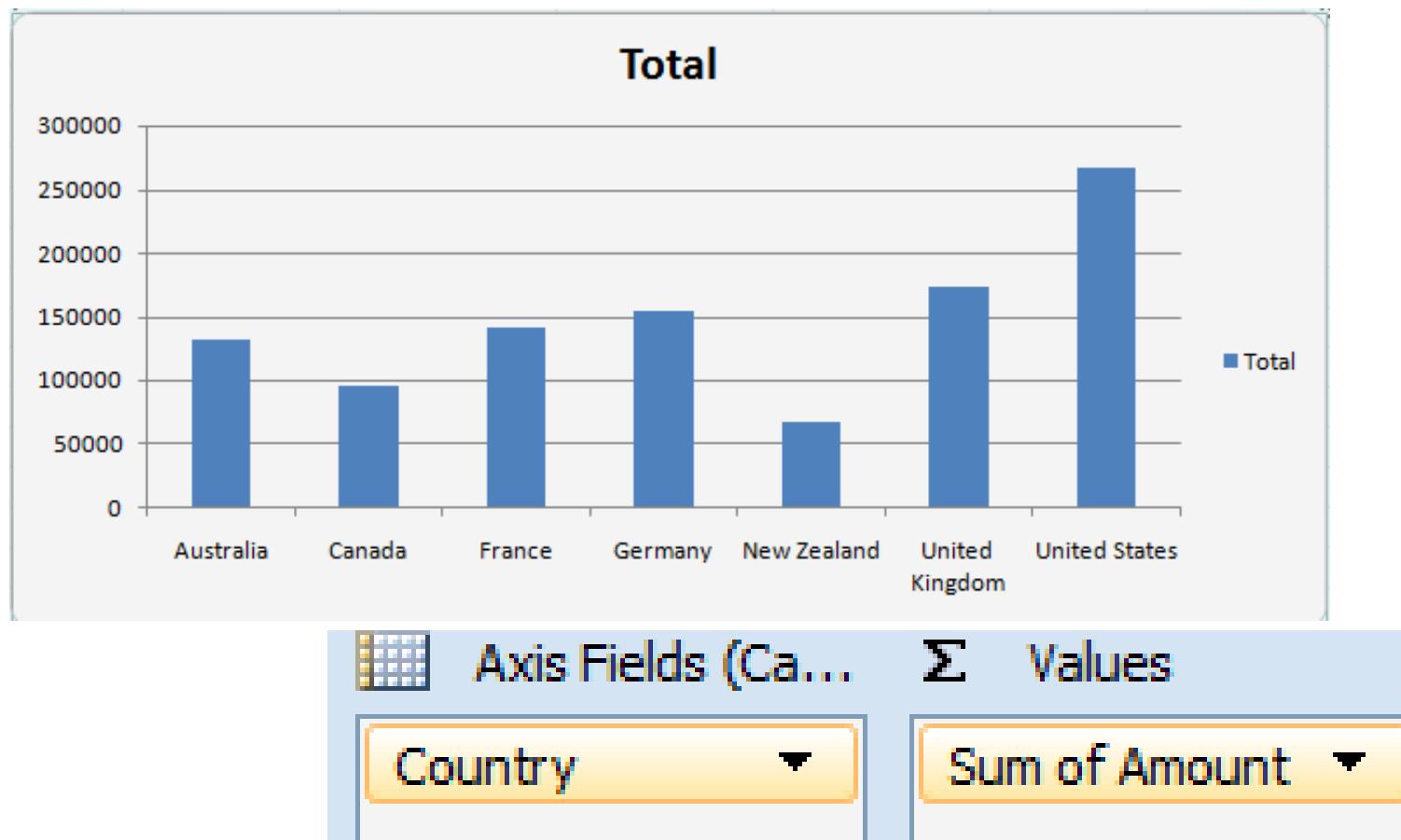
| 1 | A | B | C | D | E | F | |
|----|----------|----------|------------|---------|-----------|----------------|--|
| 1 | Order ID | Product | Category | Amount | Date | Country | |
| 2 | 1 | Carrots | Vegetables | \$4,270 | 1/6/2012 | United States | |
| 3 | 2 | Broccoli | Vegetables | \$8,239 | 1/7/2012 | United Kingdom | |
| 4 | 3 | Banana | Fruit | \$617 | 1/8/2012 | United States | |
| 5 | 4 | Banana | Fruit | \$8,384 | 1/10/2012 | Canada | |
| 6 | 5 | Beans | Vegetables | \$2,626 | 1/10/2012 | Germany | |
| 7 | 6 | Orange | Fruit | \$3,610 | 1/11/2012 | United States | |
| 8 | 7 | Broccoli | Vegetables | \$9,062 | 1/11/2012 | Australia | |
| 9 | 8 | Banana | Fruit | \$6,906 | 1/16/2012 | New Zealand | |
| 10 | 9 | Apple | Fruit | \$2,417 | 1/16/2012 | France | |
| 11 | 10 | Apple | Fruit | \$7,431 | 1/16/2012 | Canada | |
| 12 | 11 | Banana | Fruit | \$8,250 | 1/16/2012 | Germany | |

fruit-sales-data pivot-table Ready

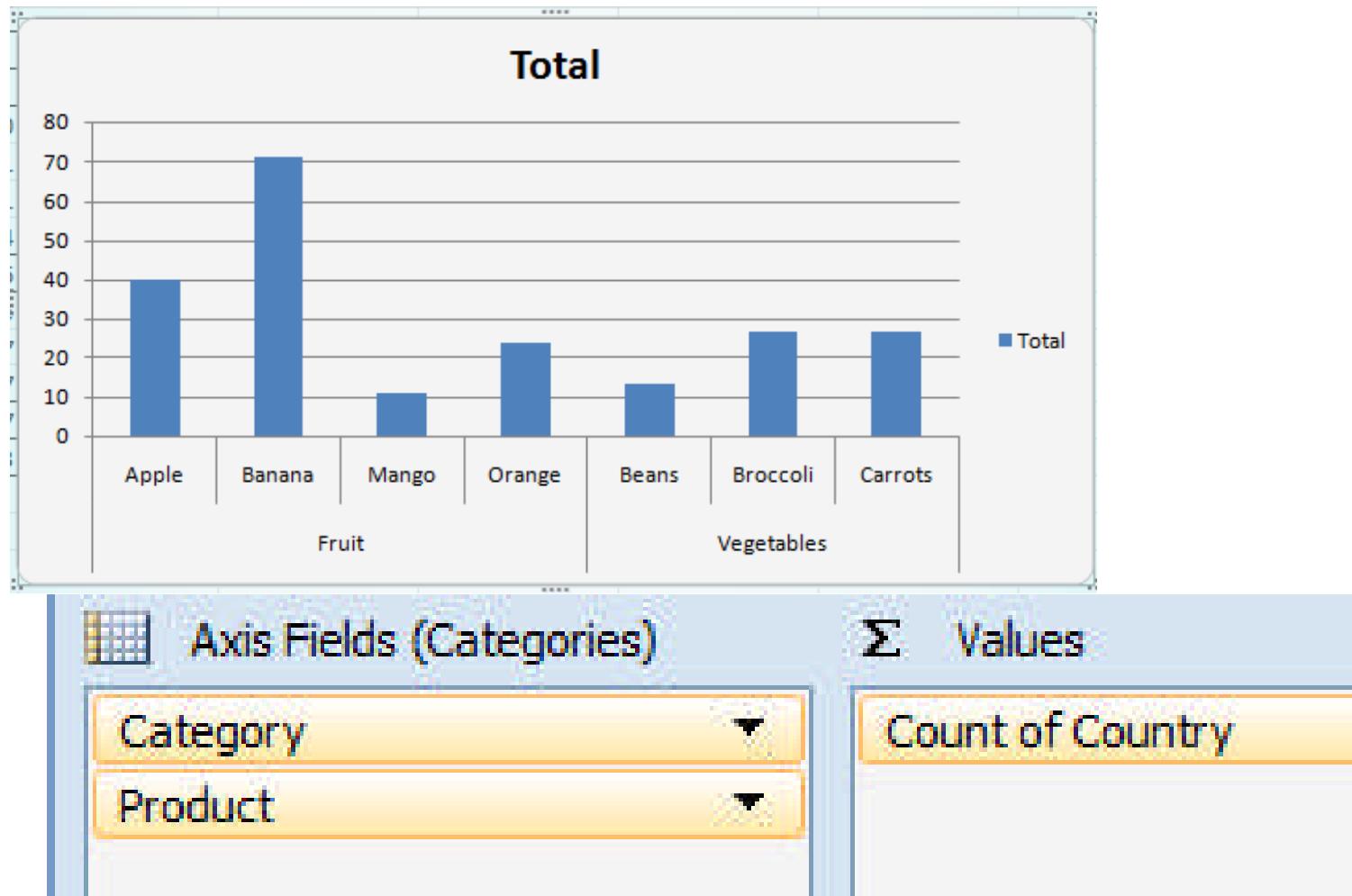
Pivot chart 1



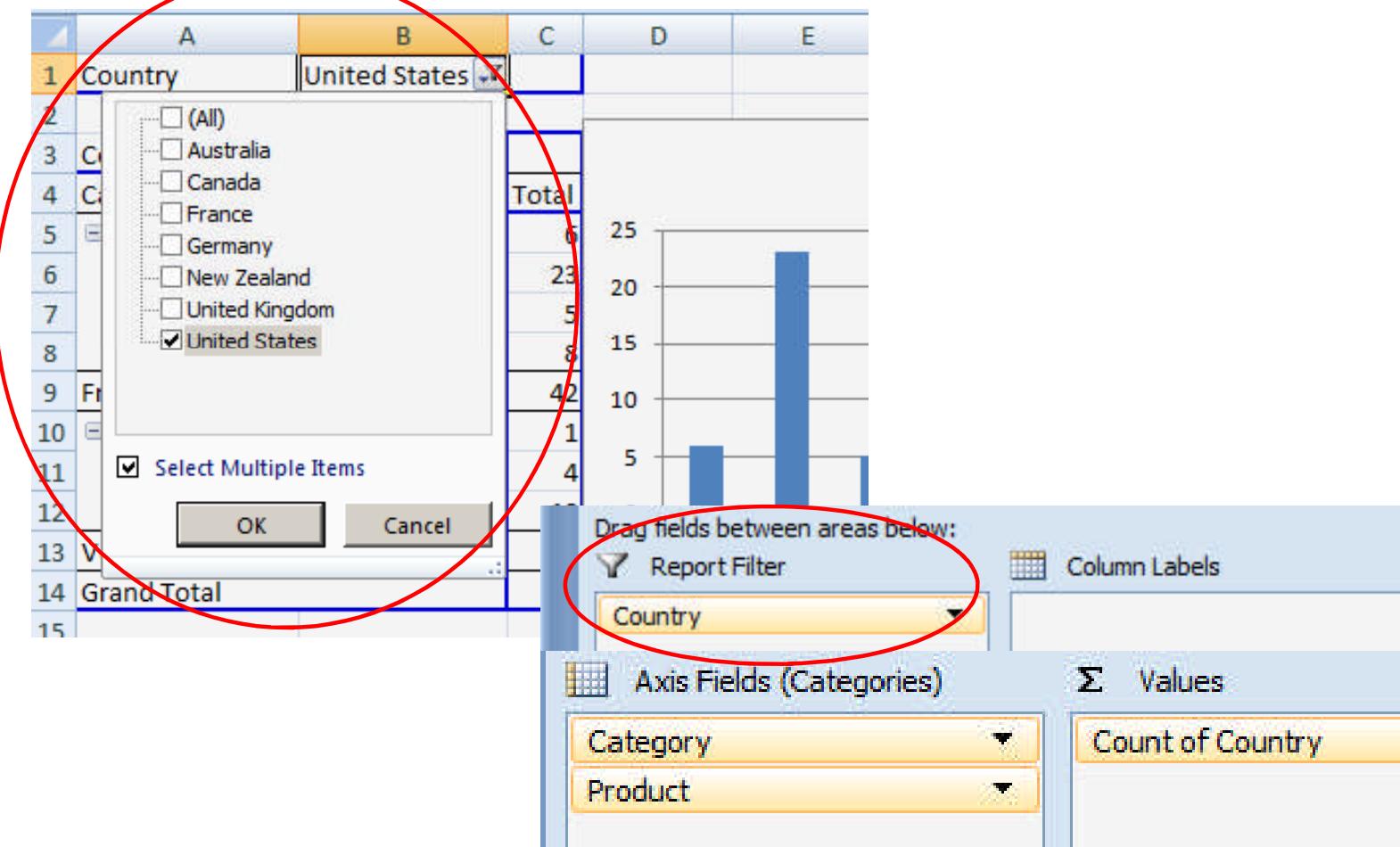
Make this pivot chart 2



Make this pivot chart 3



Make this pivot chart 4



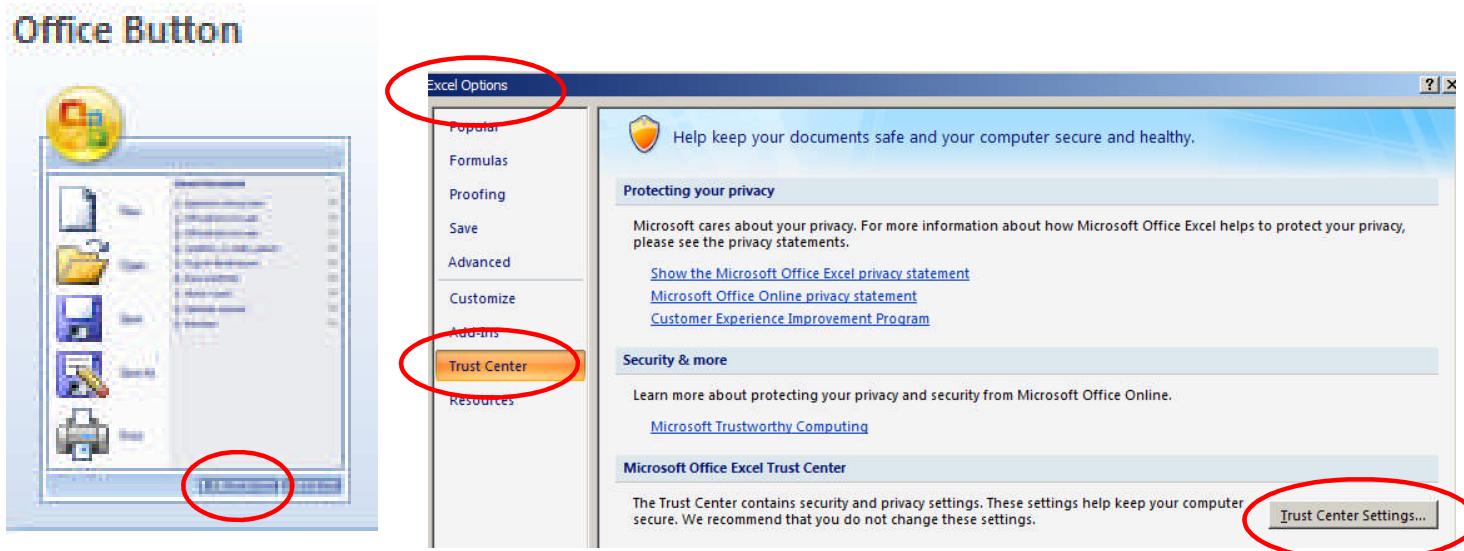


Microsoft Office
Excel 2007

Excel Macros

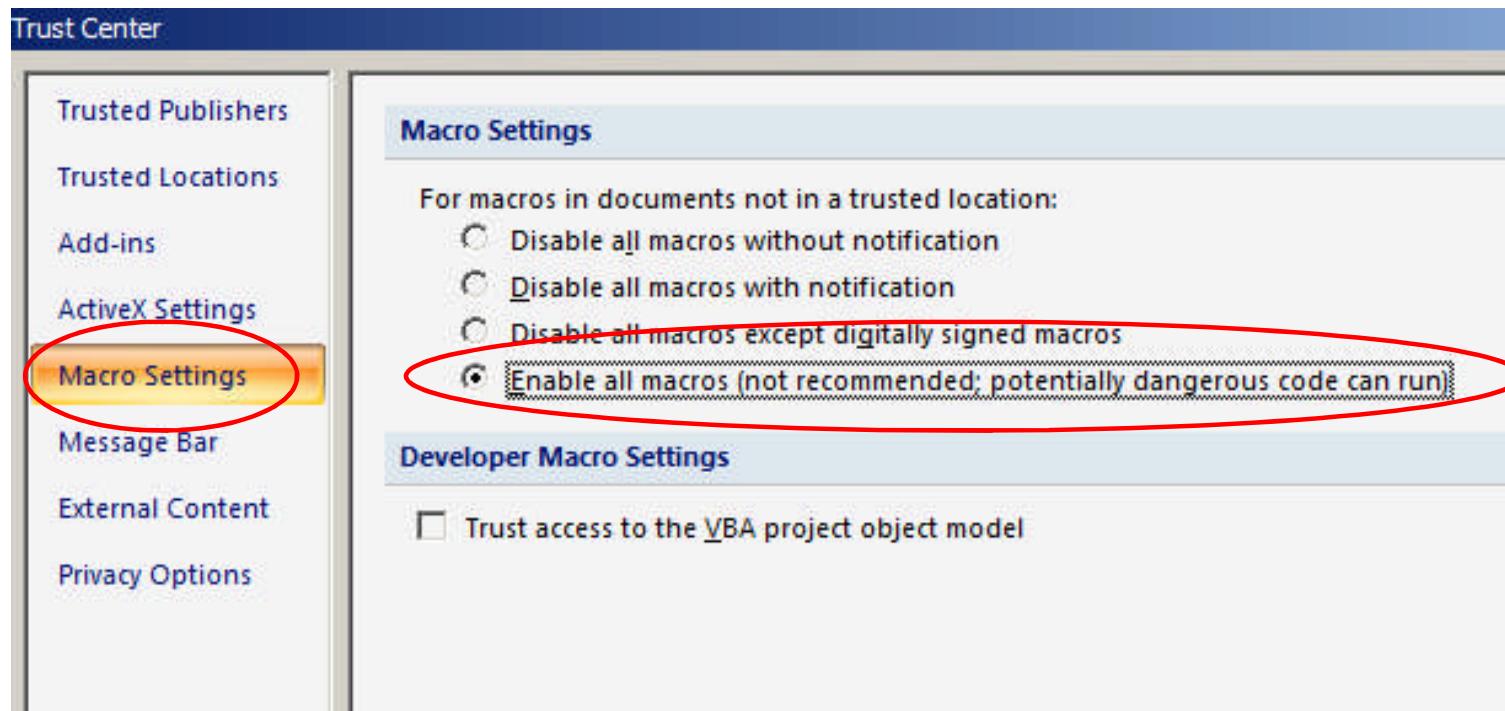
Macros

- Macros are disabled because of viruses can get into Excel.
- Office > Excel Options > Trust center > Trust center settings.



Enabling macros

- Office > options > Trust Center > Trust Center Settings > Macro settings



Create some data

| | A | B |
|---|------|-------|
| 1 | Name | Marks |
| 2 | A | 20 |
| 3 | B | 40 |
| 4 | C | 0 |

View > Macro > Record Macro

Select a cell to edit and record a macro:

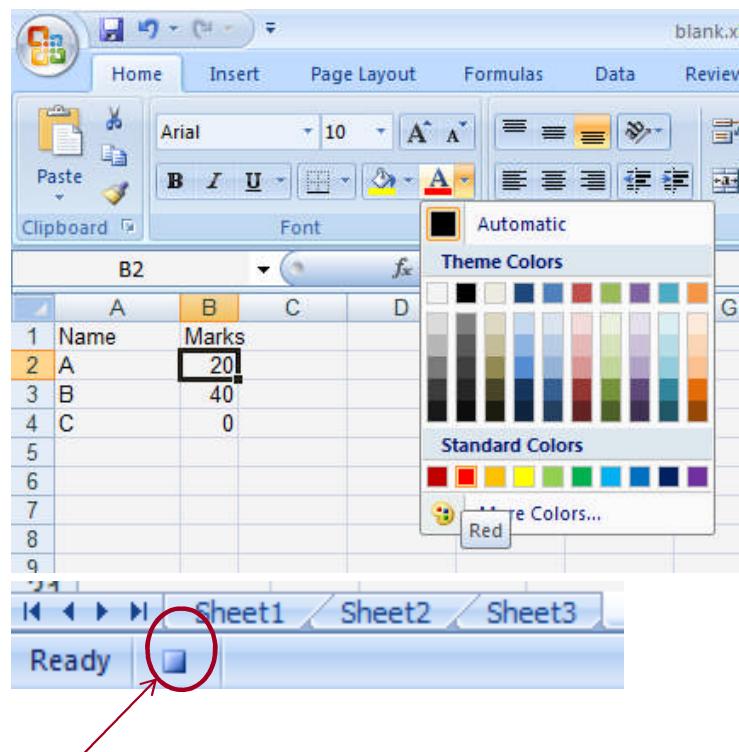
Specify [Control-K] as the shortcut key to run this macro.

The image shows two screenshots of Microsoft Excel. The left screenshot shows a spreadsheet with columns 'Name' and 'Marks'. Row 2 contains 'A' in column A and '20' in column B. The right screenshot shows the same spreadsheet with row 2 selected. A 'Record Macro' dialog box is open on the right, with the 'Macro name:' field set to 'Macro1' and the 'Shortcut key:' field set to 'Ctrl+k'. A red circle highlights the 'Ctrl+k' key combination. The status bar at the bottom of the left screenshot says: 'Record a macro. Each of the commands you perform will be saved into the macro so that you can play them back again.'

| | Name | Marks |
|---|------|-------|
| 1 | A | 20 |
| 2 | B | 40 |
| 3 | C | 0 |

| | A | B | C |
|----|------|-------|---|
| 1 | Name | Marks | |
| 2 | A | 20 | |
| 3 | B | 40 | |
| 4 | C | 0 | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |

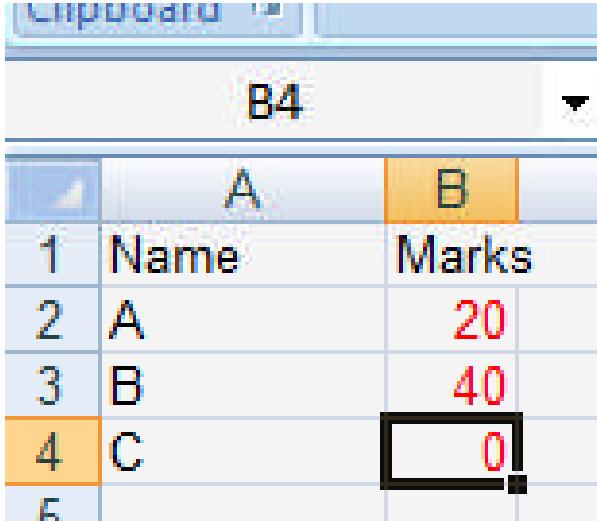
Make a number “RED” and then stop recording



Macro “Stop Recording button”

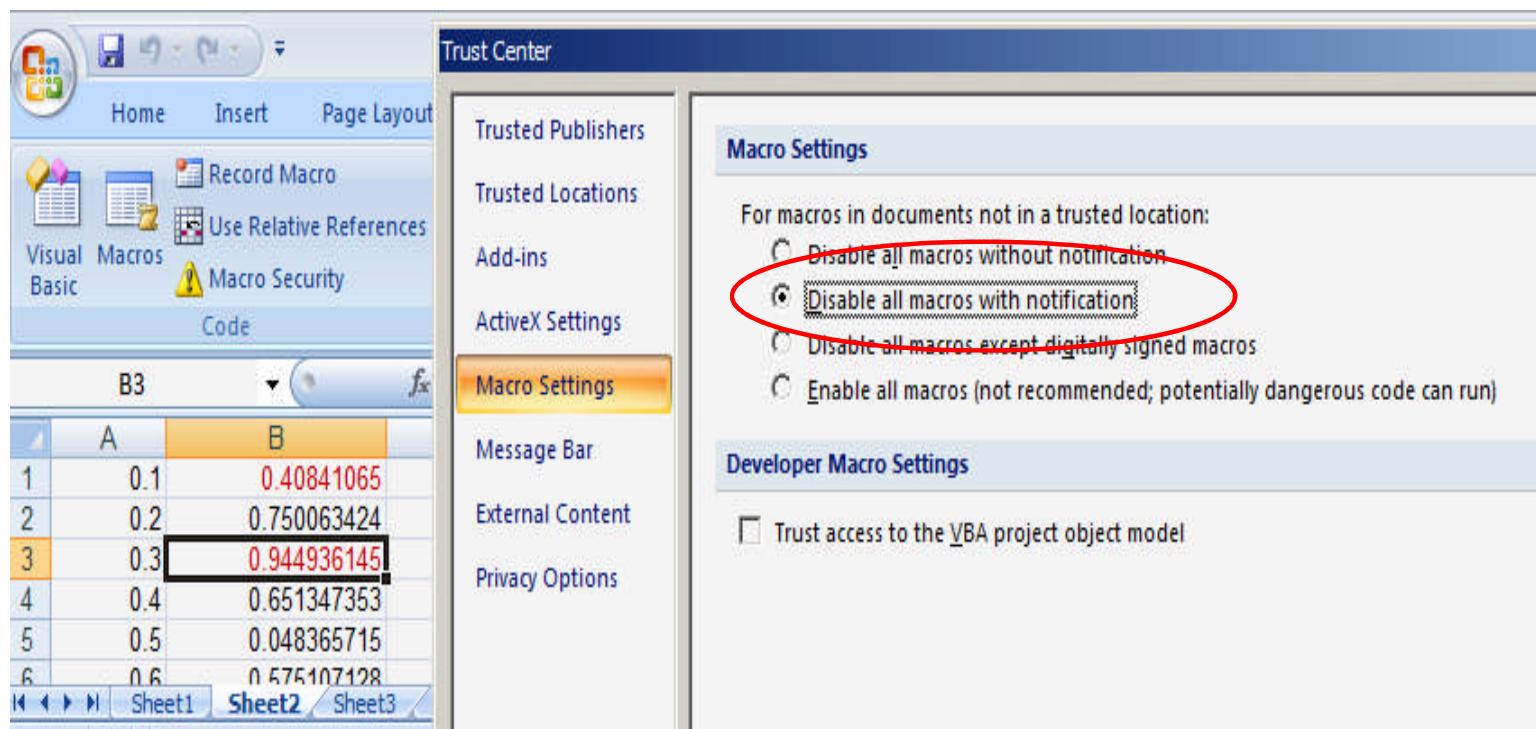
Use the macro

- Go to another cell and press Control-K, it should also become Red



| | A | B |
|---|------|-------|
| 1 | Name | Marks |
| 2 | A | 20 |
| 3 | B | 40 |
| 4 | C | 0 |
| 5 | | |

view > Macro Settings > Disable all macros with notification (to prevent viruses)



Microsoft Office
Excel 2003/2007



Excel Extra Topics

VLookUp

Vertical Lookup across tables

Exercise: create this data

| | A | B |
|---|------|-------|
| 1 | name | marks |
| 2 | Anil | 90 |
| 3 | Ball | 40 |
| 4 | Cat | 0 |

vlookup syntax

$=vlookup(key, matrix, value_col, exact)$

- Finds *key* in column 0 of matrix and returns corresponding value from matrix.
- e.g. Finds $matrix[0][key]$ using *exact* match and returns $matrix[value_col][key]$
- Limitations: key column must be before value column. Otherwise modify matrix columns.
- Better if Excel would let us specify both columns numbers: key and value:

$=vlookup(key, matrix, key_col, val_col, exact)$

Not possible in Excel, so use R

Example: vlookup Anil's marks

In B5, click on fx and type

'=vlookup("Anil", A2:B4, 2, FALSE)'

To vlookup marks of "Anil" in the matrix A2:B4,
get the marks from the 2nd column of matrix
and lastly 'FALSE' for exact match.

| | A | B | C |
|---|-----------------------------------|---|---|
| 1 | name | marks | |
| 2 | Anil | 20 | |
| 3 | Ball | 40 | |
| 4 | Cat | 0 | |
| 5 | =VLOOKUP("Anil", A2:B4, 2, FALSE) | 20 | |
| 6 | =A2 | = VLOOKUP([lookup_value], [table_array], [col_index_num], [range_lookup]) | |

Uses of vlookup?

- Merge two sheets by common column
- Example: Copy marks of Subject1 and Subject2 into MarksCard, merge using common roll number in all sheets (sql join):
e.g. =vlookup(roll2, sheet2!Marks, 2, FALSE)'

Tips

- To vlookup arg2 in different file:
arg2=[file.xls]sheet!cells
- Copy sheet into sheet with vlookup
- Copy and paste 'special values' to convert formula into numbers across files.

Another example: hourly rate

Hourly Pay:

| | A | B |
|---|---------------|-------------|
| 1 | Employee Name | Hourly Rate |
| 2 | Atkins, James | \$35.50 |
| 3 | Benn, Carol | \$25.00 |
| 4 | Benson, Paul | \$32.00 |
| 5 | Cooper, David | \$28.50 |
| 6 | Daley, Ann | \$41.00 |
| 7 | Dawson, Helen | \$32.00 |
| 8 | : | : |

Sales Team Hours Worked:

| | A | B | C | D |
|---|----------------|--------------|-------------|-------------|
| 1 | Employee Name | Hours Worked | Hourly Rate | Payment Due |
| 2 | Benson, Paul | 37.5 | | |
| 3 | Cooper, David | 40 | | |
| 4 | Dawson, Helen | 39 | | |
| 5 | Evans, Robin | 25 | | |
| 6 | Gee, Louise | 38 | | |
| 7 | Jones, Michael | 20 | | |
| 8 | : | : | | |

Sales Team Hours Worked with Vlookup Functions:

| | A | B | C | D | E |
|---|---------------|--------------|--|-------------|---|
| 1 | Employee Name | Hours Worked | Hourly Rate | Payment Due | |
| 2 | Benson, Paul | 37.5 | =VLOOKUP(A2, 'Hourly Pay'!A:B, 2, FALSE) | | |
| 3 | Cooper, David | 40 | =VLOOKUP(A3, 'Hourly Pay'!A:B, 2, FALSE) | | |
| 4 | Dawson, Helen | 39 | =VLOOKUP(A4, 'Hourly Pay'!A:B, 2, FALSE) | | |
| 5 | : | : | | | |

Vlookup Example Explained

The first call to the Vlookup function, in C2 is:

=VLOOKUP(A2, 'Hourly Pay'!A:B, 2, FALSE)

The table below explains the arguments that are supplied to this function:

| | |
|------------------|--|
| A2 | - Cell A2 is the <i>lookup_value</i> (i.e. the value to be searched for). The <i>lookup_value</i> is therefore the text string "Benson, Paul". |
| 'Hourly Pay'!A:B | - The <i>table_array</i> is made up of columns A-B of the "Hourly Pay" spreadsheet. The Vlookup function will search down the leftmost column (i.e. column A) of this array, when searching for the text string "Benson, Paul". |
| 2 | - This argument tells the function that the value to be returned should be taken from column 2 of the supplied <i>table_array</i> (i.e. from column B of the "Hourly Pay" spreadsheet). |
| FALSE | - This tells the Vlookup function that we require an <i>exact</i> match to the <i>lookup_value</i> . If an exact match is not found, then the Vlookup function should return an error. |

From: <http://www.excelfunctions.net/Vlookup-Example-Closest-Match.html>

Nearest match example

Interest Rates:

| | A | B | C |
|---|---------------|---------------|---------------|
| 1 | Lower Balance | Upper Balance | Interest Rate |
| 2 | \$0.00 | \$999.99 | 2% |
| 3 | \$1,000.00 | \$4,999.99 | 3% |
| 4 | \$5,000.00 | \$19,999.99 | 4% |
| 5 | \$20,000.00 | | 5% |

Bank Accounts:

| | A | B | C |
|---|--------------|-------------|---------------|
| 1 | Bank Account | Balance | Interest Rate |
| 2 | ABC-12345678 | \$5.69 | |
| 3 | DEF-23456789 | \$55,220.00 | |
| 4 | GHI-34567890 | \$4,500.00 | |
| 5 | : | : | : |

Bank Accounts spreadsheet with Vlookup functions:

| | A | B | C | D | E | F |
|---|--------------|-------------|---|---|---|---|
| 1 | Bank Account | Balance | Interest Rate | | | |
| 2 | ABC-12345678 | \$5.69 | =VLOOKUP(B2, 'Interest Rates'!A2:C5, 3, TRUE) | | | |
| 3 | DEF-23456789 | \$55,220.00 | =VLOOKUP(B3, 'Interest Rates'!A2:C5, 3, TRUE) | | | |
| 4 | GHI-34567890 | \$4,500.00 | =VLOOKUP(B4, 'Interest Rates'!A2:C5, 3, TRUE) | | | |
| 5 | : | : | | | | |

TRUE  Tells the Vlookup function that we require a closest match to the lookup_value.

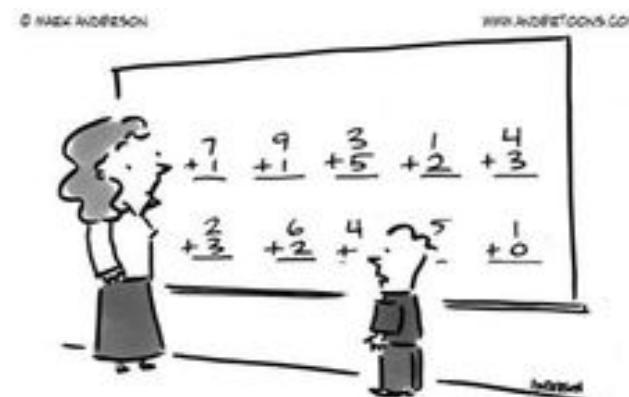
i.e. if an exact match is not found, then use the closest value below the lookup_value.

Note that this value could have been omitted from the above formula as, by default, it takes on the value TRUE.

Microsoft Office
Excel 2003/2007



Advanced Statistics with Microsoft Excel



"All I'm saying is we plug these into Excel, let it do its thing, and then we can all play until lunch!"

Agenda

1. Install Addins
2. Descriptive statistics
3. Histogram of average with a chart
4. Frequency computation

Excel 2007: Install Addins



Office

> Excel

Options

> Addins

Excel Options

Popular
Formulas
Proofing
Save
Advanced
Customize
Add-ins
Trust Center
Resources

Add-ins

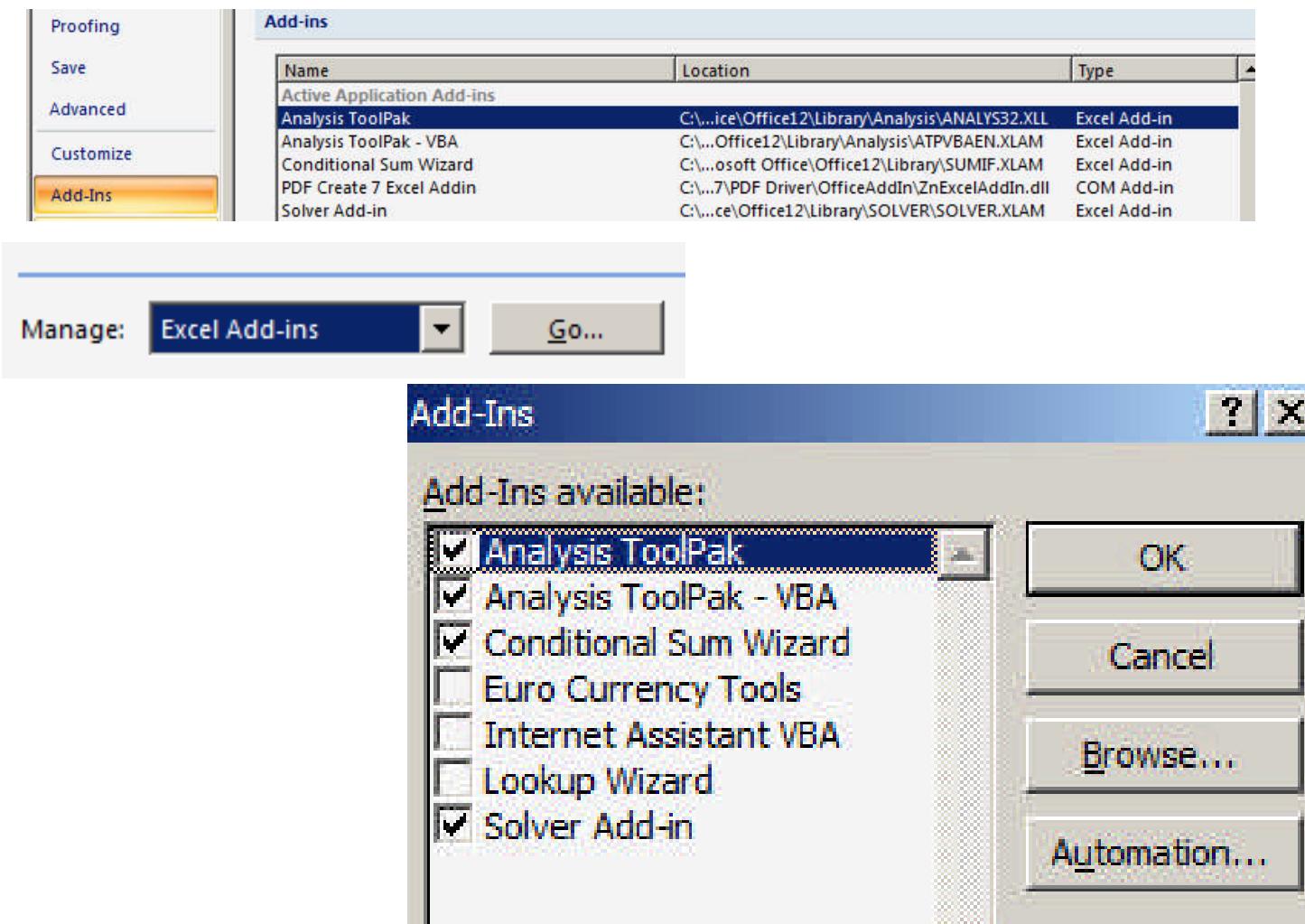
| Name | Location | Type |
|---|--|--------------------|
| Active Application Add-ins | | |
| Analysis ToolPak | C:\...ice\Office12\Library\Analysis\ANALYS32.XLL | Excel Add-in |
| Analysis ToolPak - VBA | C:\...Office12\Library\Analysis\ATPVBAEN.XLAM | Excel Add-in |
| Conditional Sum Wizard | C:\...soft Office\Office12\Library\SUMIF.XLAM | Excel Add-in |
| PDF Create 7 Excel Addin | C:\...7\PDF Driver\OfficeAddin\ZnExcelAddin.dll | COM Add-in |
| Solver Add-in | C:\...ce\Office12\Library\SQLVER\SQLVER.XLAM | Excel Add-in |
| Inactive Application Add-ins | | |
| Custom XML Data | C:\...6\Microsoft Office\Office12\OFFRHD.DLL | Document Inspector |
| Date (Smart tag lists) | C:\...iles\microsoft shared\Smart Tag\MOFL.DLL | Smart Tag |
| Euro Currency Tools | eurotool.xlam | Excel Add-in |
| Financial Symbol (Smart tag lists) | C:\...iles\microsoft shared\Smart Tag\MOFL.DLL | Smart Tag |
| Headers and Footers | C:\...6\Microsoft Office\Office12\OFFRHD.DLL | Document Inspector |
| Hidden Rows and Columns | C:\...6\Microsoft Office\Office12\OFFRHD.DLL | Document Inspector |
| Hidden Worksheets | C:\...6\Microsoft Office\Office12\OFFRHD.DLL | Document Inspector |
| Internet Assistant VBA | C:\...rosoft Office\Office12\Library\HTMLXLAM | Excel Add-in |
| Invisible Content | C:\...6\Microsoft Office\Office12\OFFRHD.DLL | Document Inspector |
| Lookup Wizard | lookup.xlam | Excel Add-in |
| Person Name (Outlook e-mail recipients) | C:\...es\microsoft shared\Smart Tag\FNAME.DLL | Smart Tag |
| Zeon Excel Addin | | COM Add-in |
| Document Related Add-ins | | |
| No Document Related Add-ins | | |

Add-in: Analysis ToolPak
Publisher: Microsoft Corporation
Location: C:\Program Files (x86)\Microsoft Office\Office12\Library\Analysis\ANALYS32.XLL

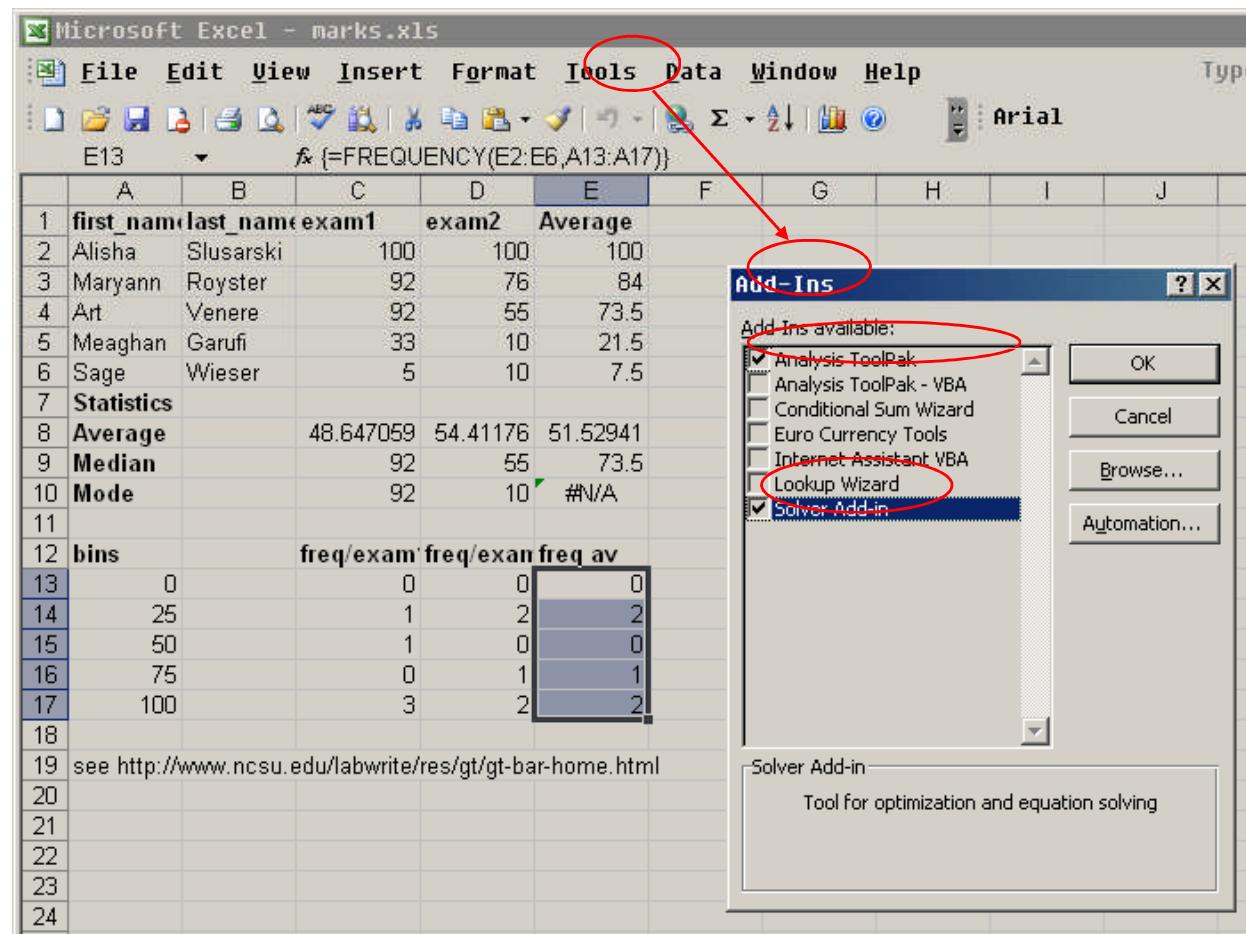
Description: Provides data analysis tools for statistical and engineering analysis

Manage: Excel Add-ins Go... OK Cancel

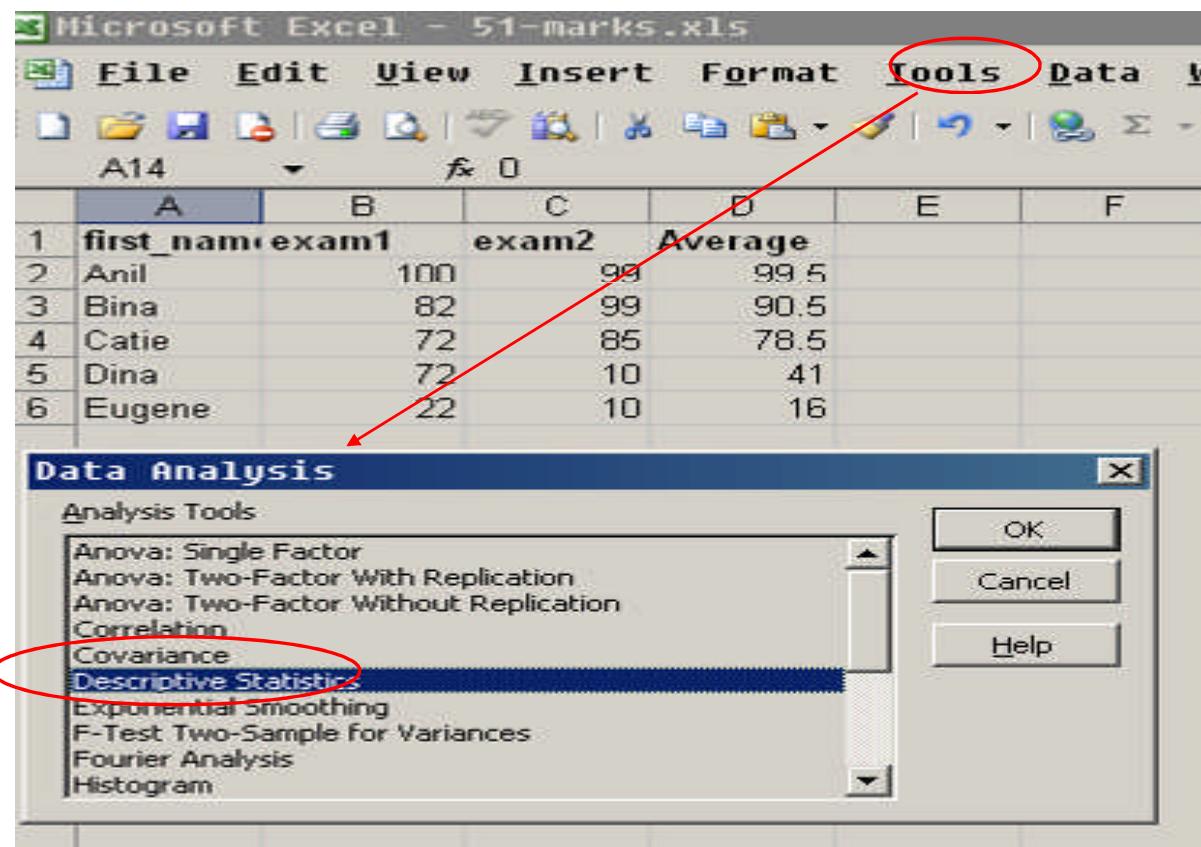
Addins to Install



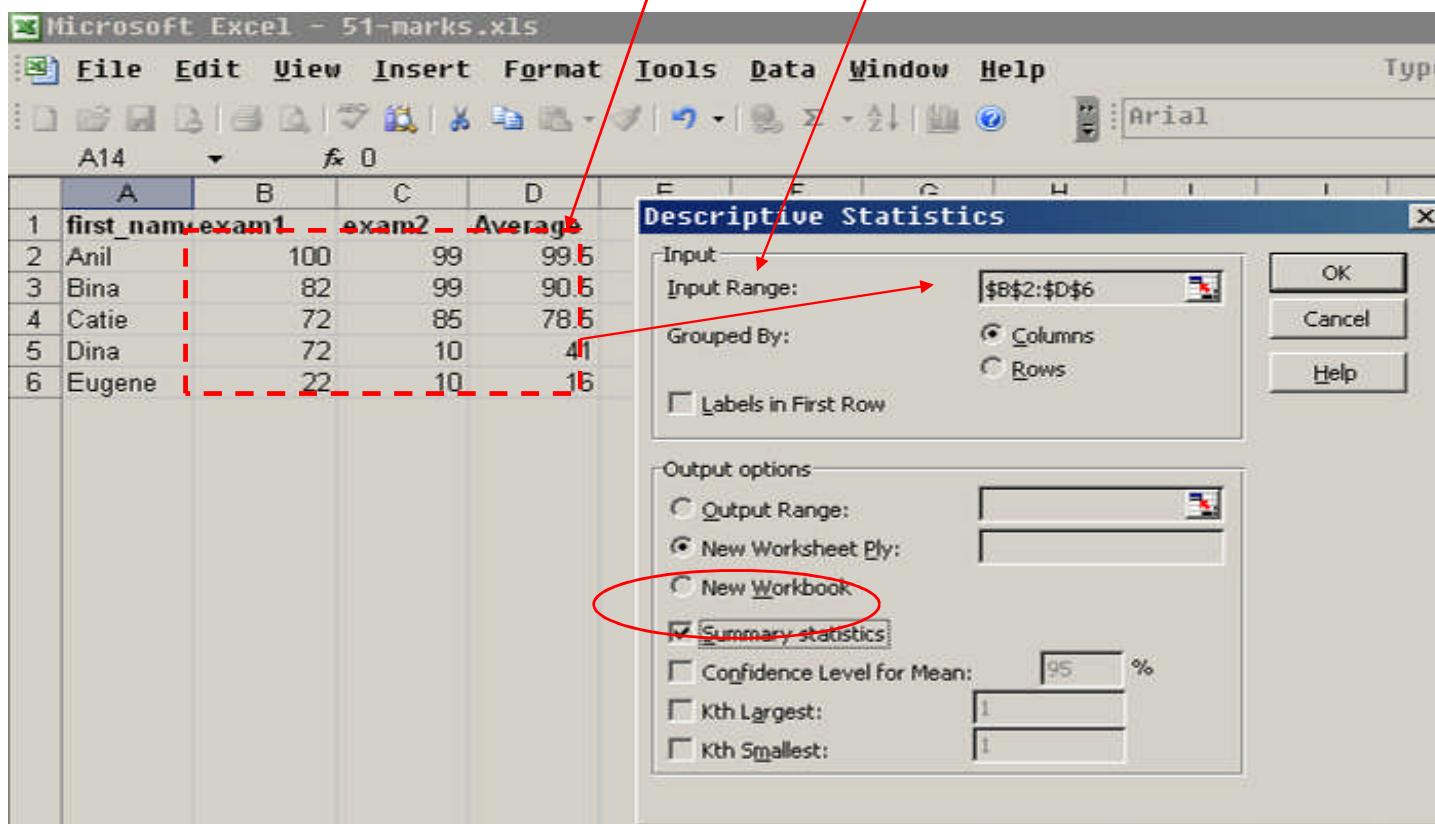
Excel 2003: Install: Tools > Add-Ins
 > Analysis & Solver ..



Tools > Data Analysis > Descriptive Statistics



Put cursor in Input Range and
Select the rectangle of data



Result sheet of "Descriptive statistics"

| | A | B | C | D | E | F |
|----|-----------------------|----------|-----------------------|----------|-----------------------|----------|
| 1 | Column1 | | Column2 | | Column3 | |
| 2 | | | | | | |
| 3 | Mean | 69.6 | Mean | 60.6 | Mean | 65.1 |
| 4 | Standard E | 12.95222 | Standard E | 20.8149 | Standard E | 15.81091 |
| 5 | Median | 72 | Median | 85 | Median | 78.5 |
| 6 | Mode | 72 | Mode | 99 | Mode | #N/A |
| 7 | Standard C | 28.96204 | Standard C | 46.54353 | Standard C | 35.35428 |
| 8 | Sample V _s | 838.8 | Sample V _s | 2166.3 | Sample V _s | 1249.925 |
| 9 | Kurtosis | 2.680026 | Kurtosis | -3.25502 | Kurtosis | -1.6007 |
| 10 | Skewness | -1.33475 | Skewness | -0.54274 | Skewness | -0.68706 |
| 11 | Range | 78 | Range | 89 | Range | 83.5 |
| 12 | Minimum | 22 | Minimum | 10 | Minimum | 16 |
| 13 | Maximum | 100 | Maximum | 99 | Maximum | 99.5 |
| 14 | Sum | 348 | Sum | 303 | Sum | 325.5 |
| 15 | Count | 5 | Count | 5 | Count | 5 |

Range of data

- Range is a measure of dispersion. It is simple the difference between the largest and smallest value
- $= \max(\text{RANGE}) - \min(\text{RANGE})$.

Median

- The median is another measure of central tendency. To get the median you have to order the data from lowest to highest. The median is the number in the middle.
- If the number of cases is odd the median is the single value, for an even number of cases the median is the average of the two numbers in the middle.
- Excel: =MEDIAN(RANGE)

Mode

- The mode refers to the most frequent, repeated or common number in the data. By age there are more students 19 years old in the sample than any other group. If all values are unique, there is no mode: #N/A.
- Excel: =MODE(RANGE)

Sample Variance (SV)

- The sample variance measures the dispersion of the data from the mean. It is the simple mean of the squared distance from the mean:
- $SV = \text{sum}(\text{sqr}(X - \text{mean of } X)) / (N-1)$
- Excel: VAR(RANGE)

Standard deviation (SD)

- The standard deviation is the squared root of the variance. Indicates how far-spread the data is from the mean.
- In a normal distribution, 68% of the values are within 1 sd from the mean, 95% within 2 sd and 99% within 3 sd.
- Excel =STDEV(range of cells with the values of interest)

Skewness

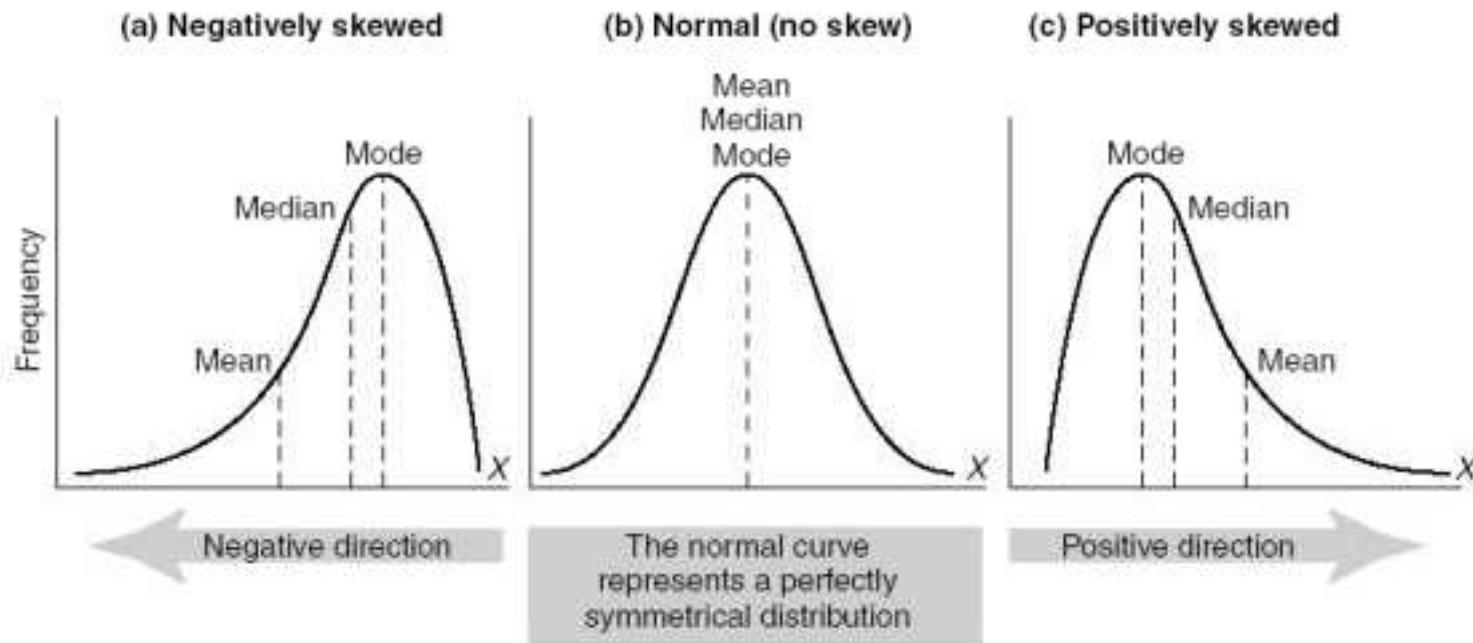


FIGURE 15.6 Examples of normal and skewed distributions

Skewness

- Skewness measures the asymmetry of the data, when in an otherwise normal curve one of the tails is longer than the other.
 - Skew = 0, is a normal distribution.
 - Skew > 0, if there is more data on the left side of the curve (right skewed, the median and the mode are lower than the mean).
 - Skew < 0, indicates that the mass of the data is concentrated on the right of the curve (left tail is longer, left skewed, the median and the mode are higher than the mean).
- Excel: =SKEW(RANGE)

Kurtosis

- Kurtosis measures the peak of the distribution. It is also an indicator of normality.
 - Positive kurtosis indicates too few cases in the tails or a tall distribution (leptokurtic),
 - Negative kurtosis too many cases in the tails or a flat distribution (platykurtic).
 - A normal distribution has a kurtosis of 0 (given a correction of -3, otherwise it will have a kurtosis of 3).
- Excel =KURT(RANGE).

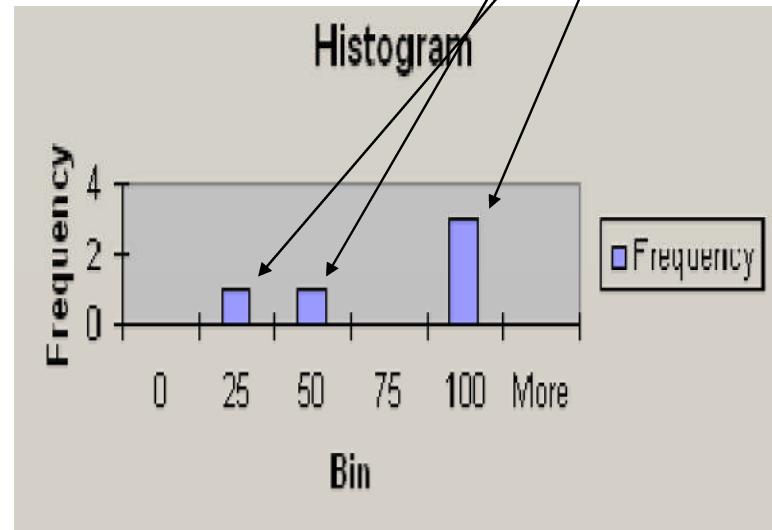


Histogram of Frequency Distribution in Excel

Histogram example

- Here Histogram shows how the average marks were distributed:
 - 3 people got marks in 75-100 range.
 - 1 person got between 25-50.
 - 1 person got between 0-25 range.

| A | B | C | D | E | |
|---|------------|-------|-------|---------|--|
| 1 | first_name | exam1 | exam2 | Average | |
| 2 | Anil | 100 | 99 | 99.5 | |
| 3 | Bina | 82 | 99 | 90.5 | |
| 4 | Catie | 72 | 85 | 78.5 | |
| 5 | Dina | 72 | 10 | 41 | |
| 6 | Eugene | 22 | 10 | 16 | |



Put cursor in Input Range and
Select the rectangle of data

The screenshot shows a Microsoft Excel window titled "Microsoft Excel - 51-marks.xls". The menu bar includes File, Edit, View, Insert, Format, Tools, Data, Window, and Help. The ribbon shows icons for various functions. The active cell is A14. The data table has columns labeled "first_name", "exam1", "exam2", and "Average". The "Input Range" in the "Descriptive Statistics" dialog box is set to "\$B\$2:\$D\$6". The "Summary statistics" checkbox is checked. Red arrows point from the text instructions above to the "Input Range" field in the dialog and to the selected data range in the spreadsheet.

| | A | B | C | D |
|---|------------|-------|-------|---------|
| 1 | first_name | exam1 | exam2 | Average |
| 2 | Anil | 100 | 99 | 99.5 |
| 3 | Bina | 82 | 99 | 90.5 |
| 4 | Catie | 72 | 85 | 78.5 |
| 5 | Dina | 72 | 10 | 41 |
| 6 | Eugene | 22 | 10 | 16 |

Descriptive Statistics

Input Range: \$B\$2:\$D\$6

Grouped By: Columns

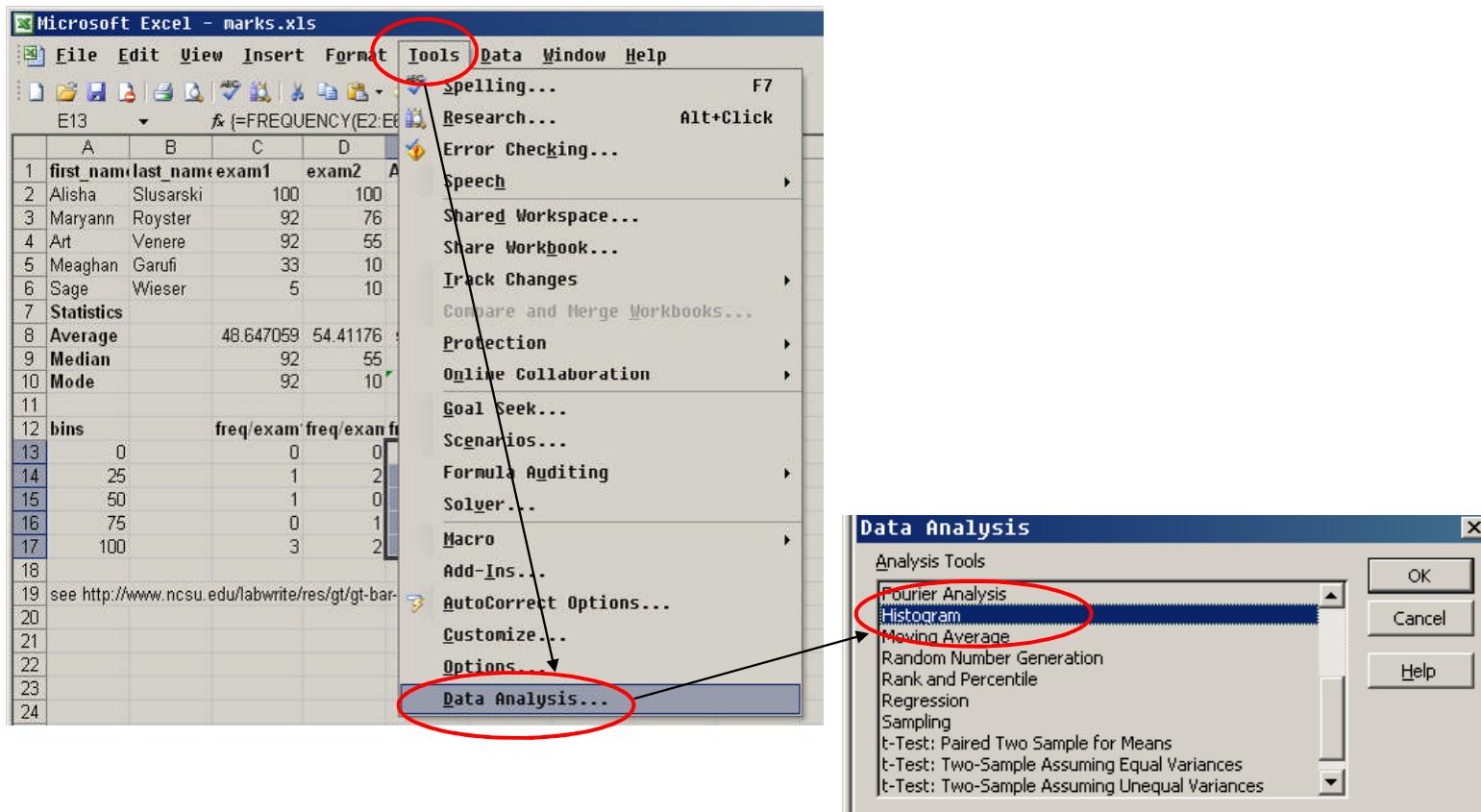
Labels in First Row

Output options

Summary statistics

OK Cancel Help

Tools > Data Analysis > Histogram



Create bins for histogram

Type into (A9:A13) =
[0,25,50,75,100]
OR

1. Type 0, 25,
2. Shift select both
3. Drag the black dot

| 14 | bins | freq |
|----|------|------|
| 15 | 0 | |
| 16 | 25 | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |

| 8 | bins |
|----|------|
| 9 | 0 |
| 10 | 25 |
| 11 | 50 |
| 12 | 75 |
| 13 | 100 |
| 14 | |
| 15 | |
| 16 | |
| 17 | |



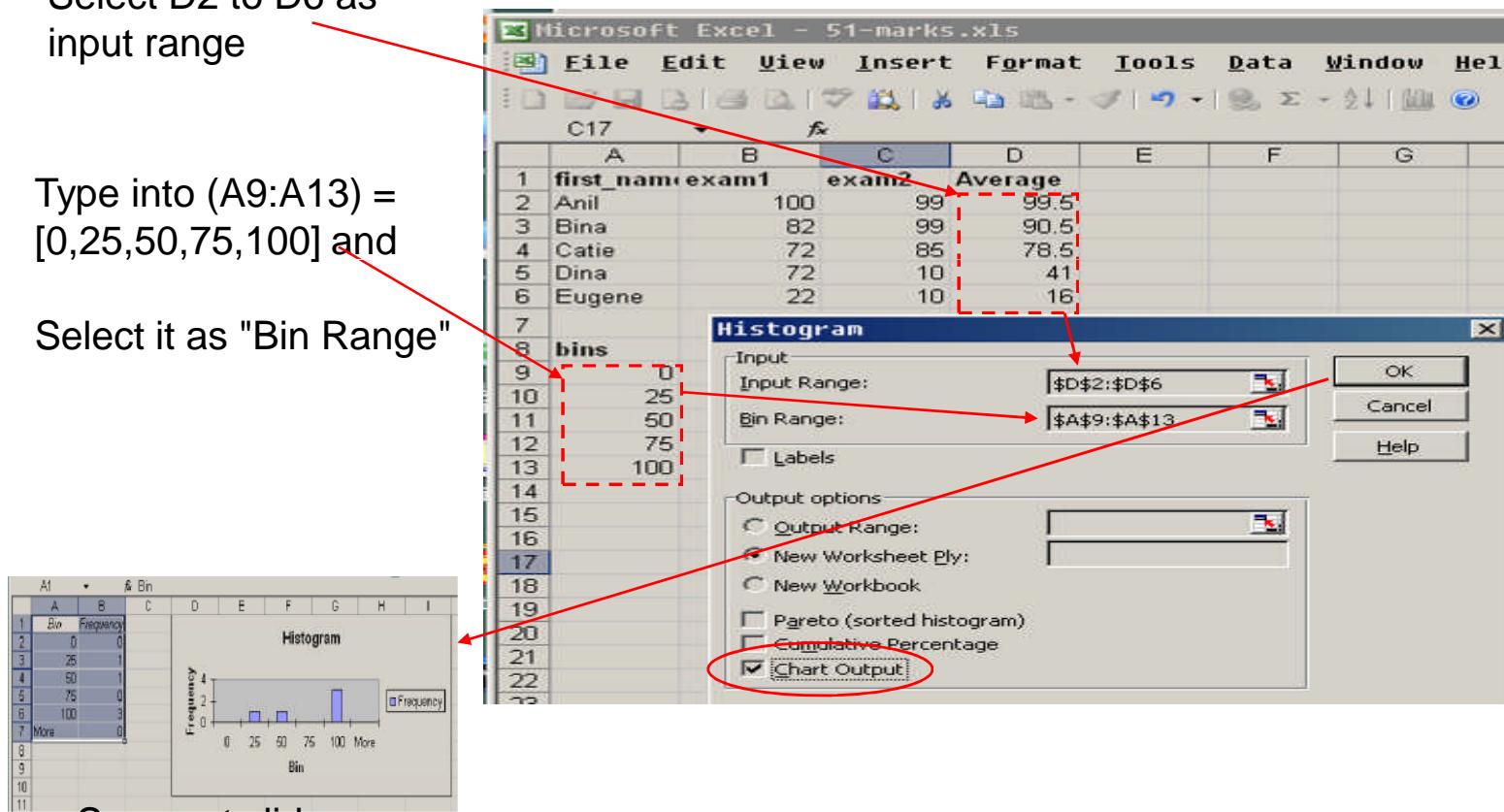
Example of bins for
Sorting things

Create the histogram

Select D2 to D6 as input range

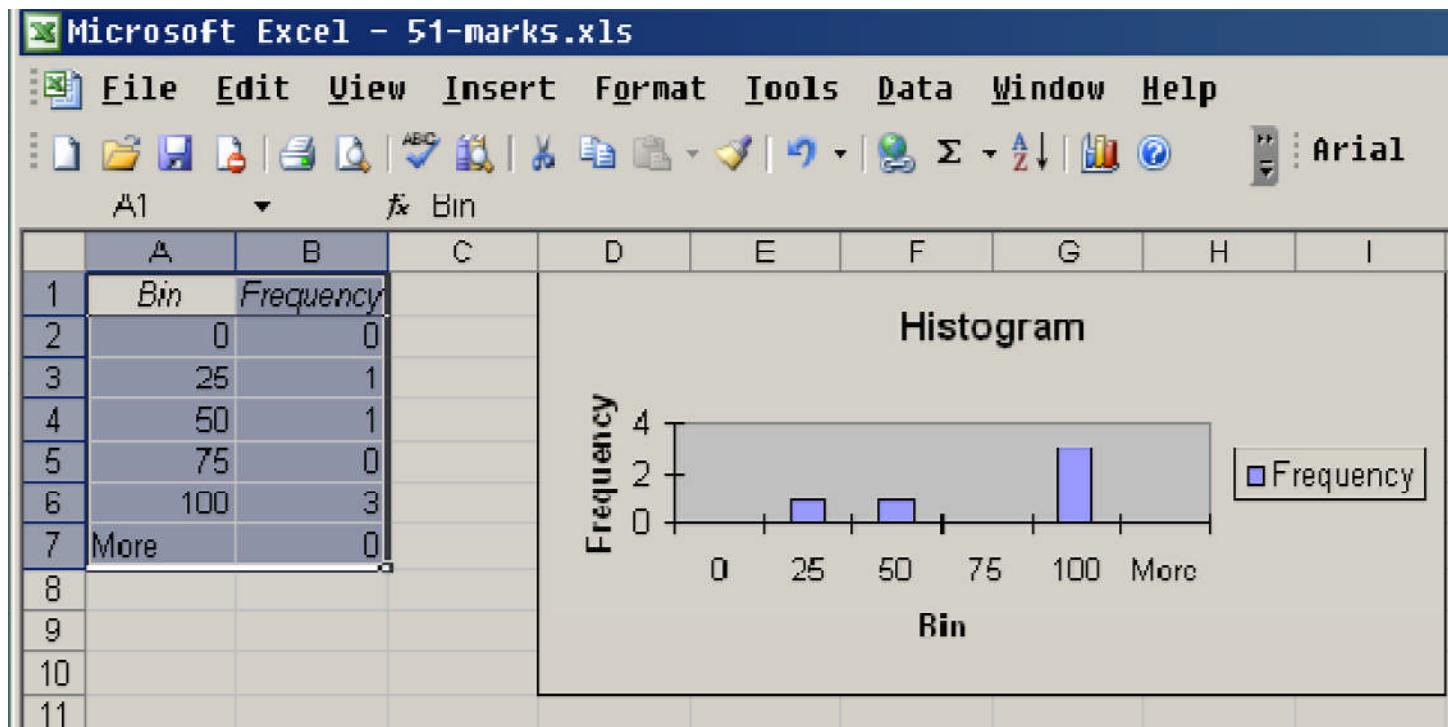
Type into (A9:A13) = [0,25,50,75,100] and

Select it as "Bin Range"



See next slide

Result of histogram of average column



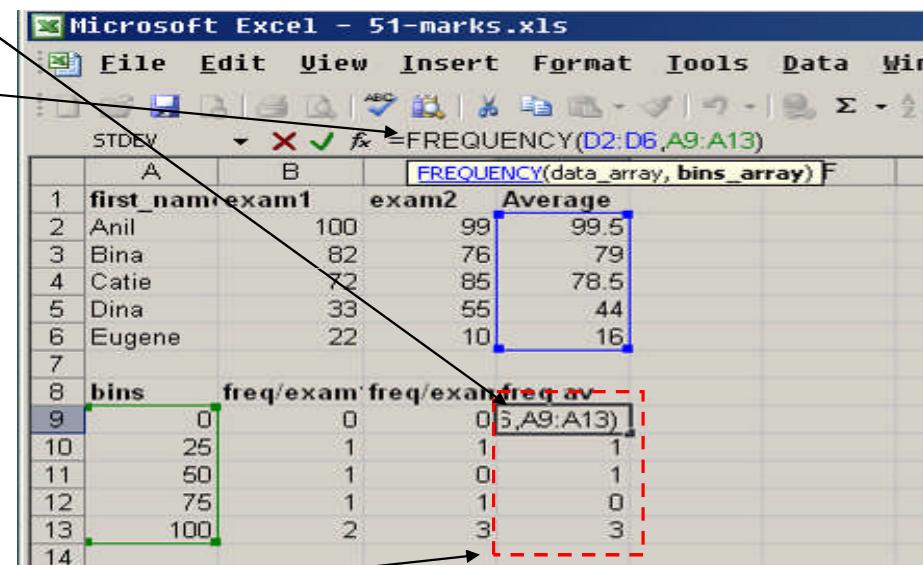
Array computation

- Example of using a function that returns an Array as it's result.

Frequency computation

1. Select cell D9,
to compute
 $Fx=Frequency($
 $D2:D6, A9:A13)$

2. Press
[Control-Shift-
Enter]
to compute
 $\{D9:D12\}$
automatically



The screenshot shows an Excel spreadsheet titled "Microsoft Excel - 51-marks.xls". The data consists of student names in column A, exam scores in columns B and C, and calculated average scores in column D. Row 8 contains the formula =FREQUENCY(D2:D6,A9:A13) in cell D9, which is highlighted with a blue border. Row 9 contains the bin values [0, 25, 50, 75, 100]. Row 10 contains the frequency counts for each bin: 0, 1, 1, 1, 2. A red dashed box highlights the range D9:D12, indicating the automatically filled array result.

| A | B | C | D |
|------------|------------|------------|----------|
| first_name | exam1 | exam2 | Average |
| Anil | 100 | 99 | 99.5 |
| Bina | 82 | 76 | 79 |
| Catie | 72 | 85 | 78.5 |
| Dina | 33 | 55 | 44 |
| Eugene | 22 | 10 | 16 |
| | | | |
| Bins | freq/exam1 | freq/exam2 | freq/avg |
| 0 | 0 | 0 | 0 |
| 25 | 1 | 1 | 1 |
| 50 | 1 | 0 | 1 |
| 75 | 1 | 1 | 0 |
| 100 | 2 | 3 | 3 |
| | | | |

Plot the data

B15 ▾ $\{=\text{FREQUENCY}(\text{B2:B6},\text{A15:A19})\}$

| | A | B | C | D |
|----|------------|------------|------------|----------|
| 1 | first_name | exam1 | exam2 | Average |
| 2 | Anil | 100 | 99 | 99.5 |
| 3 | Bina | 82 | 76 | 79 |
| 4 | Catie | 72 | 85 | 78.5 |
| 5 | Dina | 33 | 55 | 44 |
| 6 | Eugene | 22 | 10 | 16 |
| 7 | | | | |
| 8 | Statistics | | | |
| 9 | Average | 48.647059 | 54.41176 | 51.52941 |
| 10 | Median | 72 | 76 | 78.5 |
| 11 | Mode | #N/A | #N/A | #N/A |
| 12 | stddev | 33.108911 | 34.64823 | 33.15758 |
| 13 | | | | |
| 14 | bins | freq/exam1 | freq/exam2 | freq av |
| 15 | 0 | 0 | 0 | 0 |
| 16 | 25 | 1 | 1 | 1 |
| 17 | 50 | 1 | 0 | 1 |
| 18 | 75 | 1 | 1 | 0 |
| 19 | 100 | 2 | 3 | 3 |
| 20 | | | | |
| 21 | | | | |
| 22 | | | | |
| 23 | | | | |

Chart Wizard - Step 1 of 4 - Chart Type

Standard Types Custom Types

Chart type:

- Column
- Bar
- Line
- Pie
- XY (Scatter)
- Area
- Doughnut
- Radar
- Surface
- Bubble

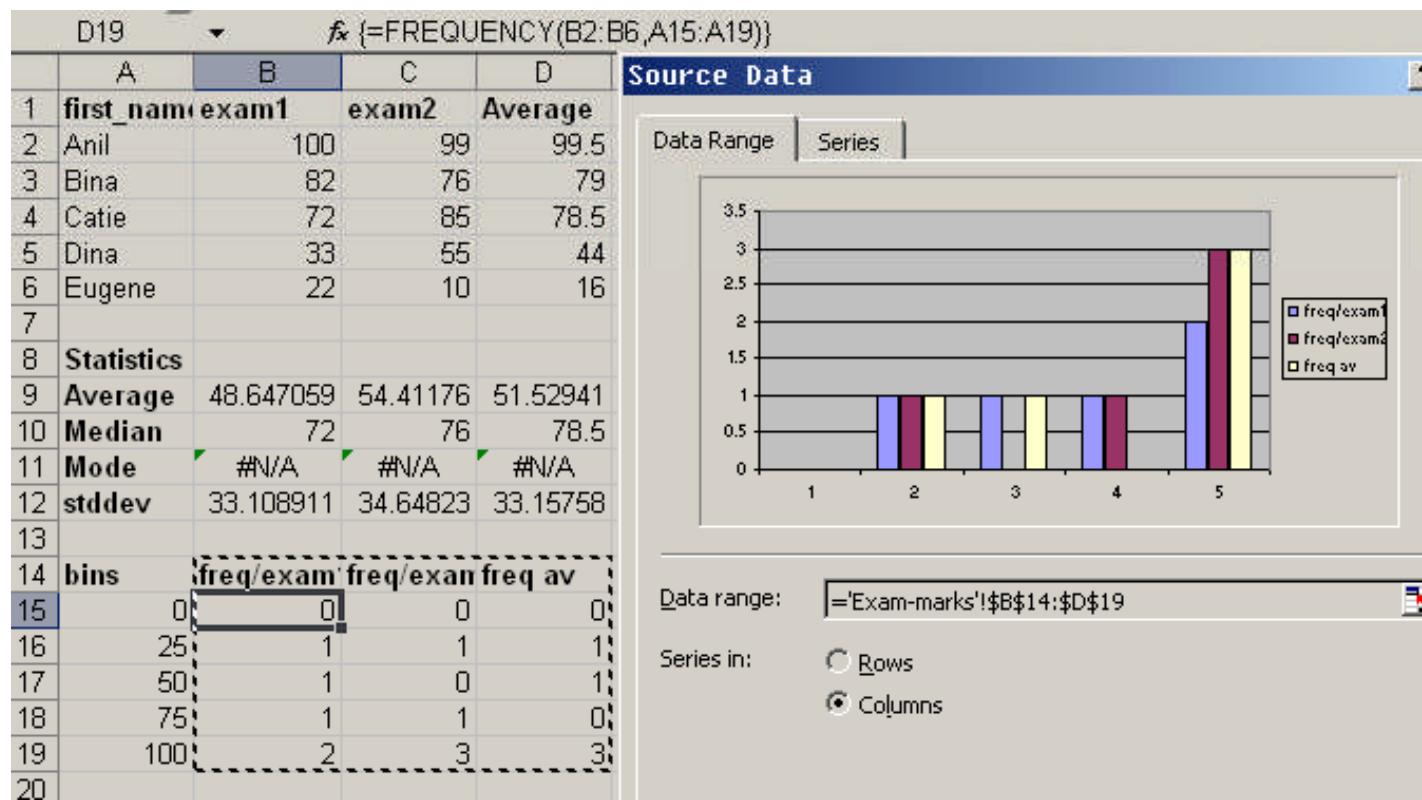
Chart sub-type:

Clustered Column. Compares values across categories.

Press and Hold to View Sample

Cancel < Back Next > Finish

Select the data to plot



Add the X axis in Series

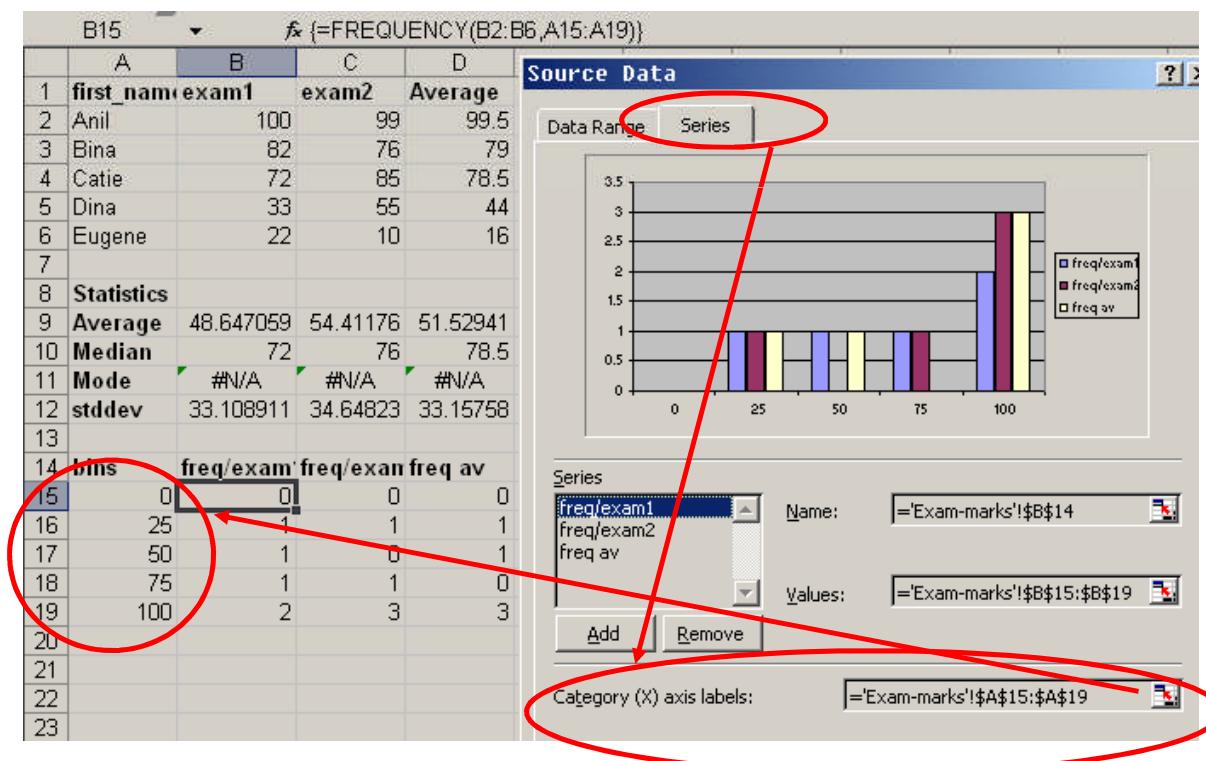
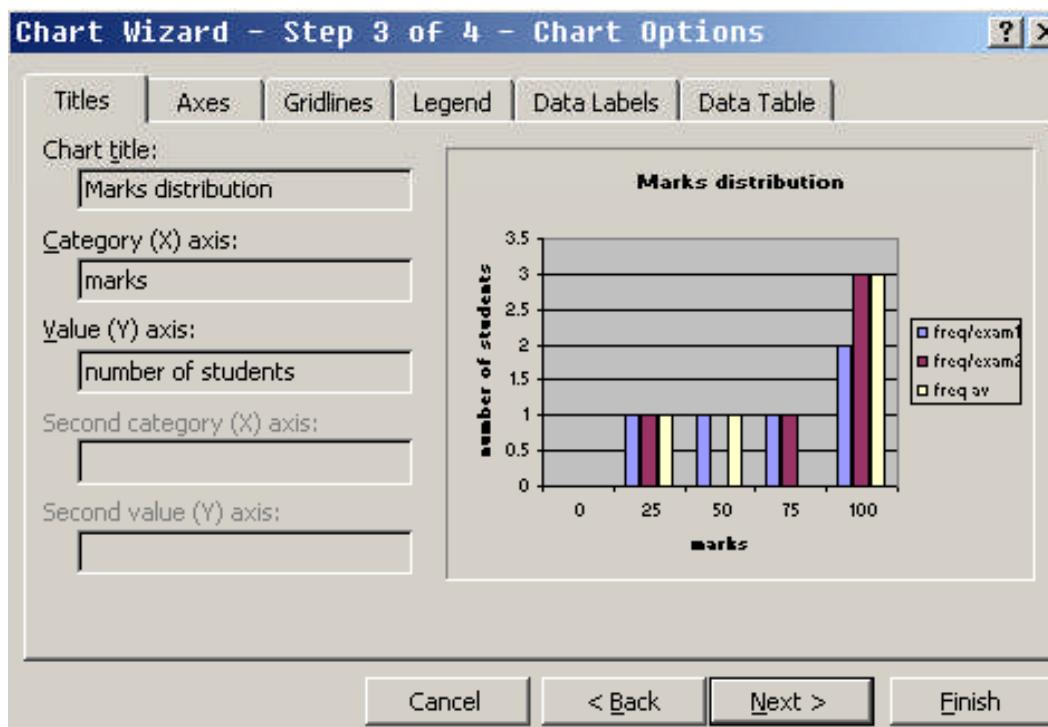
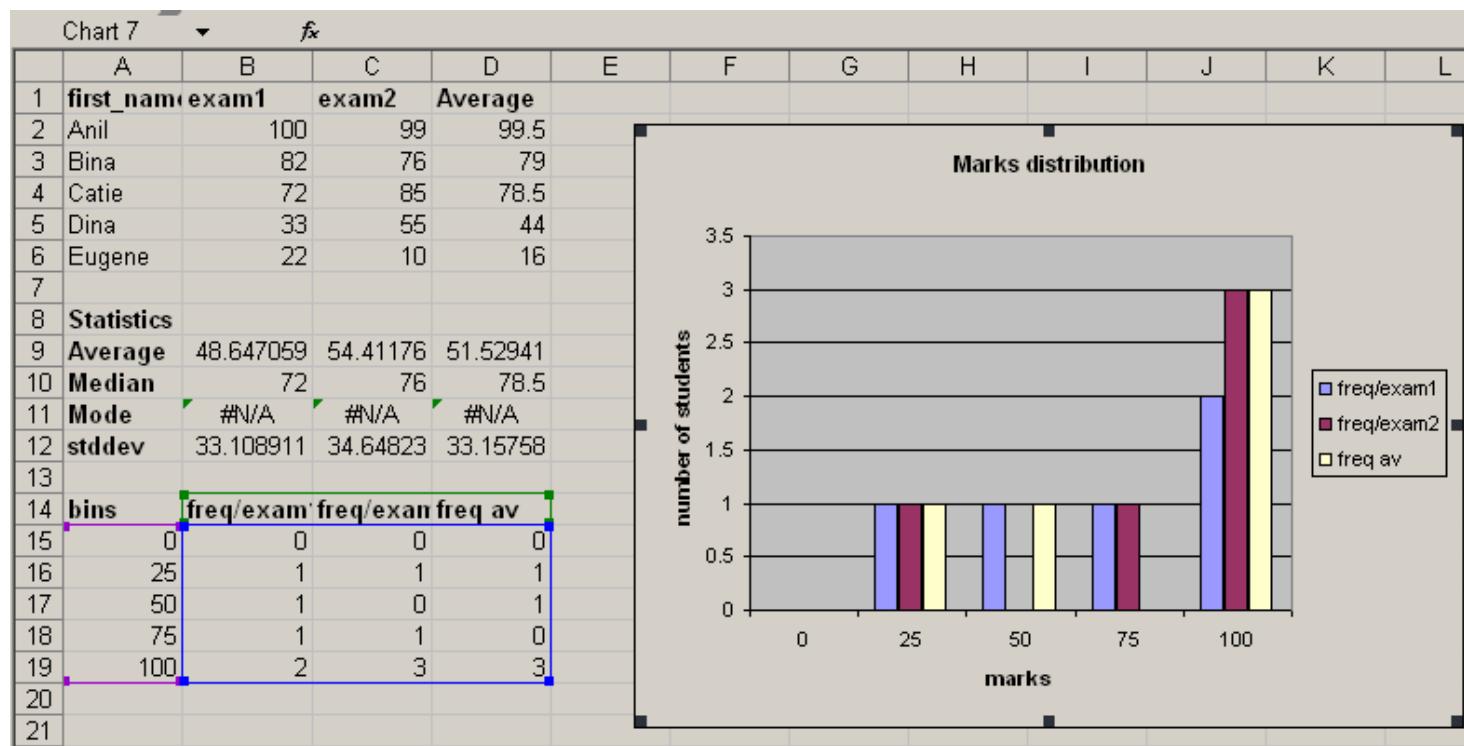


Chart wizard



Final Marks distribution

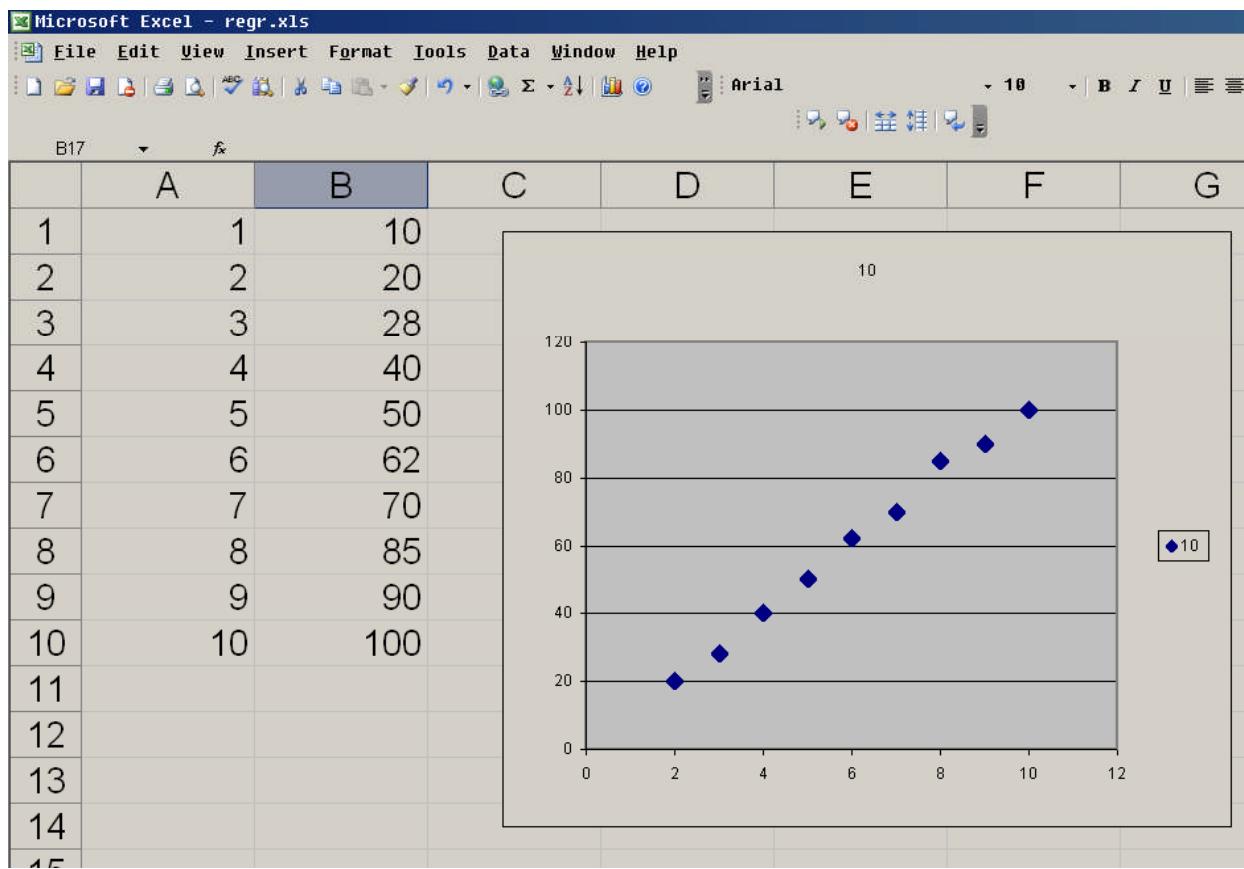


Regression with Microsoft Excel

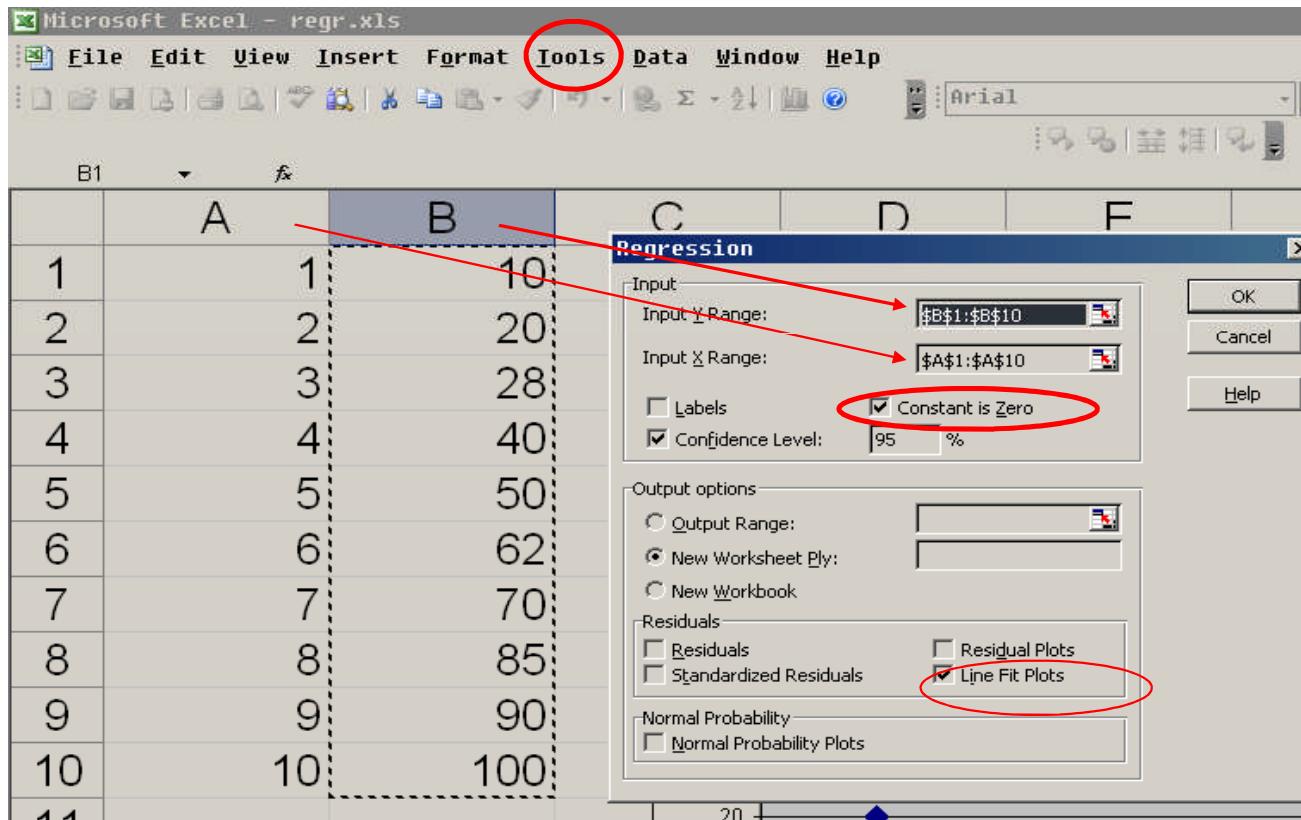


Microsoft Office
Excel 2003

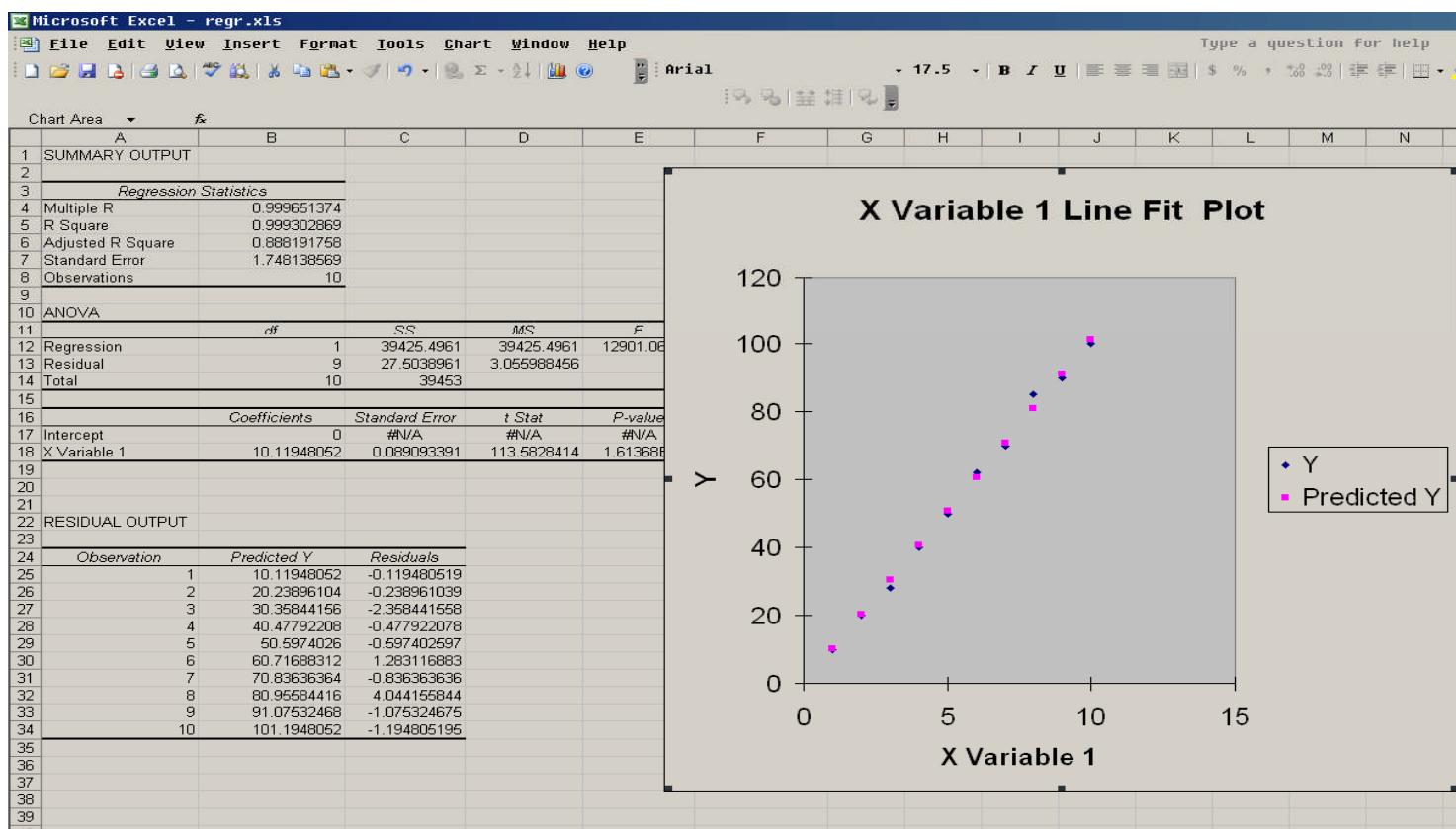
Create some XY-Data (e.g.)



Tools > Data Analysis > Regression

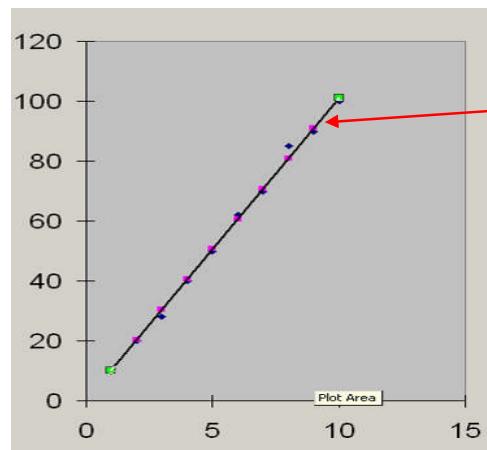
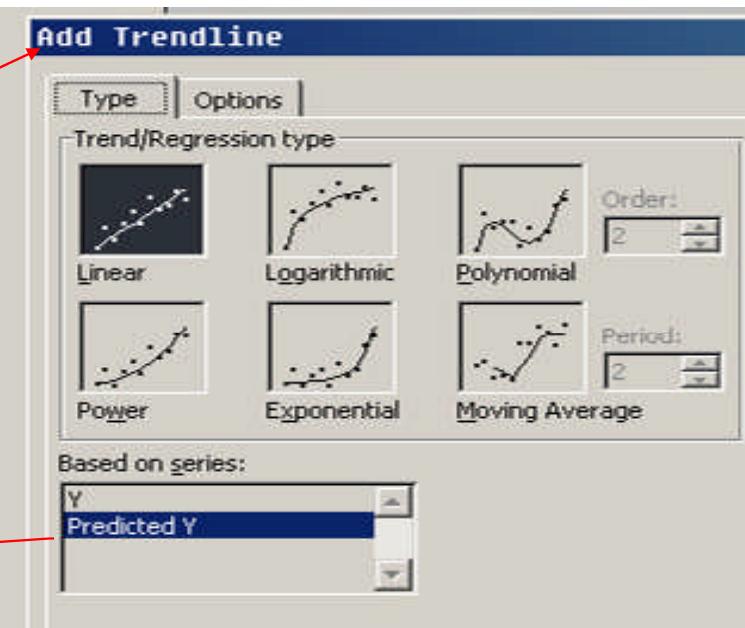
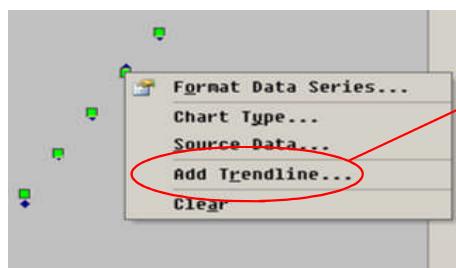


Regression output sheet



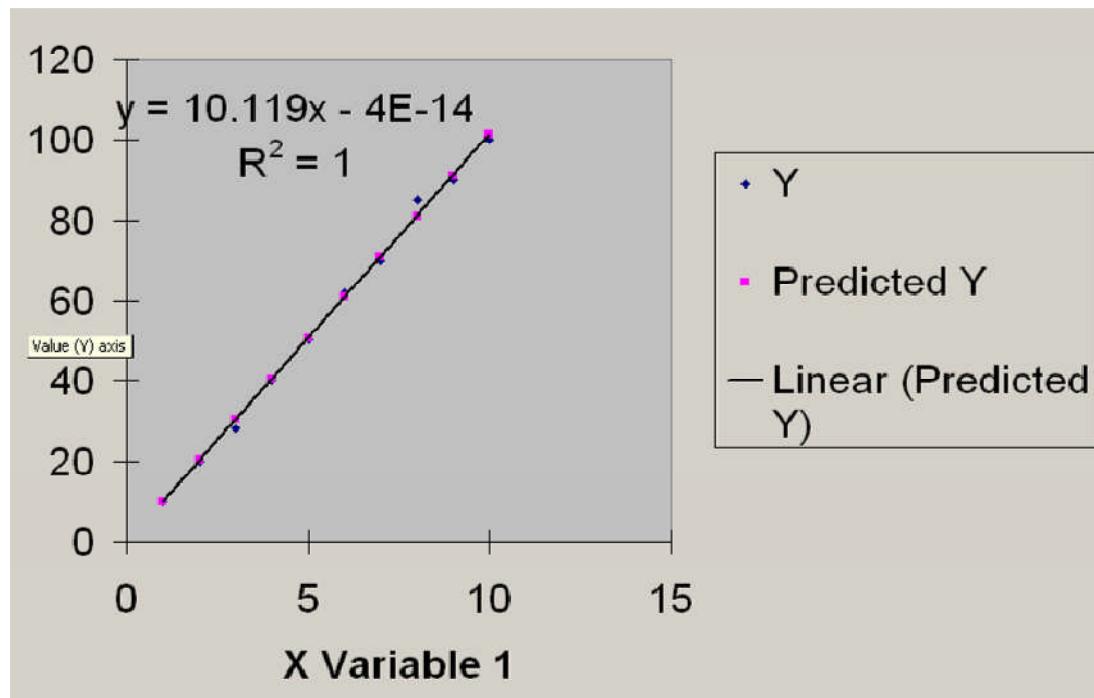
Trendline

Right mouse click on graph,
and add "Trendline"



Trendline options > show equation and R square

R² is a measure of the error between the data points and the predicted values. Its values vary between 0 = no relationship, and 1 = a perfect relationship.



Forecast (interpolate, extrapolate)

To find the value of Y at X=9.5,

- Go to the empty cell A12, and type:
- `fx=Forecast(9.5,B1:B10,A1:A10)`
- and you should get the value 96.39.

To do the inverse forecast, back from Y to X, do

- `=FORECAST(96.39,A1:A10, B1:B10)`
- and you should get 9.48

Regression with R

```
> A <- c(1:10) # c(1,2,3,4,5,6,7,8,9,10)  
> B <-  
  c(10,20,28,40,50,62,70,85,90,100)  
> plot(A,B);  
> abline(A,B)  
> cor(A,B) # Correlation of A and B is:  
[1] 0.9984757  
> fit <- lm(A ~ B) ; fit
```

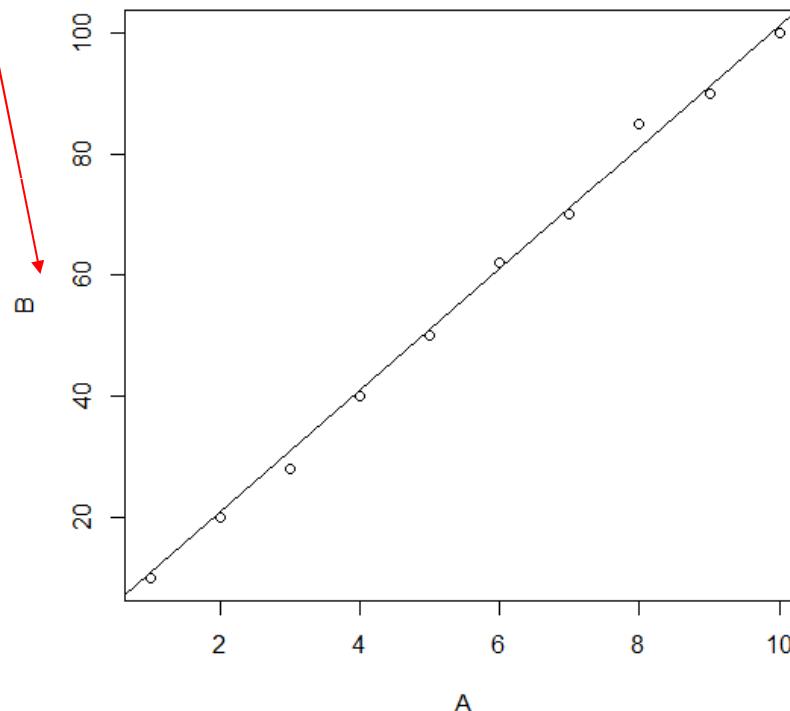
Call: lm(formula = A ~ B),

Coefficients:

| | |
|-------------|---------|
| (Intercept) | B |
| 0.08826 | 0.09751 |

```
> summary(fit)
```

...lot of details...



Anova

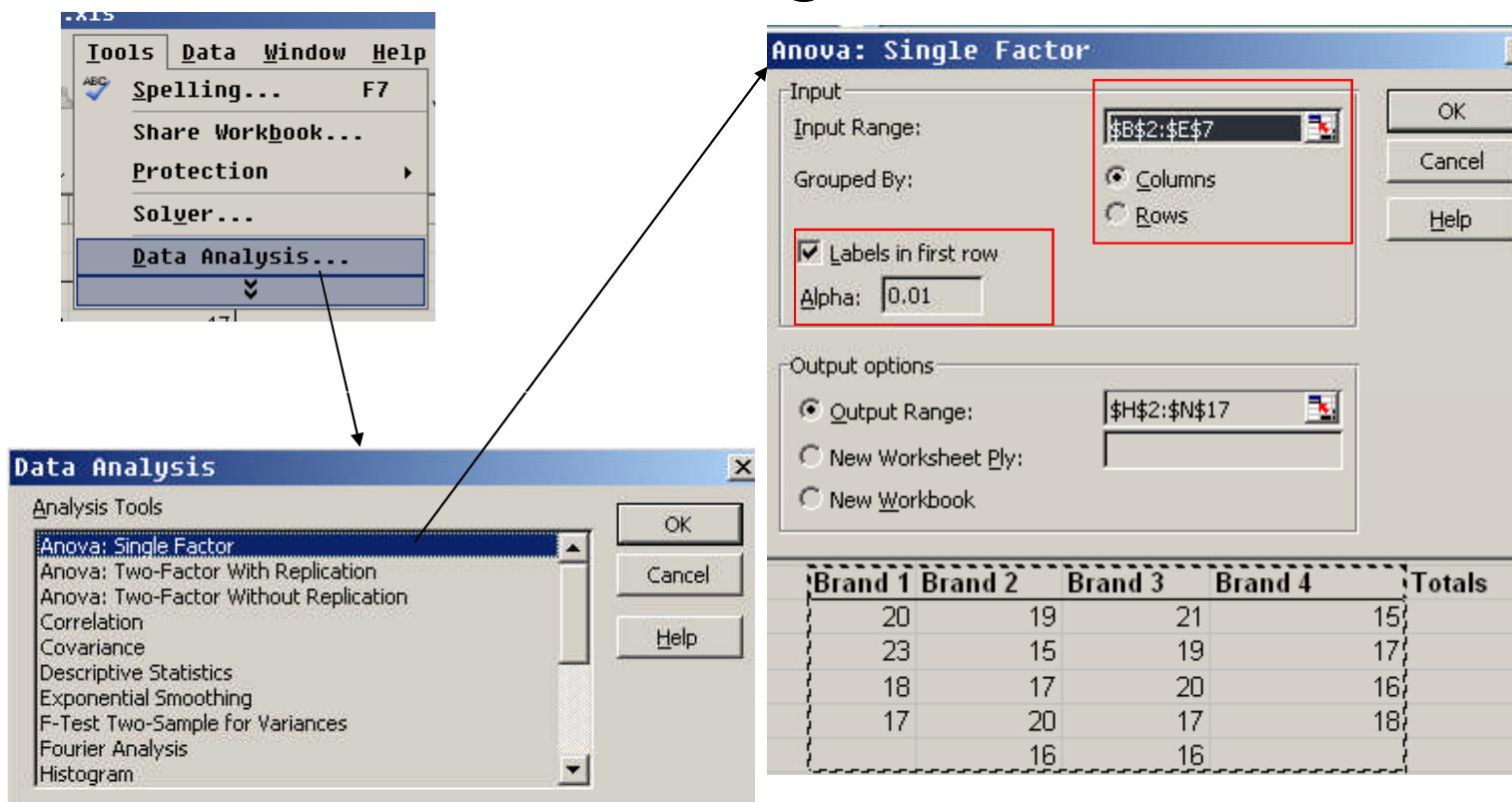
Compare four tyre brands, which brand is better?

| | A | B | C | D | E | F | |
|----|---------------------|----------------|----------------------|----------------------|----------------------|------------------|---|
| 1 | | | | | | | |
| 2 | Brands | Brand 1 | Brand 2 | Brand 3 | Brand 4 | Totals | |
| 3 | | 20 | 19 | 21 | 15 | | |
| 4 | | 23 | 15 | 19 | 17 | | |
| 5 | | 18 | 17 | 20 | 16 | | |
| 6 | | 17 | 20 | 17 | 18 | | |
| 7 | | | 16 | 16 | | | |
| 8 | Totals | =SUM(B3:B7) | =SUM(C3:C7) | =SUM(D3:D7) | =SUM(E3:E7) | =SUM(B8:E8) | G |
| 9 | sqr(T_i) | =B8*B8 | =C8*C8 | =D8*D8 | =E8*E8 | | |
| 10 | n_i | =COUNTIF(B3:B7 | =COUNTIF(C3:C7,">0") | =COUNTIF(D3:D7,">0") | =COUNTIF(E3:E7,">0") | =SUM(B10:E10) | |
| 11 | sum(sq(B_i)) | =SUMSQ(B3:B7) | =SUMSQ(C3:C7) | =SUMSQ(D3:D7) | =SUMSQ(E3:E7) | =SUM(B11:E11) | |
| 12 | BSS+CF=sqr(T_i)/n_i | =B9/B10 | =C9/C10 | =D9/D10 | =E9/E10 | =SUM(B12:E12) | |
| 13 | CF=sqr(G)/n | =G*G/18 | | | | | |
| 14 | TSS=RSS-CF | =RSS-CF | | | | | |
| 15 | BSS | =BSS1-CF | | | | | |
| 16 | WSS=TSS-BSS | =TSS-BSS2 | | | | | |
| 17 | Anova | DOF | dof | ss | mean(ss) | var/F | |
| 18 | b/brands | k-1 | 3 | 21.6 | =D18/3 | =7.2/4.31 | |
| 19 | error | n-1 | 14 | 60.4 | =D19/14 | | |
| 20 | total | n-k | 17 | 82 | | | |
| 21 | | | | | Finv(.01,3,14) | =FINV(0.01,3,14) | |
| 22 | H0 | =1.67<5.56 | Tires are same | Accept | | | |
| 23 | H1 | | Tires are diff | | | | |

Anova, accept H0, alpha=0.01

| | A | B | C | D | E | F |
|----|---------------------|---------|----------------|---------|------------|----------|
| 1 | | | | | | |
| 2 | Brands | Brand 1 | Brand 2 | Brand 3 | Brand 4 | Totals |
| 3 | | 20 | 19 | 21 | 15 | |
| 4 | | 23 | 15 | 19 | 17 | |
| 5 | | 18 | 17 | 20 | 16 | |
| 6 | | 17 | 20 | 17 | 18 | |
| 7 | | | 16 | 16 | | |
| 8 | Totals | 78 | 87 | 93 | 66 | 324 G |
| 9 | sqr(T_i) | 6084 | 7569 | 8649 | 4356 | |
| 10 | n_i | 4 | 5 | 5 | 4 | 18 |
| 11 | sum(sq(B_i)) | 1542 | 1531 | 1747 | 1094 | 5914 |
| 12 | BSS+CF=sqr(T_i)/n_i | 1521 | 1513.8 | 1729.8 | 1089 | 5853.6 |
| 13 | CF=sqr(G)/n | 5832 | | | | |
| 14 | TSS=RSS-CF | 82 | | | | |
| 15 | BSS | 21.6 | | | | |
| 16 | WSS=TSS-BSS | 60.4 | | | | |
| 17 | Anova | DOF | dof | ss | mean(ss) | var/F |
| 18 | b/brands | k-1 | | 21.6 | 7.2 | 1.670534 |
| 19 | error | n-1 | | 14 | 60.4 | 4.314286 |
| 20 | total | n-k | | 17 | 82 | |
| 21 | | | | | Finv(.01,3 | 5.563886 |
| 22 | H0 | TRUE | Tires are sam | Accept | | |
| 23 | H1 | | Tires are diff | | | |
| 24 | | | | | | |

Excel > tools > data analysis > Anova single factor



Excel does Anova

Compare with
calculator

| Anova: Single Factor | | | | | | |
|----------------------|-------|-----|-----------|--------------|---------|-------------|
| SUMMARY | | | | | | |
| Groups | Count | Sum | Average | Variance | | |
| Brand 1 | 4 | 78 | 19.5 | 7 | | |
| Brand 2 | 5 | 87 | 17.4 | 4.3 | | |
| Brand 3 | 5 | 93 | 18.6 | 4.3 | | |
| Brand 4 | 4 | 66 | 16.5 | 1.6666666667 | | |
| ANOVA | | | | | | |
| Source of Variation | SS | df | MS | F | P-value | F crit |
| Between Groups | 21.6 | 3 | 7.2 | 1.668874172 | 0.2191 | 5.563885843 |
| Within Groups | 60.4 | 14 | 4.3142857 | | | |
| Total | 82 | 17 | | | | |

| Brands | Brand 1 | Brand 2 | Brand 3 | Brand 4 | Totals |
|--------------|---------|---------|---------|----------------|---------|
| | 20 | 19 | 21 | 15 | |
| | 23 | 15 | 19 | 17 | |
| | 18 | 17 | 20 | 16 | |
| | 17 | 20 | 17 | 18 | |
| | 16 | 16 | 16 | | |
| Totals | 78 | 87 | 93 | 66 | 324 |
| sqr(T_i) | 6084 | 7569 | 8649 | 4356 | |
| n_i | 4 | 5 | 5 | 4 | 18 |
| sum(sq(B_i)) | 1542 | 1531 | 1747 | 1094 | 5914 |
| BSS+CF=s | 1521 | 1513.8 | 1729.8 | 1089 | 5853.6 |
| CF=sqr(G_i) | 5832 | | | | |
| TSS=RSS | 82 | | | | |
| BSS | 21.6 | | | | |
| WSS-TSS | 60.4 | | | | |
| Anova | DOF | dof | ss | mean(ss) | var/F |
| b/brands | k-1 | 3 | 21.6 | 7.2 | 1.67053 |
| error | n-1 | 14 | 60.4 | 4.314285714 | |
| total | n-k | 17 | 82 | | |
| | | | | Finv(1%,3,14)= | 5.56389 |

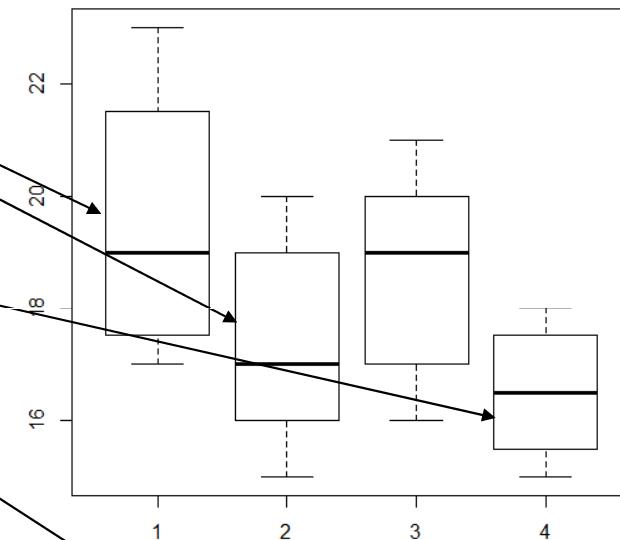
Chi Square

| | A | B | C | D | E | F | |
|----|-------------|----------|----------|-----|----------|------------|--|
| 1 | Month | O | E=100/10 | O-E | sqr(O-E) | sqr(O-E)/E | |
| 2 | 1 | 12 | 10 | 2 | 4 | 0.4 | |
| 3 | 2 | 8 | 10 | -2 | 4 | 0.4 | |
| 4 | 3 | 20 | 10 | 10 | 100 | 10 | |
| 5 | 4 | 2 | 10 | -8 | 64 | 6.4 | |
| 6 | 5 | 14 | 10 | 4 | 16 | 1.6 | |
| 7 | 6 | 10 | 10 | 0 | 0 | 0 | |
| 8 | 7 | 15 | 10 | 5 | 25 | 2.5 | |
| 9 | 8 | 6 | 10 | -4 | 16 | 1.6 | |
| 10 | 9 | 9 | 10 | -1 | 1 | 0.1 | |
| 11 | 10 | 4 | 10 | -6 | 36 | 3.6 | |
| 12 | | | | | | chisq | |
| 13 | sum | 100 | 100 | 0 | 266 | 26.6 | |
| 14 | dof | 9 | | | | | |
| 15 | chilnv(9,5) | 16.91898 | <26.6 | | | | |
| 16 | H0 | FALSE | | | | | |
| 17 | chisq | 0.001628 | >0.05? | | | | |
| 18 | | | | | | | |

Anova in R

The data

```
> x1 = c( 20, 23, 18, 17)
> x2 = c( 19, 15, 17, 20, 16)
> x3 = c( 21, 19, 20, 17, 16)
> x4 = c( 15, 17, 16, 18)
> boxplot(x1,x2,x3,x4)
> all.scores = c(x1,x2,x3,x4)
> grp = c("x1","x2","x3","x4")
> n = c(4, 5, 5, 4)
> groups = rep(grp, n)
```



Box plot of the data

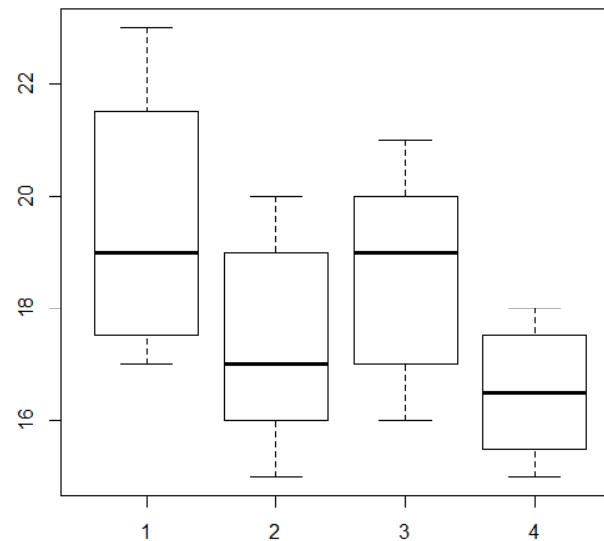
Continued ...

Anova in R, continued

```
> results = aov(all.scores ~  
+   factor(groups))  
> summary(results)  
factor(groups)  
  Df Sum Sq Mean Sq F value  
Pr(>F)  
  3 21.6    7.200  1.669  
  0.219  
Residuals  
  1      4     60.4    4.314
```

```
# Compute the f critical at 1% for dof1=3  
and dof2=14
```

```
> qf(.99, df1=3, df2=14)  
[1] 5.563886
```



Box plot of the data

Hypothesis Testing

Statistics of sampling

- We have a population N .
 - We measure only a small sample of it, of size n .
 - Is our measurement valid for the whole population?
-
- Example: We ask some people ($n=100$) who they will vote for, then we can predict how the whole country ($N=1000,000,000$) will vote.
 - Example: We check a few packets of rice, and if they are ok, we assume the whole lot is good.

Tolerance to Accept or Reject.

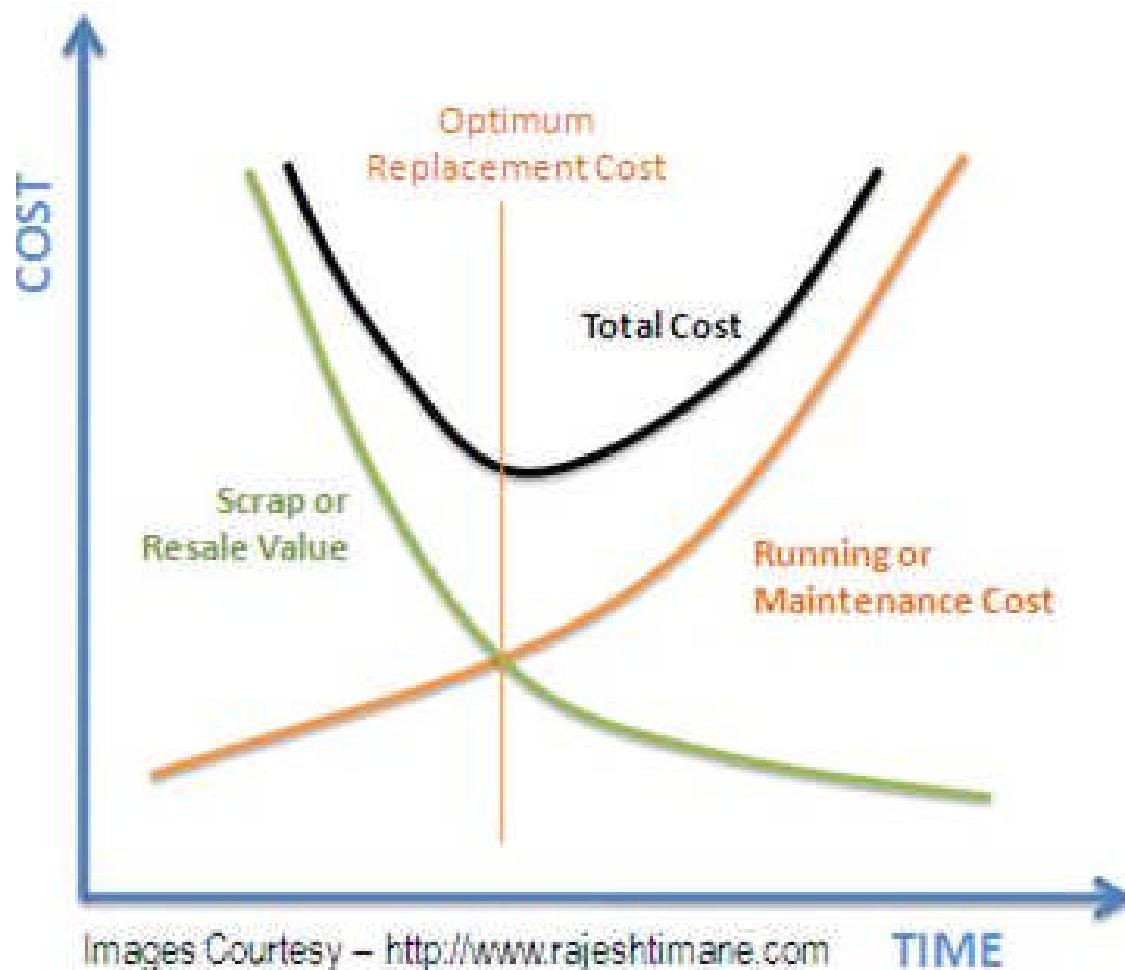
- Example: We say a bus takes 100 minutes to go from Mangalore to NITTE.
- A bus taking 104 minutes is acceptable if we tolerate 5% variation,
- $(104-100) = (4/100) < 5\% (=5/100)$
- If we tolerate only 1% variation, then 104 minutes bus timing will be rejected.

Null Hypothesis (H_0 , H_1).

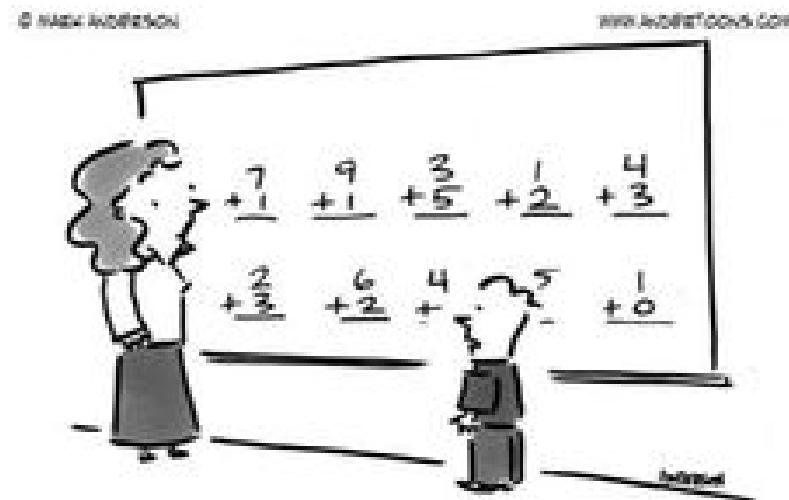
- We make a guess about the population, call it null-hypothesis H_0 , and the alternative of H_0 is called H_1 .
- We measure a sample.
- We pick a tolerance of 1% or 5%.
- We calculate a “test-statistic” of the sample.
- We look up the tabulated value for the tolerance in the statistics tables.
- We compare the measured with the expected value.
- If the difference $<$ tolerance, we accept the null hypothesis.
- If difference $>$ tolerance, we reject the guess, and accept the alternate hypothesis H_1 .

Replacement Theory

Replacement cost over time



Solving LP with MS Excel



"All I'm saying is we plug these into Excel, let it do its thing, and then we can all play until lunch!"

Excel Grid



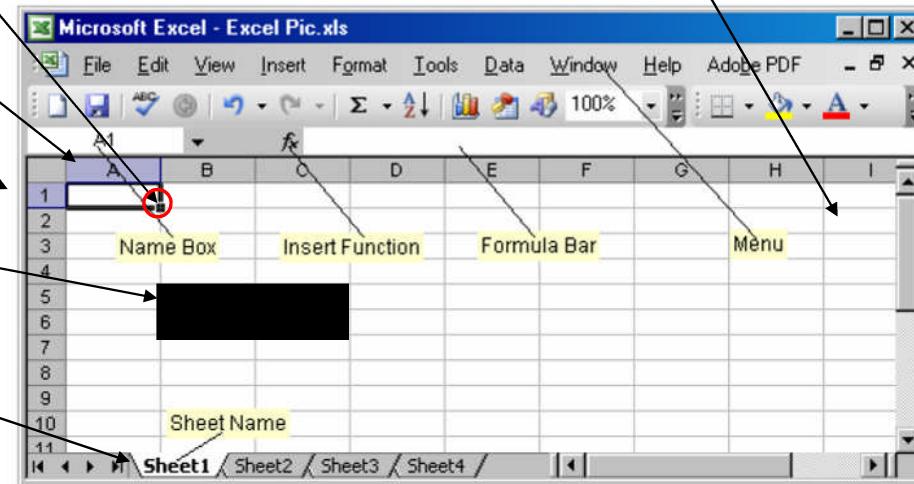
- Excel file have extension .xls or .xlsx (2007).
- Work book is a 2D matrix/grid of **CELLS** containing data
- Cells are then named by Column+Row, e.g. A1, B5, I2
- Draggable corner to copy cells

Columns are: A,B,C,D

Rows are: 1,2,3,4,...

Matrix: B5:B6;C5:C6

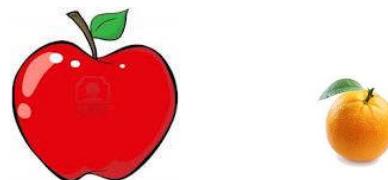
Sheets: 1,2,...



LP example to help a farmer

We have following linear constraints:

- 6 acres of land: $3x + y \leq 6$
- 6 tons of fertilizer: $2x + 3y \leq 6$
- 8 hour work day: $x + 5y \leq 8$
- Apples sell for twice as much as oranges
- We want to maximize profit: $z = 2x + y$
- Production is positive: $x \geq 0, y \geq 0$



Enter the data into Excel

x : apple

y : orange

Price apple = 2 price orange

maximize profit: $z = 2x + y$

Constraints:

$$6 \text{ acres of land: } 3x + y < 6$$

$$6 \text{ tons of fertilizer: } 2x + 3y < 6$$

$$8 \text{ hour work day: } x + 5v < 8$$

Production is positive: $x > 0$, $y > 0$

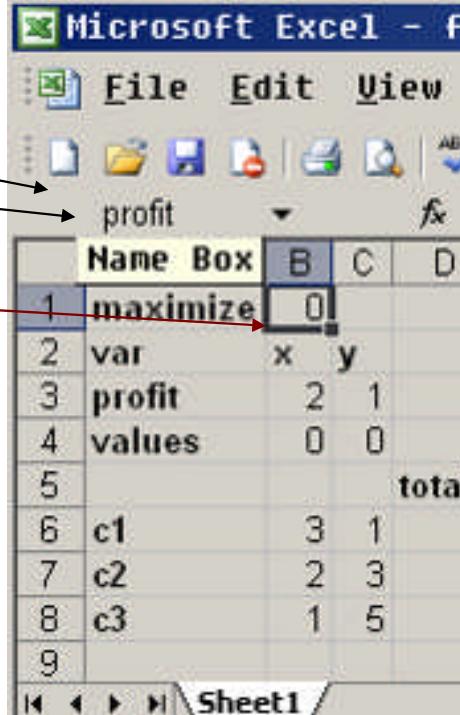
The screenshot shows a Microsoft Excel spreadsheet titled "Microsoft Excel - Farmer.xls". The menu bar includes File, Edit, View, Insert, Format, Tools, and a toolbar with various icons. The formula bar displays the formula $=SUMPRODUCT(B3:C3,B4:C4)$. The worksheet contains the following data:

| | A | B | C | D | E | F | G | H |
|---|----------|---|-------|------|-------|------------|---|---|
| 1 | maximize | 0 | | | | | | |
| 2 | var | x | y | | | | | |
| 3 | profit | | 2 | 1 | | | | |
| 4 | values | | 0 | 0 | | | | |
| 5 | | | total | | limit | | | |
| 6 | c1 | 3 | 1 | 0 <= | 6 | land | | |
| 7 | c2 | 2 | 3 | 0 <= | 6 | fertilizer | | |
| 8 | c3 | 1 | 5 | 0 <= | 8 | labour | | |
| 9 | | | | | | | | |

The formula bar shows $=SUMPRODUCT(B3:C3,B4:C4)$.

Naming a cell

- Select B1
- Click on "name box",
Type "profit",
Press "Control-Shift-Enter"
- Press "Control-Shift-Enter"
to name B1 profit.



The screenshot shows a Microsoft Excel window with the title bar 'Microsoft Excel - F...'. The menu bar includes 'File', 'Edit', and 'View'. The ribbon tabs are 'ABC' and 'ABC'. The 'Name Box' dropdown shows 'profit' selected. The main worksheet area displays the following data:

| | Name Box | B | C | D |
|---|----------|---|---|-------|
| 1 | maximize | 0 | | |
| 2 | var | x | y | |
| 3 | profit | 2 | 1 | |
| 4 | values | 0 | 0 | |
| 5 | | | | total |
| 6 | c1 | 3 | 1 | |
| 7 | c2 | 2 | 3 | |
| 8 | c3 | 1 | 5 | |
| 9 | | | | |

The status bar at the bottom shows 'Sheet1'.

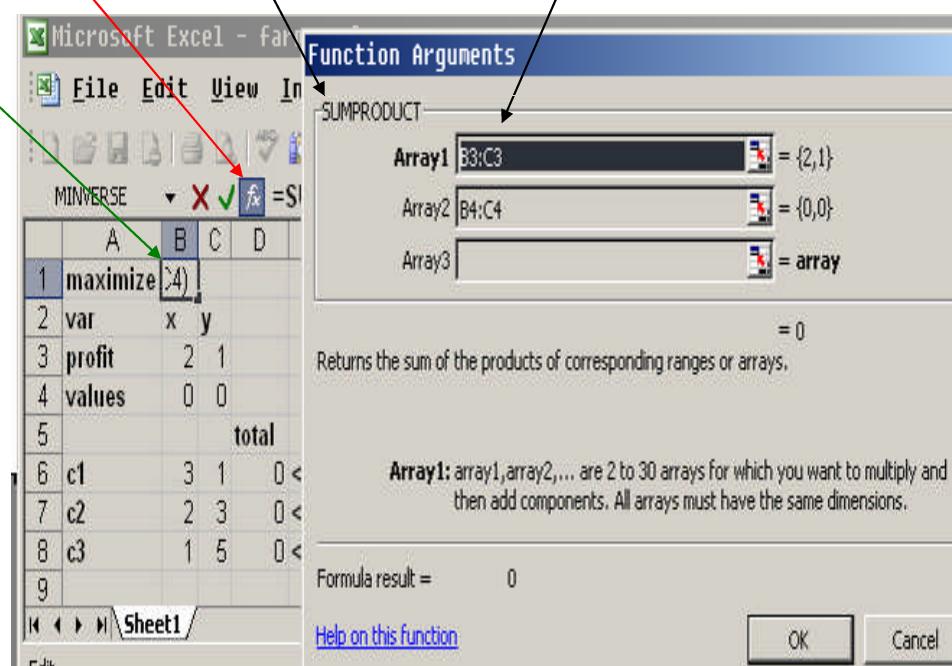
Input the objective function, (equation for profit)

Select cell **B1**, Click on **fx**, Select **sumproduct**, Array1=B3:C3

Array2=B4:C4

So profit is

$$z = 2 * x + 1 * y$$
$$B1 = B3 * B4 + C3 * C4$$



Enter the formula for constraints

Type formula for D6

- $D6 = \text{SUMPRODUCT}(B6:C6, \$B\$4:\$C\$4)$

Drag the black dot over D7
and D8 to fill these:

- $D7 = \text{SUMPRODUCT}(B7:C7, \$B\$4:\$C\$4)$
- $D8 = \text{SUMPRODUCT}(B8:C8, \$B\$4:\$C\$4)$

| | A | B | C | D | E | F | G |
|----|-------------|----------|----------|-------|-------|---|------------|
| 1 | maximize | 4.285714 | | | | | |
| 2 | var | x | y | | | | |
| 3 | profit | 2 | 1 | | | | |
| 4 | values | 1.714286 | 0.857143 | | | | |
| 5 | | | | total | limit | | |
| 6 | constraint1 | 3 | 1 | 6 | <= | 6 | land |
| 7 | constraint2 | 2 | 3 | 6 | <= | 6 | fertilizer |
| 8 | constraint3 | 1 | 5 | 6 | <= | 8 | labour |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | total | |
|---|--|-------|----|
| 1 | | 6 | <= |
| 2 | | 6 | <= |
| 3 | | 6 | <= |

Formulas Auditing toolbar

- Press **CTRL+`** (backquote below tilde ~): To switch between results and formulas; Or use the
- Menu: Tools > [Formula Auditing] > [Formula Auditing Mode]
- Use **F9** to recalculate formulas and update the sheet.

Formula editing toolbar

The screenshot shows a Microsoft Excel spreadsheet with a 'Formula Auditing' toolbar overlaid. The spreadsheet contains the following data:

| | A | B | C | D | E | F | G |
|---|-------------|---|---|----------------------------------|----|---|------------|
| 1 | maximize | 0 | | | | | |
| 2 | var | x | y | | | | |
| 3 | profit | 2 | 1 | | | | |
| 4 | values | 0 | 0 | | | | |
| 5 | | | | total | | | |
| 6 | constraint1 | 3 | 1 | =SUMPRODUCT(B6:C6,\$B\$4:\$C\$4) | <= | 6 | land |
| 7 | constraint2 | 2 | 3 | =SUMPRODUCT(B7:C7,\$B\$4:\$C\$4) | <= | 6 | fertilizer |
| 8 | constraint3 | 1 | 5 | =SUMPRODUCT(B8:C8,\$B\$4:\$C\$4) | <= | 8 | labour |
| 9 | | | | | | | |

The 'Formula Auditing' toolbar is visible at the bottom of the screen, featuring various icons for auditing and formula manipulation.

Tools > Solver

The image shows a screenshot of an Excel spreadsheet and its Solver Parameters dialog box.

Excel Spreadsheet Data:

| | A | B | C | D | E | F | G |
|---|----------|---|---|-------|---|------------|---|
| 1 | maximize | 0 | | | | | |
| 2 | var | x | y | | | | |
| 3 | profit | 2 | 1 | | | | |
| 4 | values | 0 | 0 | | | | |
| 5 | | | | total | | limit | |
| 6 | c1 | 3 | 1 | 0 <= | 6 | land | |
| 7 | c2 | 2 | 3 | 0 <= | 6 | fertilizer | |
| 8 | c3 | 1 | 5 | 0 <= | 8 | labour | |

Solver Parameters Dialog Box:

- Set Target Cell:** profit
- Equal To:** Max (radio button selected)
- By Changing Cells:** \$B\$4:\$C\$4
- Subject to the Constraints:**
 - \$D\$6 <= \$F\$6
 - \$D\$7 <= \$F\$7
 - \$D\$8 <= \$F\$8
- Buttons:** Solve, Close, Options, Guess, Add, Change, Delete, Reset All, Help

Red arrows point from the spreadsheet cells B4:C4 and D6:D8 to the corresponding fields in the Solver dialog box. A red circle highlights the **Options** button.

Adding solver constraints by clicking on cells

- Solver > Add constraints > Add
- Then click on icon and cells, example is numbered below, Excel will fill in the cell numbers details based on your clicks

The screenshot shows an Excel spreadsheet with the following data:

| | A | B | C | D | E | F | G |
|---|-------------|----------|----------|-------|-------|---|------------|
| 1 | maximize | 4.285714 | | | | | |
| 2 | var | x | y | | | | |
| 3 | profit | 2 | 1 | | | | |
| 4 | values | 1.714286 | 0.857143 | | | | |
| 5 | | | | total | limit | | |
| 6 | constraint1 | 3 | 1 | 6 | <= | 6 | land |
| 7 | constraint2 | 2 | 3 | 6 | <= | 6 | fertilizer |
| 8 | constraint3 | 1 | 5 | 6 | <= | 8 | labour |

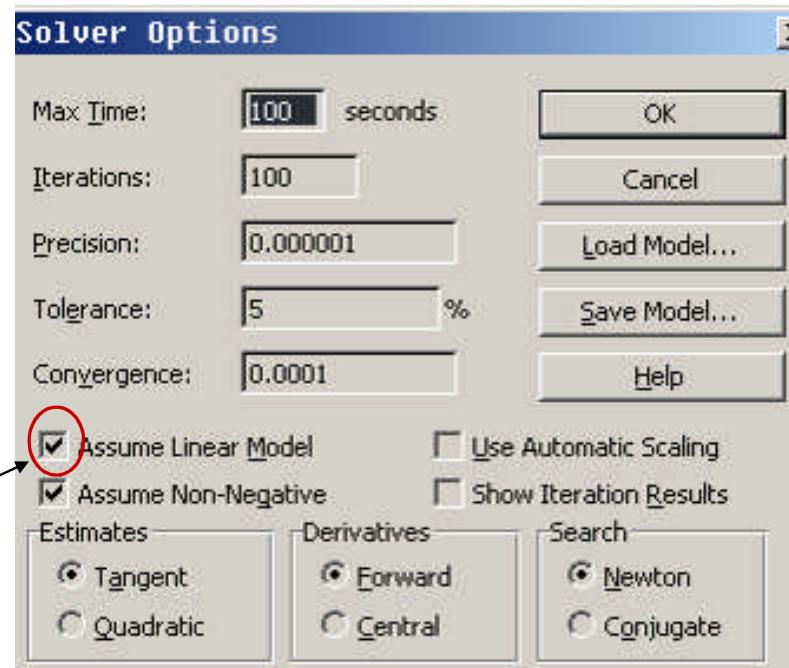
An 'Add Constraint' dialog box is open at the bottom, showing the following settings:

- Cell Reference: \$D\$6 (circled 1)
- Constraint: <= (operator)
- Constraint Value: =\$F\$6 (circled 2)

Solver > Options

- The default solver options are good.

Simplex



Solved (in 1 click and 1 second)

- $x=1.714$
- $y=0.857$
- $z = 4.28$

The screenshot shows a Microsoft Excel spreadsheet titled "Microsoft Excel - Farmer.xls". The spreadsheet contains data for a linear programming problem:

| | A | B | C | D | E | F | G | H |
|---|-------------|----------|----------|-------|----|-------|------------|---|
| 1 | maximize | 4.285714 | | | | | | |
| 2 | var | x | y | | | | | |
| 3 | profit | | 2 | 1 | | | | |
| 4 | values | 1.714286 | 0.857143 | | | | | |
| 5 | | | | total | | limit | | |
| 6 | constraint1 | 3 | 1 | 6 | <= | 6 | land | |
| 7 | constraint2 | 2 | 3 | 6 | <= | 6 | fertilizer | |
| 8 | constraint3 | 1 | 5 | 6 | <= | 8 | labour | |

The cell D8 contains the formula `=SUMPRODUCT(B8:C8,B4:C4)`. A red box highlights the range B8:C8, which corresponds to the values for variables x and y.

A "Solver Results" dialog box is open at the bottom, stating: "Solver found a solution. All constraints and optimality conditions are satisfied." It contains two radio buttons: Keep Solver Solution (circled in red) and Restore Original Values. The "Reports" section includes options for Answer, Sensitivity, and Limits. Buttons at the bottom include OK, Cancel, Save Scenario..., and Help.

Answer report

Microsoft Excel - farmer.xls

B25 fx

| | A | B | C | D | E | F | G |
|----|-------------------------------------|-------------------|-----------------------|--------------------|---------------|--------------|---|
| 1 | Microsoft Excel 11.0 Answer Report | | | | | | |
| 2 | Worksheet: [farmer.xls]Sheet1 | | | | | | |
| 3 | Report Created: 04/29/13 7:43:00 PM | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | Target Cell (Max) | | | | | | |
| 7 | Cell | Name | Original Value | Final Value | | | |
| 8 | \$B\$1 | profit | 4.285714286 | 4.285714286 | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | Adjustable Cells | | | | | | |
| 12 | Cell | Name | Original Value | Final Value | | | |
| 13 | \$B\$4 | values x | 1.714285714 | 1.714285714 | | | |
| 14 | \$C\$4 | values y | 0.857142857 | 0.857142857 | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | Constraints | | | | | | |
| 18 | Cell | Name | Cell Value | Formula | Status | Slack | |
| 19 | \$D\$6 | constraint1 total | 6 | \$D\$6<=\$F\$6 | Binding | 0 | |
| 20 | \$D\$7 | constraint2 total | 6 | \$D\$7<=\$F\$7 | Binding | 0 | |
| 21 | \$D\$8 | constraint3 total | 6 | \$D\$8<=\$F\$8 | Not Binding | 2 | |

◀ ▶ \ Answer Report 1 / Sensitivity Report 1 / Limits Report 1 / Sheet1 /

Ready

Sensitivity report

Microsoft Excel - farmer.xls

File Edit View Insert Format Tools Data Window Help

C21 f

| A | B | C | D | E | F | G | H |
|--------|---|-------------|--------------|-----------------------|--------------------|--------------------|---|
| 1 | Microsoft Excel 11.0 Sensitivity Report | | | | | | |
| 2 | Worksheet: [farmer.xls]Sheet1 | | | | | | |
| 3 | Report Created: 04/29/13 7:43:00 PM | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | Adjustable Cells | | | | | | |
| Cell | Name | Final Value | Reduced Cost | Objective Coefficient | Allowable Increase | Allowable Decrease | |
| \$B\$4 | values x | 1.714285714 | 0 | 2 | 1 | 1.333333333 | |
| \$C\$4 | values y | 0.857142857 | 0 | 1 | 2 | 0.333333333 | |
| 11 | | | | | | | |
| 12 | Constraints | | | | | | |
| Cell | Name | Final Value | Shadow Price | Constraint R.H. Side | Allowable Increase | Allowable Decrease | |
| \$D\$6 | constraint1 total | 6 | 0.571428571 | 6 | 3 | 2 | |
| \$D\$7 | constraint2 total | 6 | 0.142857143 | 6 | 1 | 2 | |
| \$D\$8 | constraint3 total | 6 | 0 | 8 | 1E+30 | 2 | |

Answer Report 1 | **Sensitivity Report 1** | Limits Report 1 | Sheet1 |

Ready

Limits Report

Microsoft Excel - Farmer.xls

File Edit View Insert Format Tools Data Window Help

D17 fx

| | A | B | C | D | E | F | G | H | I | J |
|----|--|-------------|--------------|--------------------|----------------------|--------------------|----------------------|---|---|---|
| 1 | Microsoft Excel 11.0 Limits Report | | | | | | | | | |
| 2 | Worksheet: [farmer.xls]Limits Report 1 | | | | | | | | | |
| 3 | Report Created: 04/29/13 7:43:00 PM | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | Target | | | | | | | | | |
| 7 | Cell | Name | Value | | | | | | | |
| 8 | \$B\$1 | profit | 4.285714286 | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | Adjustable | | | Lower Limit | Target Result | Upper Limit | Target Result | | | |
| 12 | Cell | Name | Value | | | | | | | |
| 13 | \$B\$4 | values x | 1.714285714 | 0 | 0.857142857 | 1.714285714 | 4.285714286 | | | |
| 14 | \$C\$4 | values y | 0.857142857 | 0 | 3.428571429 | 0.857142857 | 4.285714286 | | | |
| 15 | | | | | | | | | | |

Answer Report 1 / Sensitivity Report 1 / **Limits Report 1** / Sheet1 /

Ready

Farm Problem in Excel

- Use the attached xls file



R 4 MBA

Statistical Programming Language
(slides merged into R-Intro and R-details)

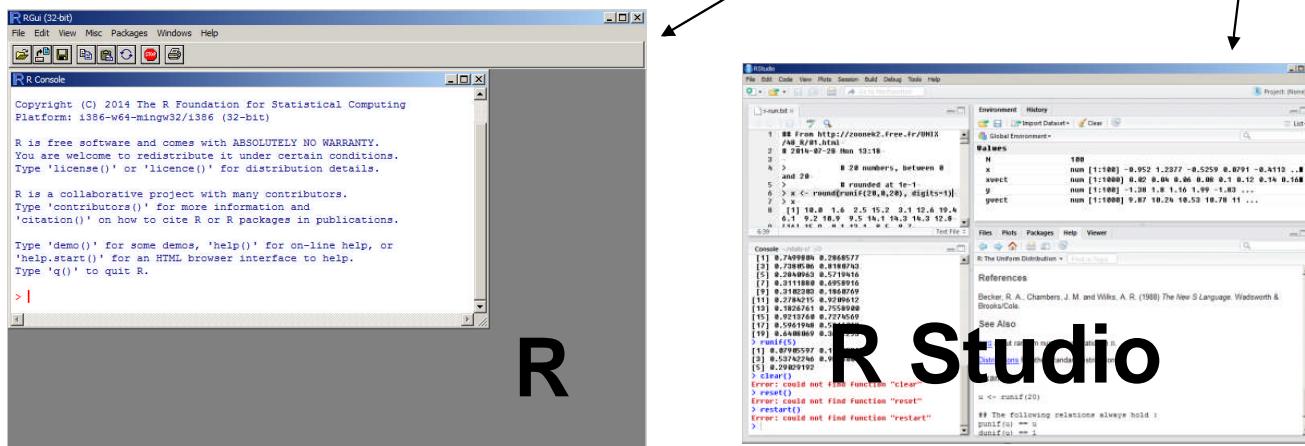
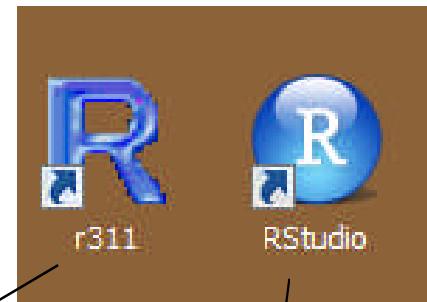
Presented by Kavya, Nishita, Nikita,
Jovita, Meet, Laxmi for
TechBugs, JKSHIM, 12/8/2014.

History of R

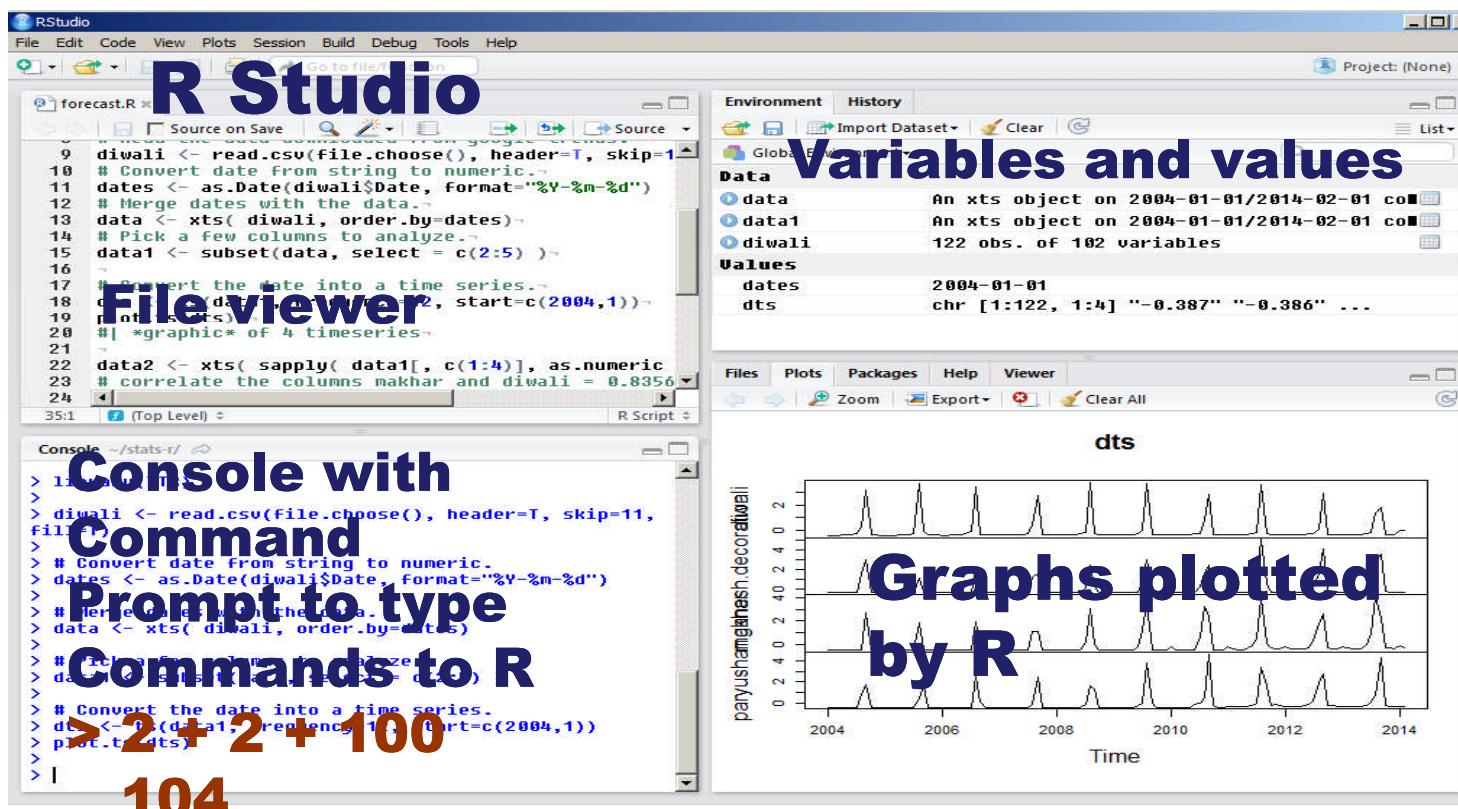
- Ross Ihaka and Robert Gentleman created R in 1993, in University of Auckland, New Zealand.
- R language is the programming language that you write your commands and run in.
- R is the successor to the S, the statistics language from Bell Labs in 1976.

Installing R

- Google “R stats windows download”
- Download R and R-Studio
- Install R and R-Studio
- Start R by clicking on it



R Studio

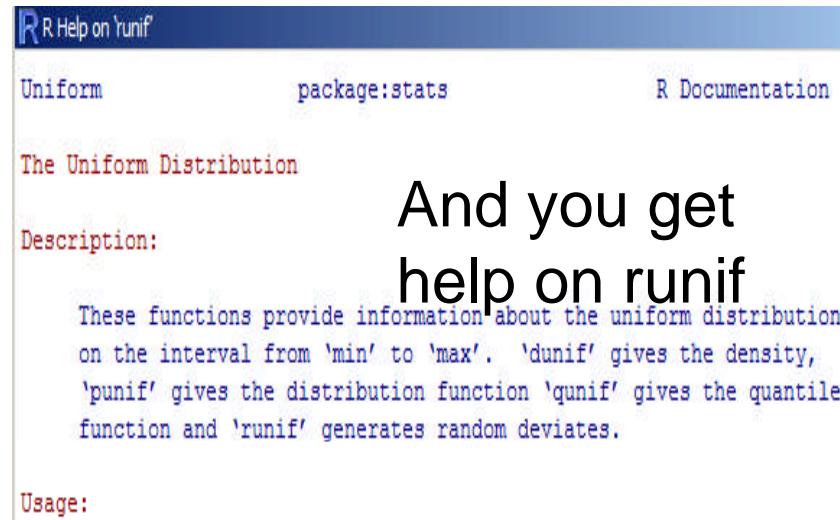


Workflow in R

1. Read Data into R
2. Analyze Data
3. Visualize Data
4. Make Conclusions from Data

Help in R Studio

> ?runif



R Help on 'runif'

Uniform package:stats R Documentation

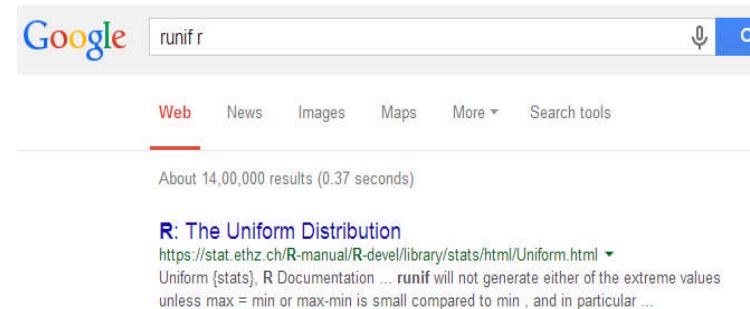
The Uniform Distribution

Description:

These functions provide information about the uniform distribution on the interval from 'min' to 'max'. 'dunif' gives the density, 'punif' gives the distribution function 'qunif' gives the quantile function and 'runif' generates random deviates.

Usage:

Or google
R statistics runif



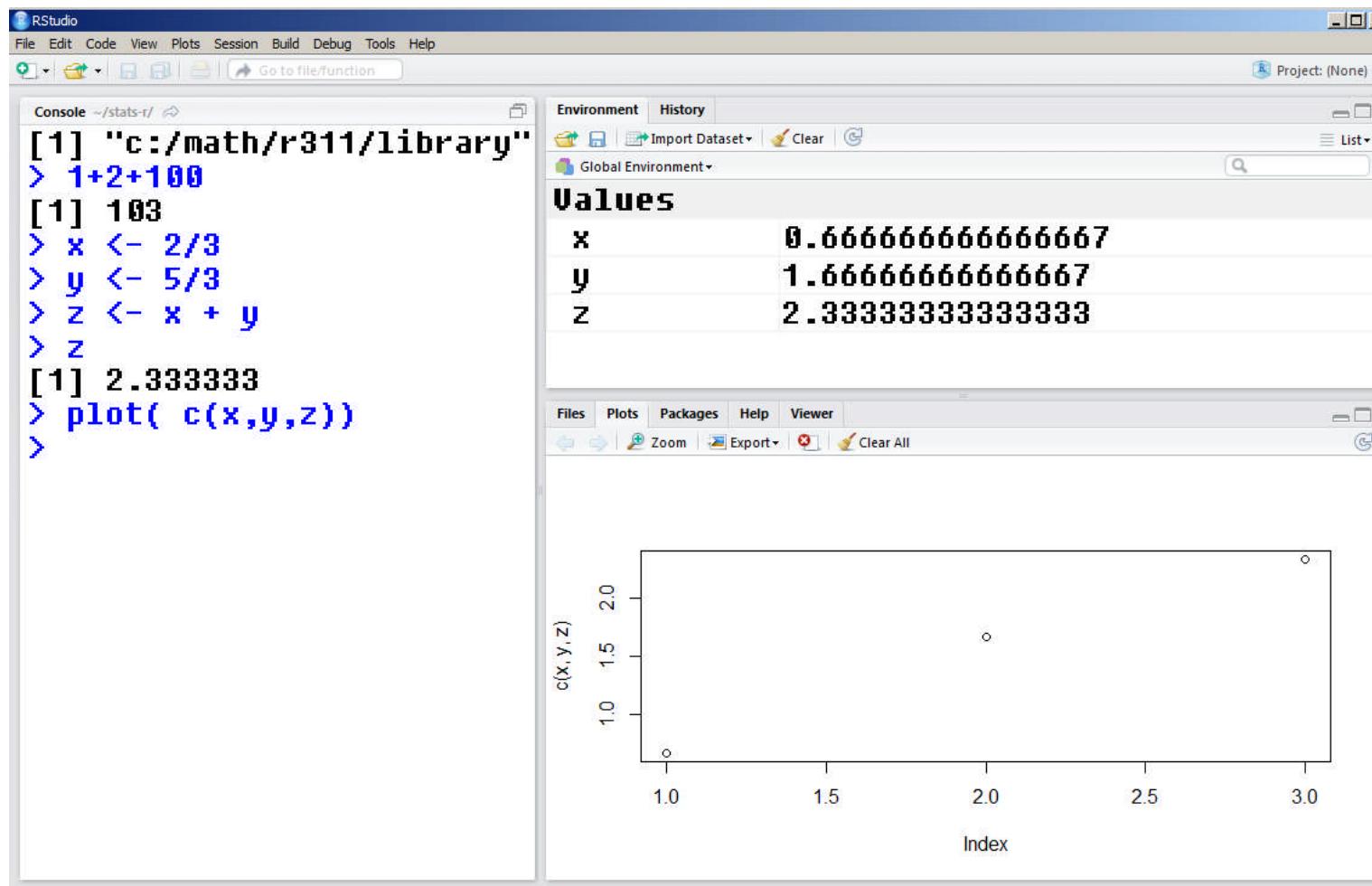
Google runif r

Web News Images Maps More Search tools

About 14,00,000 results (0.37 seconds)

R: The Uniform Distribution
<https://stat.ethz.ch/R-manual/R-devel/library/stats/html/Uniform.html> ▾
Uniform [stats], R Documentation ... runif will not generate either of the extreme values unless max = min or max-min is small compared to min , and in particular ...

R as a calculator



R as a Scientific calculator

```
> 1+1/2+1/3+2/3
```

```
[1] 2.5
```



```
> 1/0      # undefined to divide by zero
```

```
[1] Inf    # Infinite
```

```
> 0/0
```

```
[1] NaN    # undefined, not-a-number
```

```
> sqrt(2i)  # Complex numbers
```

```
[1] 1+1i
```

R Command Prompt

1. Start R by clicking on its icon

```
> # Comment lines are ignored by R  
  
> 2+2 # You type commands at the R prompt.  
[1] 4    # Result '4' printed by R, ignore [1].  
  
> 1+1/2+1/3+2/3  
[1] 2.5
```

Vector of numbers

```
# Sequence of numbers from 1 : to 10
```

```
> 1:10
```

```
[1] 1 2 3 4 5 6 7 8 9 10
```

```
# Create 4 numbers and save the  
# vector in variable named u.
```

```
> u <- c(1, 4, 0, -2)
```

Sequence, vector

```
> 1:5                      # 1 2 3 4 5  
> c(1,2,3,4,5)            # 1 2 3 4 5  
> seq( 0, 4, len=3)       # 0 2 4  
> seq( 0, 4, by=2)        # 0 2 4  
  
> c(a=1, b=5, c=10) # Named vector  
a   b   c  
1   5   10
```

```
summary(data)
```

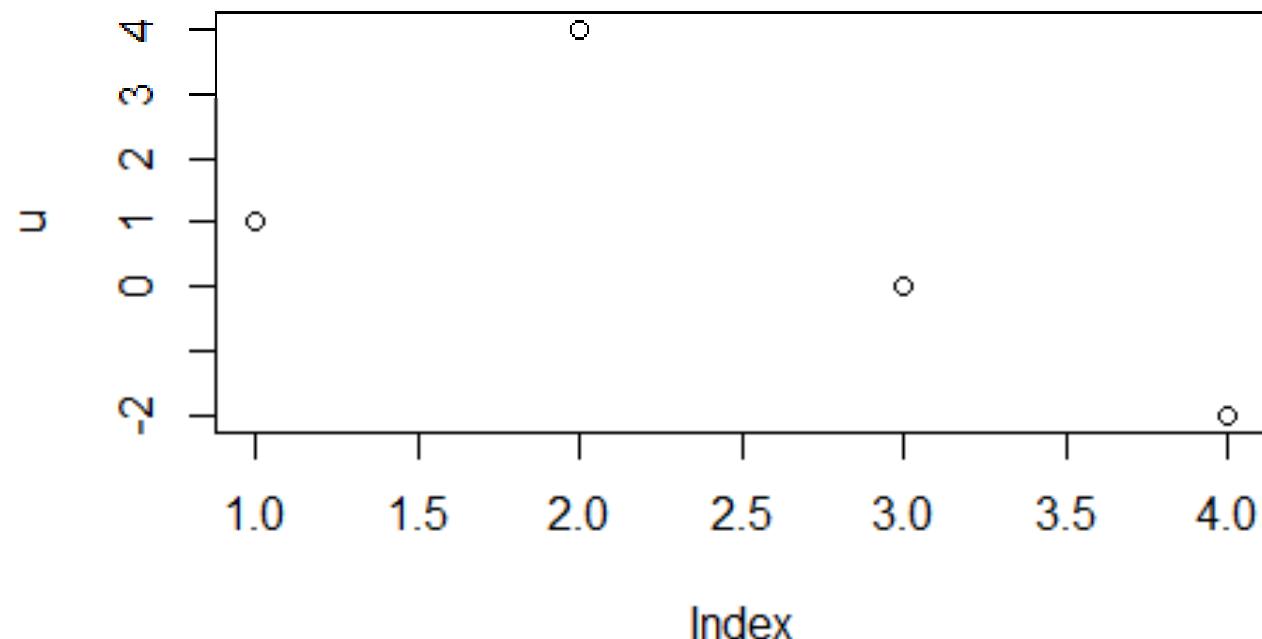
```
> u <- c(1, 4, 0, -2)
> summary(u)
Min. 1Q. Median Mean 3Q. Max.
-2    -0.5   0.5    0.75  1.75  4
```

quantile(data)

```
> u <- c(1, 4, 0, -2)  
> quantile(u)  
 0%   25%   50%   75% 100%  
-2    -0.5    0.5   1.75  4
```

```
> quantile(u, c(0,.33,.66,1))  
 0%   33%   66% 100%  
-2   -0.02   0.98  4
```

```
plot(data)  
> u <- c(1, 4, 0, -2)  
> plot(u)
```



boxplot(data)

```
> u <- c(1, 4, 0, -2)
```

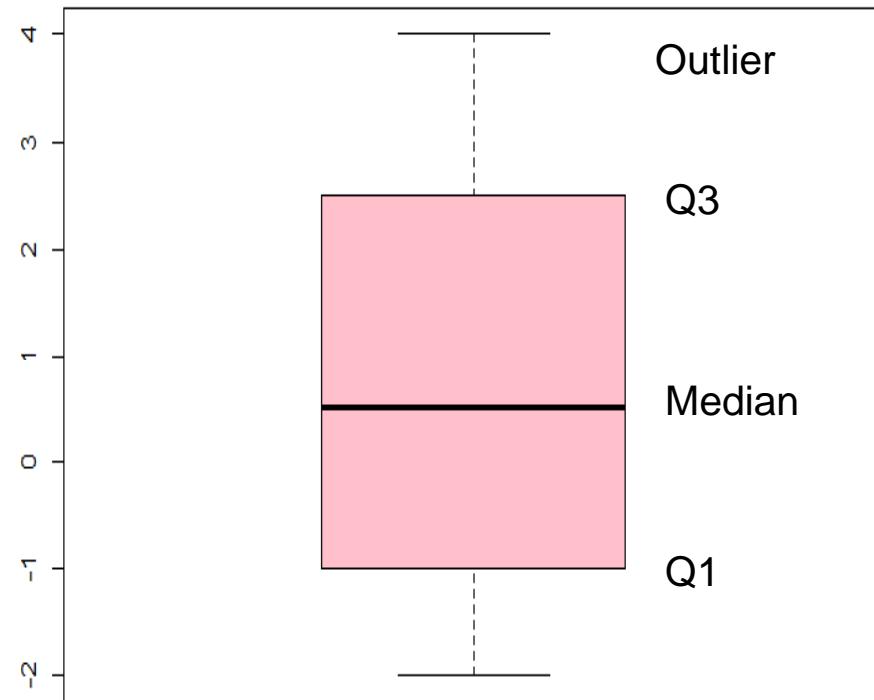
```
> boxplot(u)
```

```
> median(u)
```

```
0.5
```

```
> summary(u)
```

| Min. | 1Q. | Median | Mean | 3Q. | Max. |
|------|------|--------|------|------|------|
| -2 | -0.5 | 0.5 | 0.75 | 1.75 | 4 |

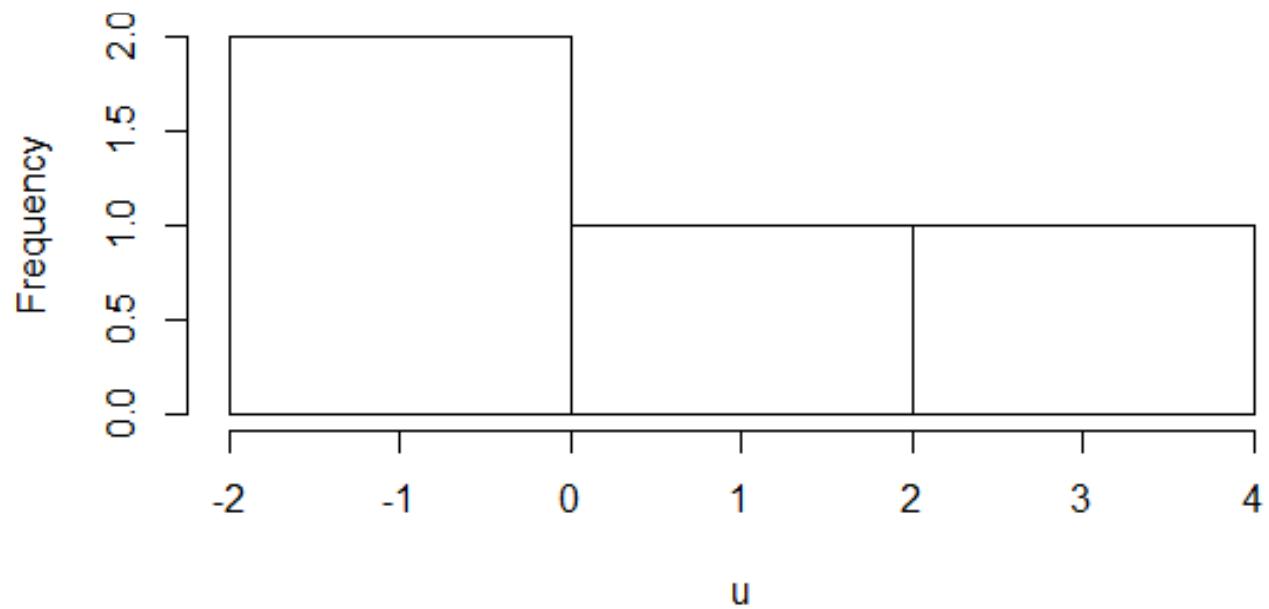


histogram(data)

```
> u <- c(1, 4, 0, -2)
```

```
> hist(u)
```

Histogram of u



Statistical functions

```
> u <- c(1, 4, 0, -2)
> mean(u)
  0.75
> sd(u); max(u); min(u); median(u); var(u)
  2.5,     4,     -2,      0.5,      6.25
> sum(u) ; length(u)
  3,     4,
```

Not Available: NA and NaN

```
> str( log( c(-1, 0, 1, 2, NA) ) )  
      NaN -Inf 0 0.693 NA
```

Warning .. NaNs produced

```
> is.finite( log(c(-1, 0, 1, 2, NA)) )  
      F F T T F
```

Dealing with Missing Values

```
> x <- c(1,5,9,NA,2)
```

```
> mean(x)
```

NA # NA = Not Available

Find mean after removing NA

```
> mean(x, na.rm=T)
```

4.25

Find NA in x

```
> is.na(x)
```

F F F T F

Make some random numbers

```
# Make 3 random uniform numbers
```

```
> runif(3)
```

```
0.428 0.142 0.877
```

```
# Make 3 numbers between 5 to 10
```

```
> runif(3, 5,10)
```

```
6.749 8.611 8.108
```

Random numbers

```
# Generate 3 random numbers in  
# the range 5 to 10,  
# round them to 1 decimal digit.
```

```
> round( runif(3, 5, 10), digits=1)  
[1] 5.5 9.7 9.5
```

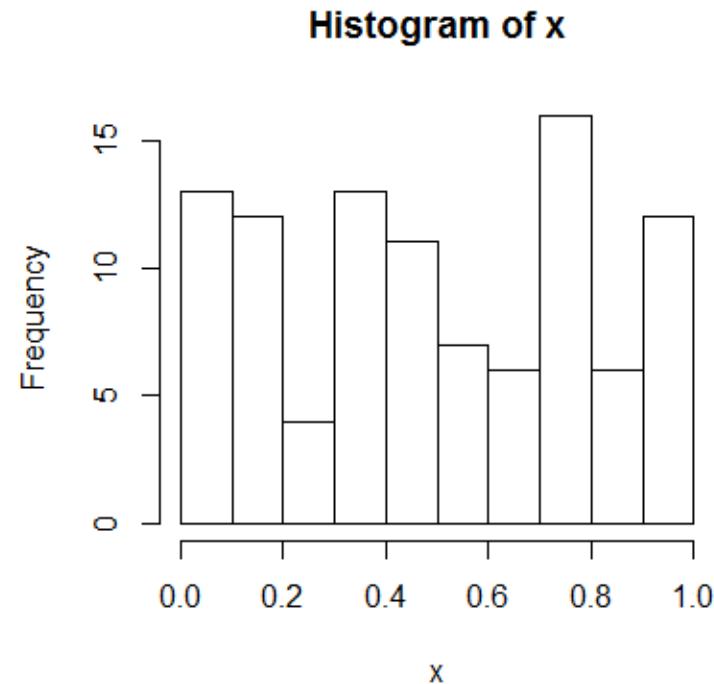
Save the numbers in variable y

```
# Save 3 numbers in a variable named y  
> y <- runif(3)  
# See what's in y  
> y  
[1] 0.179 0.384 0.176
```

Histogram

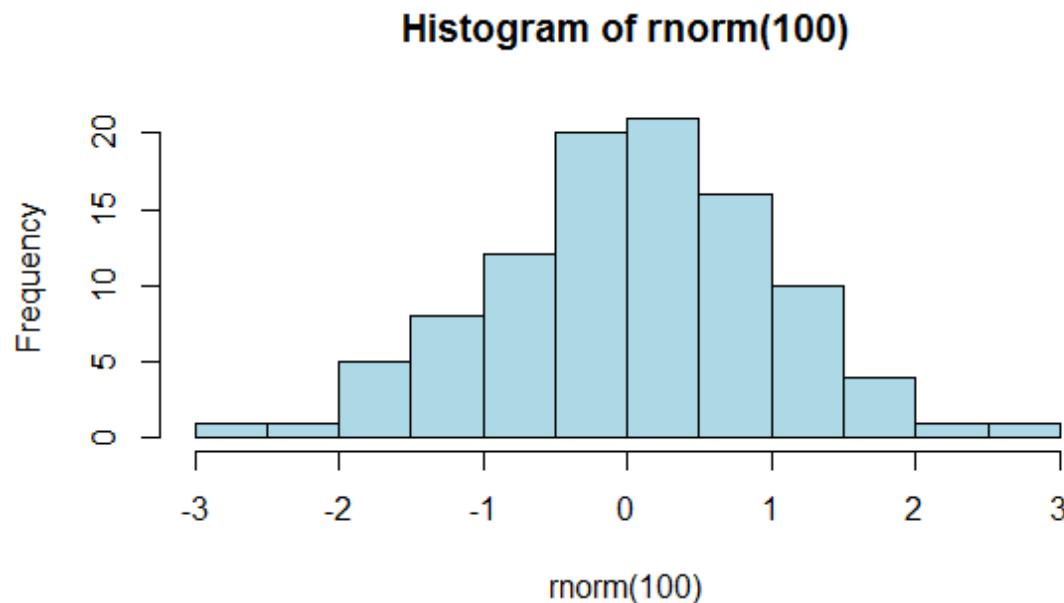
```
# Save 100 numbers in a  
# variable named x  
> x <- runif(100)
```

```
# Plot the histogram  
> hist( x )
```



Histogram of normal random numbers in blue color

```
# 100 normal distributed random numbers  
> hist( rnorm(100), col="light blue" )
```



To roll a Dice (Die) 10 times.

```
> sample(1:6, 1) # one throw
```

```
2
```



```
# Throw dice 10 times
```

```
> sample( 1:6, 10, replace=T)
```

```
5 6 3 2 5 5 3 4 1 6
```

Replace=T means, the same number can repeat.

Replace=F means, each number can appear only once.

Toss a coin 10 times.

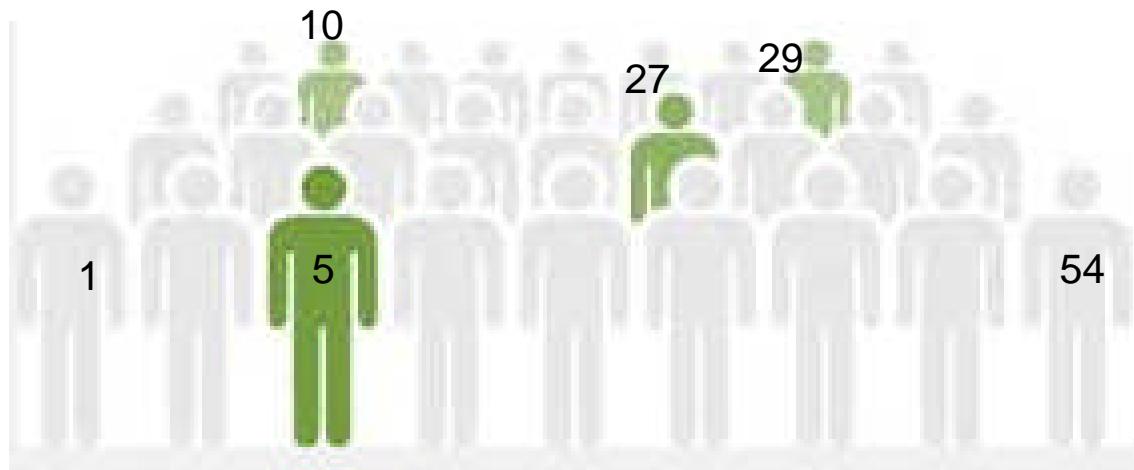
```
> sample(c("H","T"),10,replace=TRUE)  
"T" "H" "H" "H" "T" "H" "T" "H" "T" "T"
```



Select 4 different students from
a class of 54 students

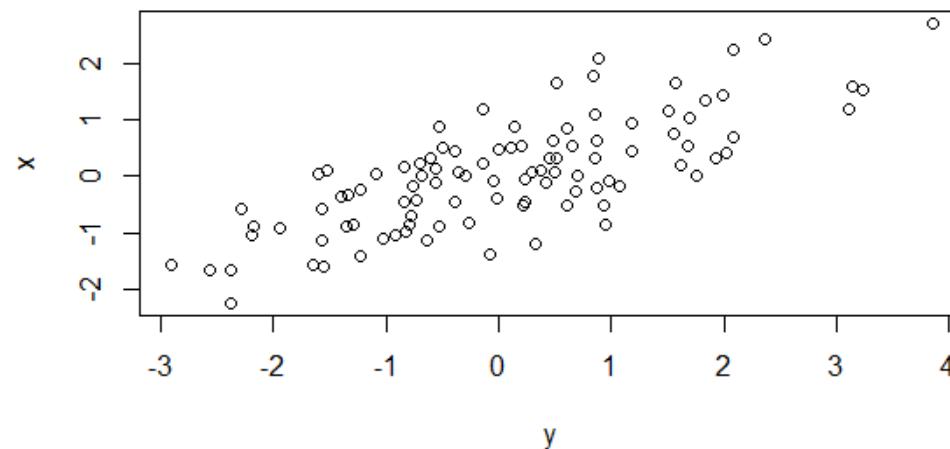
```
> sample(1:54, 4) # default is no replacement
```

```
[1] 27 5 10 29
```



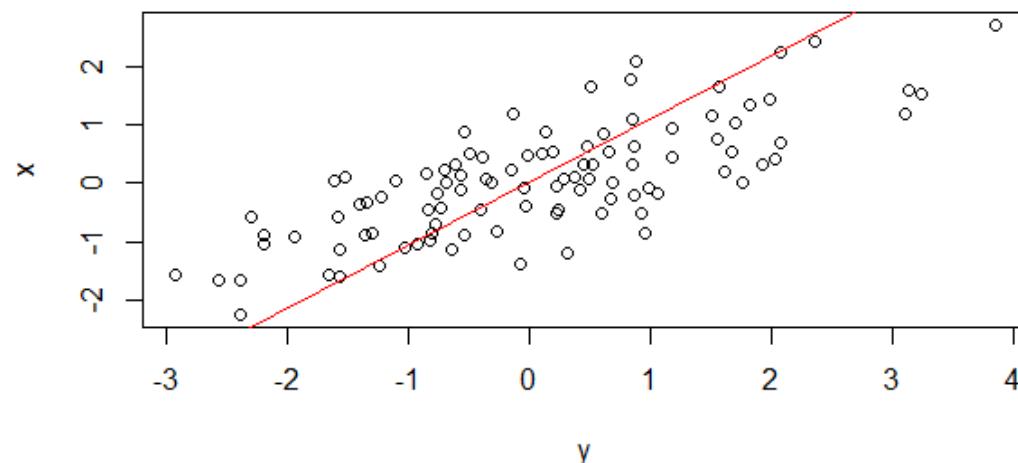
Scatter plot of two variables

```
> x <- rnorm(100)  
> y <- x + rnorm(100)  
> plot( x ~ y)
```



Add a Regression Line

```
> x <- rnorm(100)  
> y <- x + rnorm(100)  
> plot( x ~ y)  
> abline( lm(y ~ x), col = "red" )
```



Sharing Data with Excel

Data sharing with Excel, SPSS

```
# Reading excel csv data files  
sales <- read.csv( file.choose() )  
prices <- read.csv("prices-2012.csv")
```

```
# Load the foreign package  
library(foreign)  
# Import the spss data file  
read.spss("newData.sav")
```

Data frame (excel sheet)

```
# 3 columns: a, b c  
> x <- data.frame(a=1:3, b=5:7,  
c=11:13 )  
> x  
      a b c  
1    1 5 11  
2    2 6 12  
3    3 7 13  
> x$a    # Get column 'a' of x, same as x[['a']]  
1 2 3
```

Columns of a data frame

```
> x$c <- NULL # delete column c.  
> x$d <- 21:23 # add new column d.  
> x  
   a  b  d  
1  1  5 21  
2  2  6 22  
3  3  7 23
```

cbind to Combine two sheets

```
> y <- 31:33  
> cbind( x, y )  
      a  b  d  y  
1 1 5 21 31  
2 2 6 22 32  
3 3 7 23 33
```

Omit rows with NA data

```
> x <- c(1,2,NA,4)
> d <- data.frame(x, y=rev(x))
> d
      x     y
1   1     4
2   2    NA
3   NA    2
4   4     1
> na.omit(d)      # Remove rows with NA
      x     y
1   1     4
2   4     1
```

Matrix

```
> m <- matrix( c(1,2,3,4), nrow=2)
```

```
> m
```

| | [,1] | [,2] | |
|------|------|------|---------|
| [1,] | 1 | 3 | # Row 1 |
| [2,] | 2 | 4 | # Row 2 |

```
> det(m) # Determinant of m=1x4-2x4
```

```
-2
```

Define your own function

Create a function.

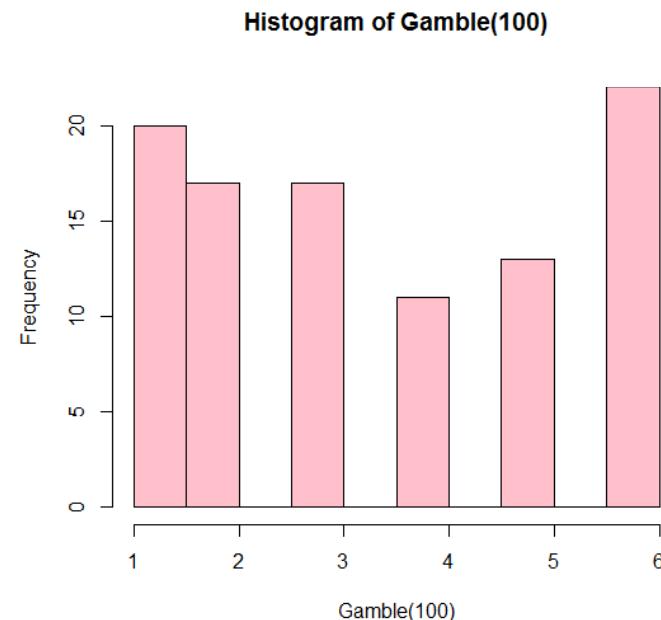
```
> Gamble = function(n)  
sample(1:6, n, replace=T)
```

Call Gamble with n=4

```
> Gamble(4)  
[1] 3 4 3 6
```

Plot Gamble

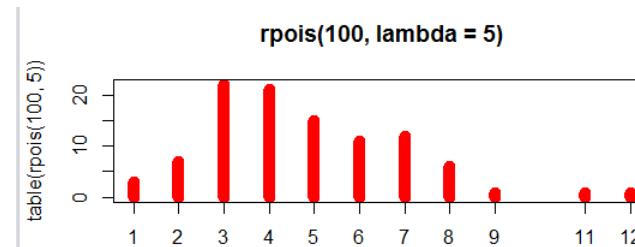
```
> hist( Gamble(100),  
       col="pink")
```



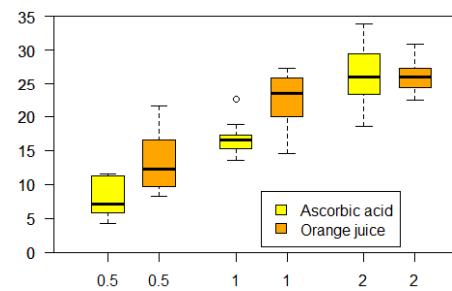
Builtin Examples

Try these examples in R

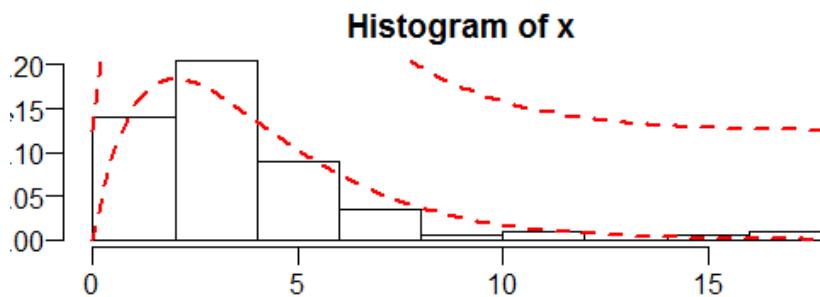
```
> example(plot)
```



```
> example(boxplot)
```



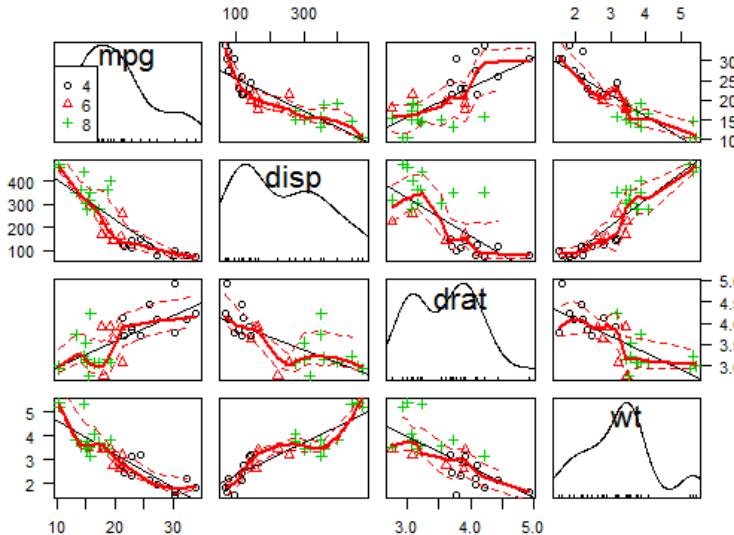
```
> example(hist)
```



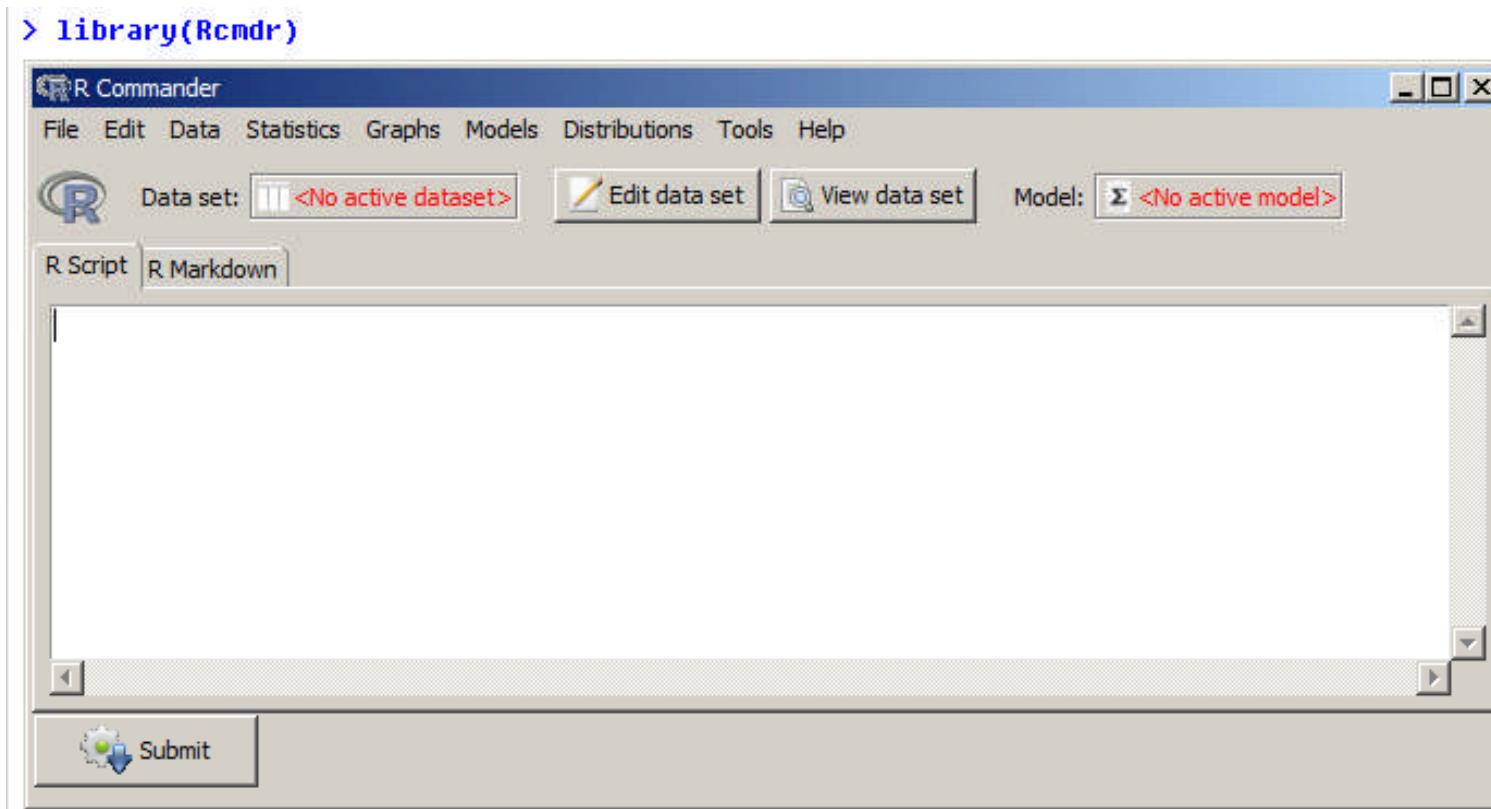
Playing with Builtin Data

Scatterplot Matrices from the car Package

```
> library(car)  
> scatterplotMatrix(~mpg +disp +drat +wt |cyl,  
+ data=mtcars)
```

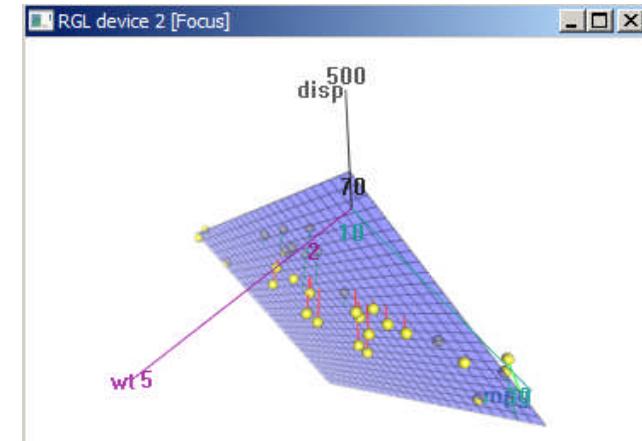


R Commander: Rcmdr



3D graphs

```
> library(Rcmdr)  
> attach(mtcars)          # see ?mtcars  
> scatter3d(wt, disp, mpg)
```



References

1. Intro to R, Venables and Smith, <http://cran.r-project.org/doc/manuals/R-intro.pdf>
<http://cran.r-project.org/manuals.html>
2. Basic Statistics tests in R,
<http://www.statmethods.net/stats/index.html>
3. Advanced Probability/Statistics in R,
http://zoonek2.free.fr/UNIX/48_R/all.html
4. More Statistics tests in R,
<http://www.ats.ucla.edu/stat/r/whatstat/whatstat.htm>
5. 7 lectures on Financial Trading with R,
<http://www.rfortraders.com/>

R 4 MBA

Introduction to R

R is Statistical Programming Language

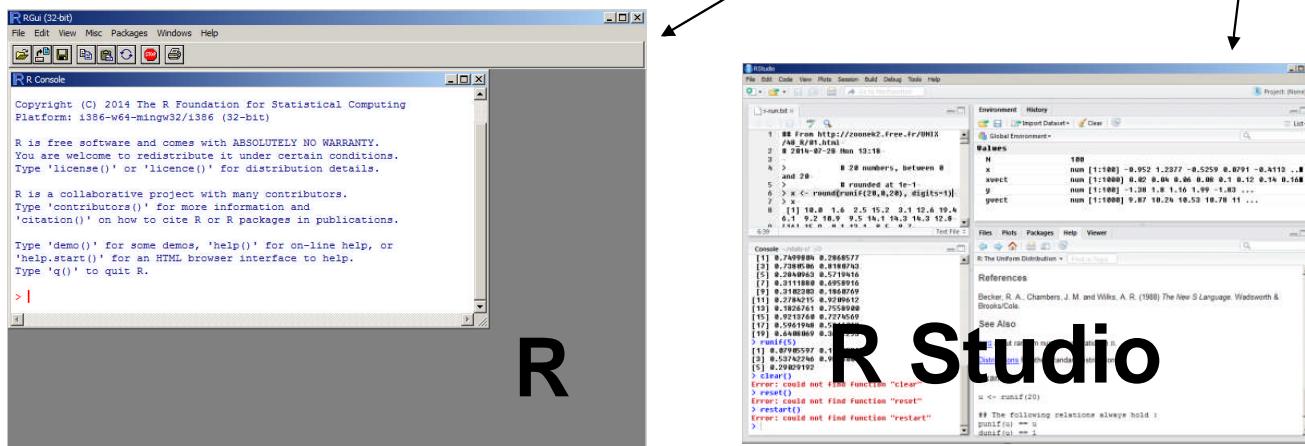
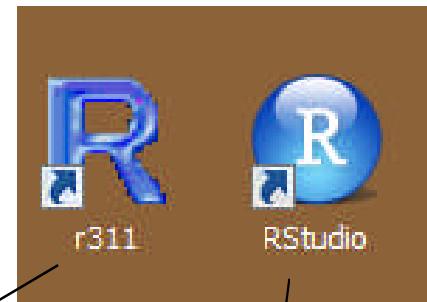
Moshahmed@gmail.com
JKSHIM, 16/4/16.

History of R

- Ross Ihaka and Robert Gentleman created R in 1993, in University of Auckland, New Zealand.
- R language is the programming language that you write your commands and run in.
- R is the successor to the S, the statistics language from Bell Labs in 1976.

Installing R

- Google “R stats windows download”
- Download R and R-Studio
- Install R and R-Studio
- Start R by clicking on it



R Studio

The screenshot shows the R Studio interface with several overlaid text annotations:

- File viewer**: Located in the top-left corner of the code editor area.
- Console with Command Prompt to type Commands to R**: Located in the bottom-left corner of the console area.
- > 2 + 2 + 100**: A mathematical expression displayed in the console.
- 104**: A large orange number at the bottom left.
- Variables and values**: A blue text overlay on the right side of the environment pane.
- dts**: A blue text overlay on the right side of the plot area.
- Graphs plotted by R**: A blue text overlay on the right side of the plot area.

The R Studio interface includes:

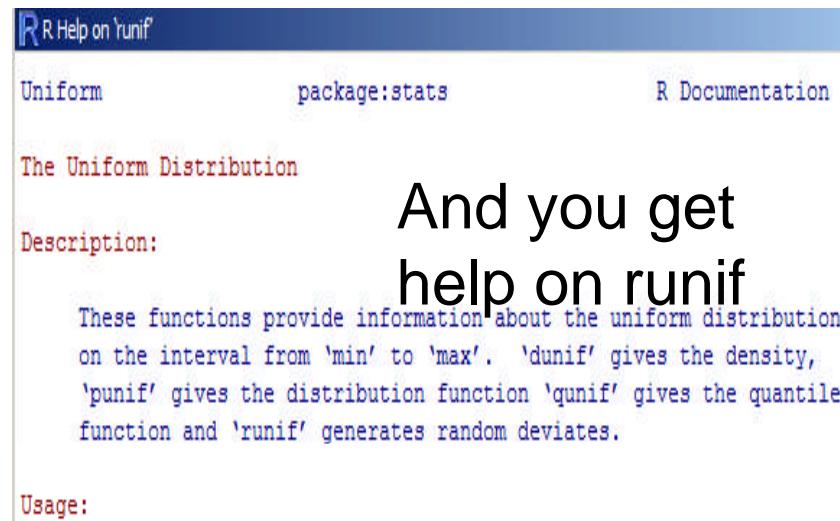
- File**, **Edit**, **Code**, **View**, **Plots**, **Session**, **Build**, **Debug**, **Tools**, **Help** menu bar.
- Source on Save** button in the toolbar.
- forecast.R** file open in the code editor.
- Environment** and **History** tabs in the top-right pane.
- Data** section showing objects: **data** (An xts object), **data1** (An xts object), and **diwali** (122 obs. of 102 variables).
- Values** section showing **dates** (2004-01-01) and **dts** (chr [1:122, 1:4] "-0.387" "-0.386" ...).
- Files**, **Plots**, **Packages**, **Help**, **Viewer** tabs in the bottom navigation bar.
- Console** tab showing R commands and their output.
- Plots** tab showing a time series plot titled "dts" with peaks over time from 2004 to 2014.

Workflow in R

1. Read Data into R
2. Analyze Data
3. Visualize Data
4. Make Conclusions from Data

Help in R Studio

> ?runif



R Help on 'runif'

Uniform package:stats R Documentation

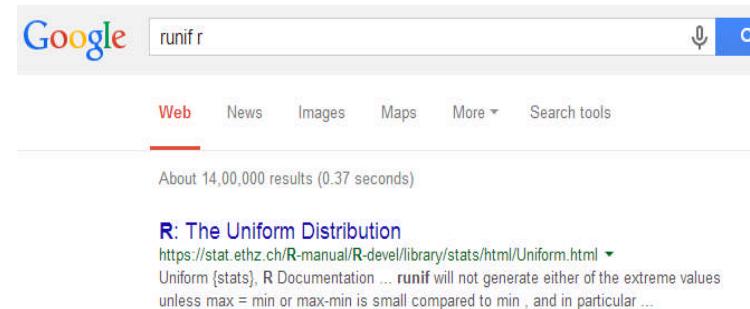
The Uniform Distribution

Description:

These functions provide information about the uniform distribution on the interval from 'min' to 'max'. 'dunif' gives the density, 'punif' gives the distribution function 'qunif' gives the quantile function and 'runif' generates random deviates.

Usage:

Or google
R statistics runif



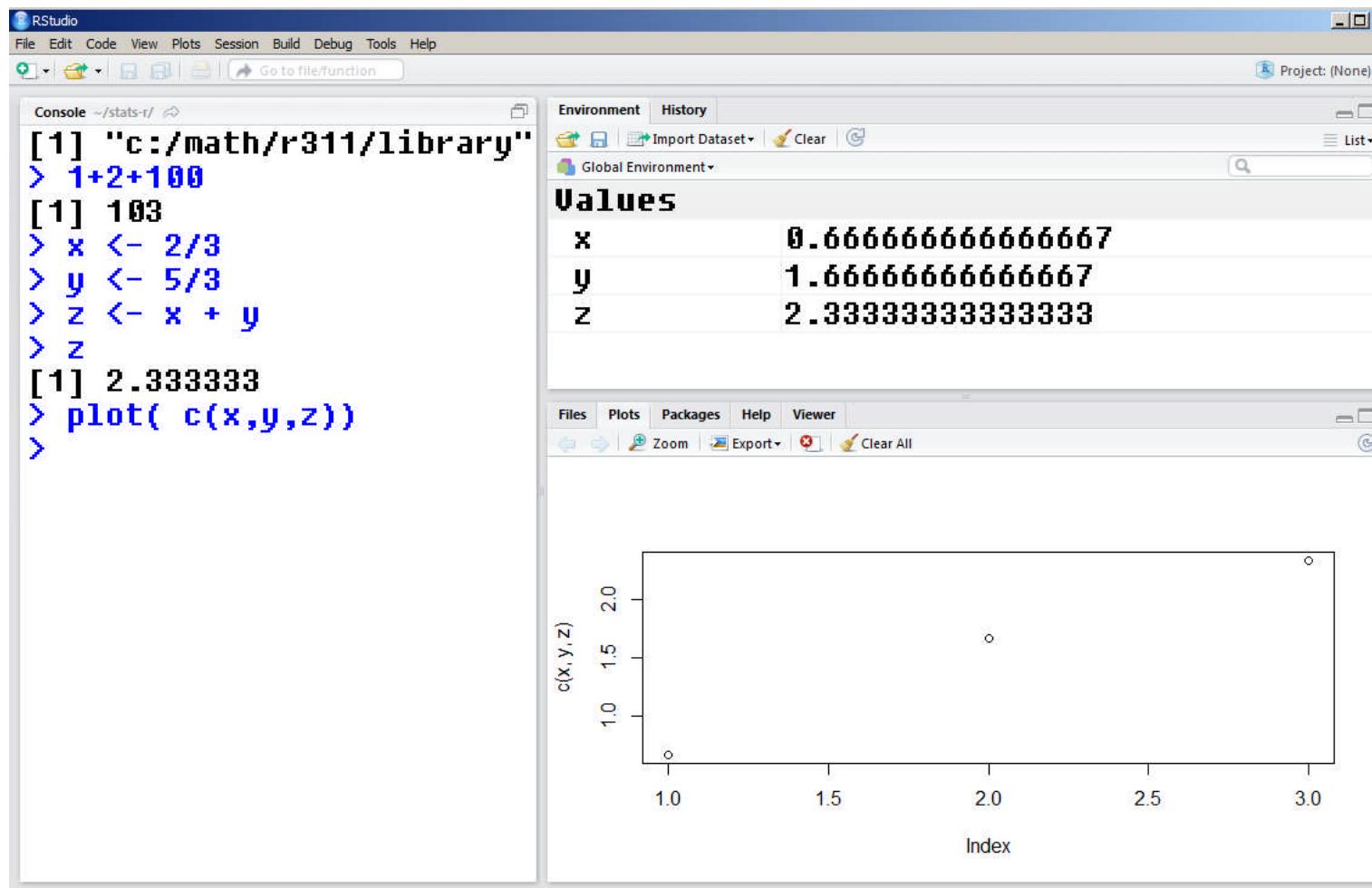
Google runif r

Web News Images Maps More Search tools

About 14,00,000 results (0.37 seconds)

R: The Uniform Distribution
<https://stat.ethz.ch/R-manual/R-devel/library/stats/html/Uniform.html> ▾
Uniform [stats], R Documentation ... runif will not generate either of the extreme values unless max = min or max-min is small compared to min , and in particular ...

R as a calculator



R as a Scientific calculator

```
> 1+1/2+1/3+2/3
```

```
[1] 2.5
```



```
> 1/0 # undefined to divide by zero
```

```
[1] Inf # Infinite
```

```
> 0/0
```

```
[1] NaN # undefined, not-a-number
```

```
> sqrt(2i) # Complex numbers
```

```
[1] 1+1i
```

R Command Prompt

1. Start R by clicking on its icon

```
> # Comment lines are ignored by R  
  
> 2+2 # You type commands at the R prompt.  
[1] 4    # Result '4' printed by R, ignore [1].  
  
> 1+1/2+1/3+2/3  
[1] 2.5
```

Vector of numbers

```
# Sequence of numbers from 1 : to 10
```

```
> 1:10
```

```
[1] 1 2 3 4 5 6 7 8 9 10
```

```
# Create 4 numbers and save the  
# vector in variable named u.
```

```
> u <- c(1, 4, 0, -2)
```

Sequence, vector

```
> 1:5                      # 1 2 3 4 5  
> c(1,2,3,4,5)            # 1 2 3 4 5  
> seq( 0, 4, len=3)       # 0 2 4  
> seq( 0, 4, by=2)        # 0 2 4  
  
> c(a=1, b=5, c=10) # Named vector  
a   b   c  
1   5   10
```

summary(data)

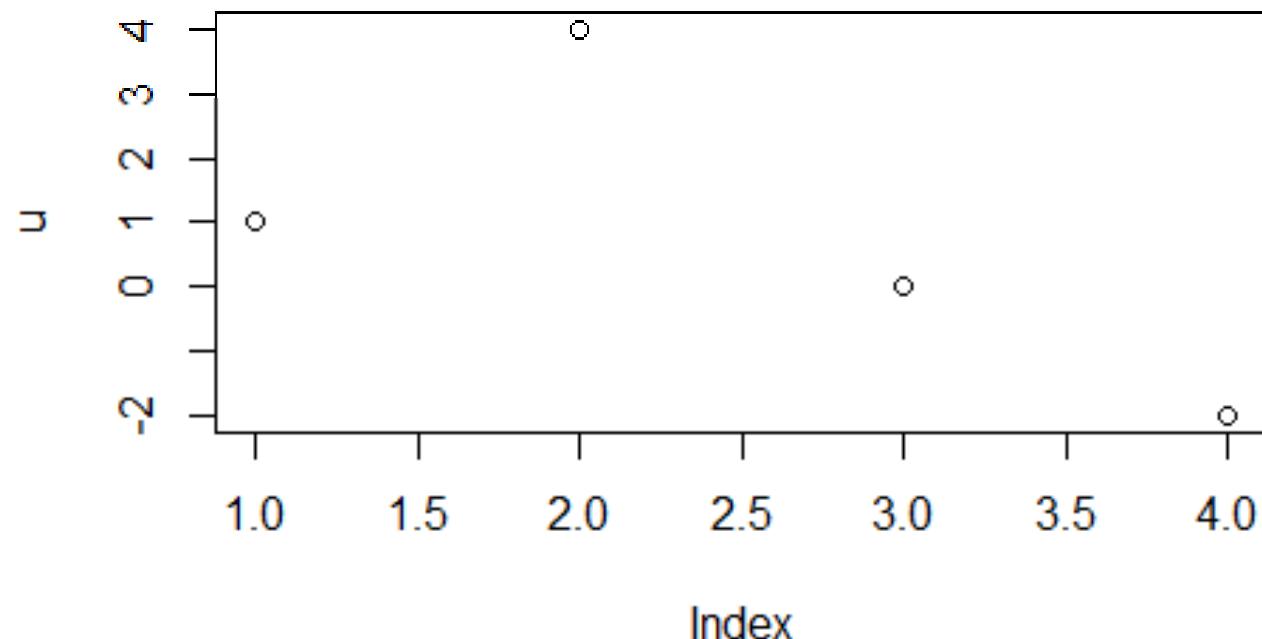
```
> u <- c(1, 4, 0, -2)
> summary(u)
Min. 1Q. Median Mean 3Q. Max.
-2    -0.5   0.5    0.75  1.75  4
```

quantile(data)

```
> u <- c(1, 4, 0, -2)  
> quantile(u)  
 0%   25%   50%   75% 100%  
-2    -0.5    0.5   1.75  4
```

```
> quantile(u, c(0,.33,.66,1))  
 0%   33%   66% 100%  
-2   -0.02   0.98  4
```

```
plot(data)  
> u <- c(1, 4, 0, -2)  
> plot(u)
```



boxplot(data)

```
> u <- c(1, 4, 0, -2)
```

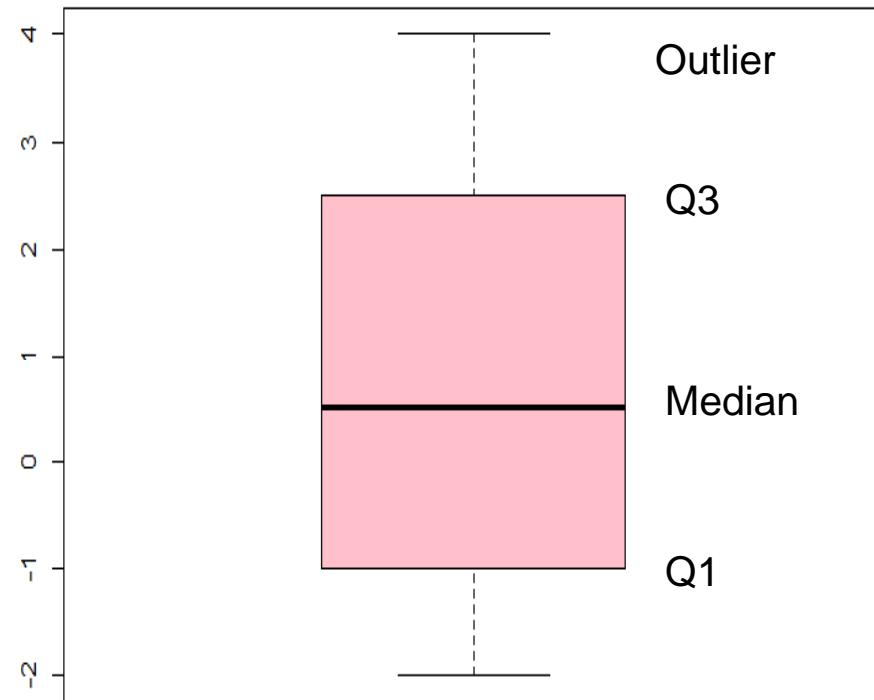
```
> boxplot(u)
```

```
> median(u)
```

```
0.5
```

```
> summary(u)
```

| Min. | 1Q. | Median | Mean | 3Q. | Max. |
|------|------|--------|------|------|------|
| -2 | -0.5 | 0.5 | 0.75 | 1.75 | 4 |

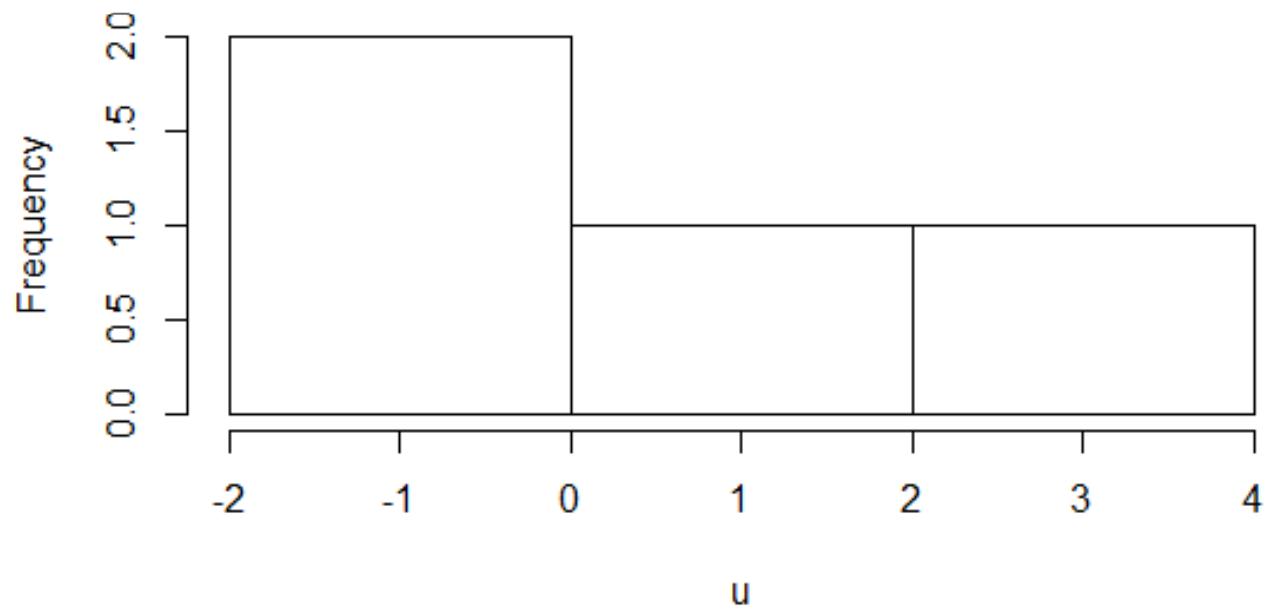


histogram(data)

```
> u <- c(1, 4, 0, -2)
```

```
> hist(u)
```

Histogram of u



Statistical functions

```
> u <- c(1, 4, 0, -2)
> mean(u)
  0.75
> sd(u); max(u); min(u); median(u); var(u)
  2.5,     4,     -2,      0.5,     6.25
> sum(u) ; length(u)
  3,     4,
```

Not Available: NA and NaN

```
> str( log( c(-1, 0, 1, 2, NA) ) )  
      NaN -Inf 0 0.693 NA
```

Warning .. NaNs produced

```
> is.finite( log(c(-1, 0, 1, 2, NA)) )  
      F F T T F
```

Dealing with Missing Values

```
> x <- c(1,5,9,NA,2)
```

```
> mean(x)
```

NA # NA = Not Available

Find mean after removing NA

```
> mean(x, na.rm=T)
```

4.25

Find NA in x

```
> is.na(x)
```

F F F T F

Make some random numbers

```
# Make 3 random uniform numbers
```

```
> runif(3)
```

```
0.428 0.142 0.877
```

```
# Make 3 numbers between 5 to 10
```

```
> runif(3, 5,10)
```

```
6.749 8.611 8.108
```

Random numbers

```
# Generate 3 random numbers in  
# the range 5 to 10,  
# round them to 1 decimal digit.
```

```
> round( runif(3, 5, 10), digits=1)  
[1] 5.5 9.7 9.5
```

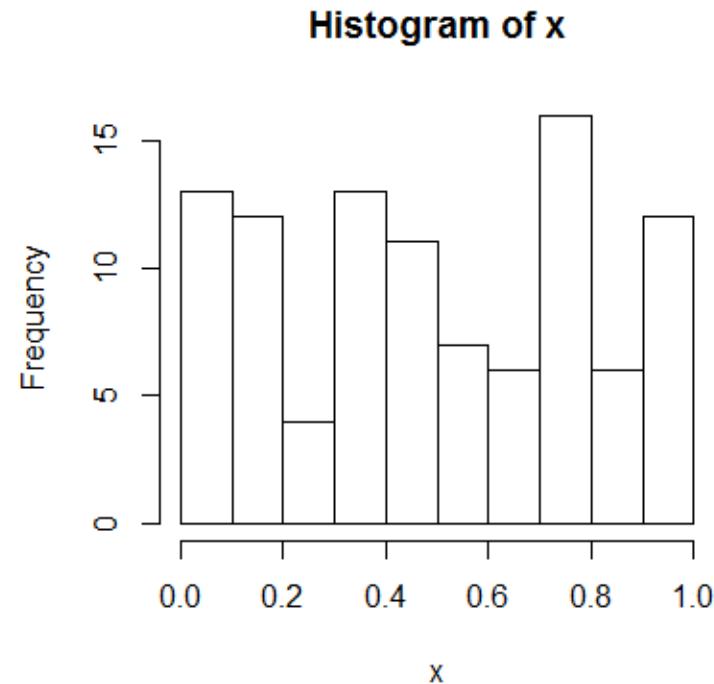
Save the numbers in variable y

```
# Save 3 numbers in a variable named y  
> y <- runif(3)  
# See what's in y  
> y  
[1] 0.179 0.384 0.176
```

Histogram

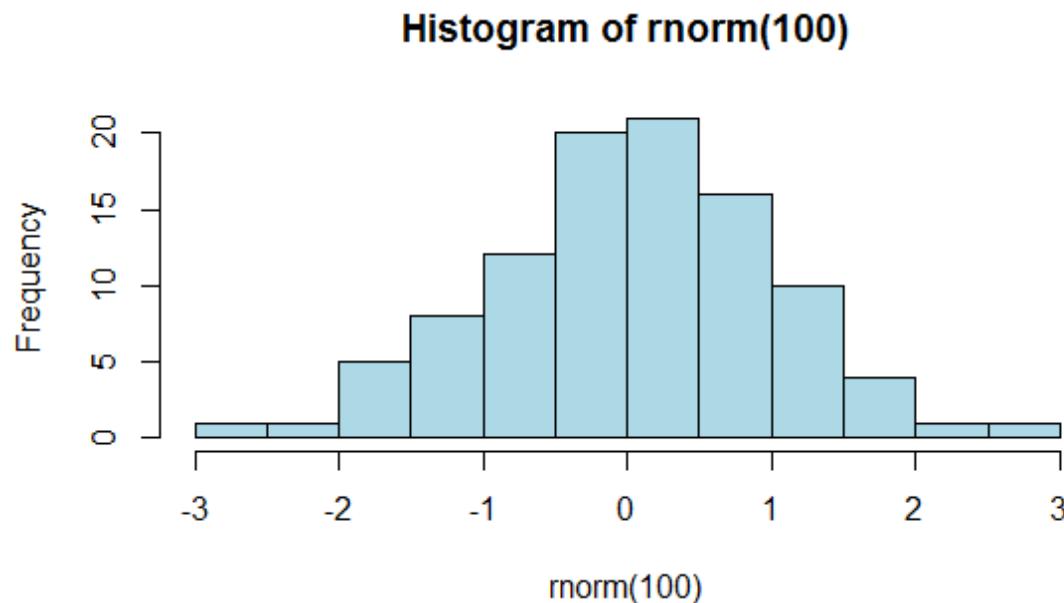
```
# Save 100 numbers in a  
# variable named x  
> x <- runif(100)
```

```
# Plot the histogram  
> hist( x )
```



Histogram of normal random numbers in blue color

```
# 100 normal distributed random numbers  
> hist( rnorm(100), col="light blue" )
```



To roll a Dice (Die) 10 times.

```
> sample(1:6, 1) # one throw
```

```
2
```



```
# Throw dice 10 times
```

```
> sample( 1:6, 10, replace=T)
```

```
5 6 3 2 5 5 3 4 1 6
```

Replace=T means, the same number can repeat.

Replace=F means, each number can appear only once.

Toss a coin 10 times.

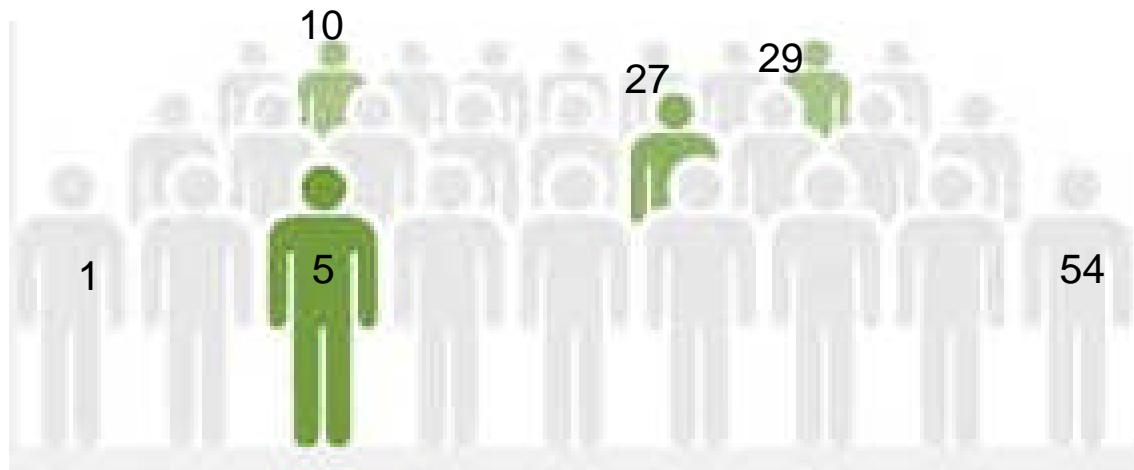
```
> sample(c("H","T"),10,replace=TRUE)  
"T" "H" "H" "H" "T" "H" "T" "H" "T" "T"
```



Select 4 different students from
a class of 54 students

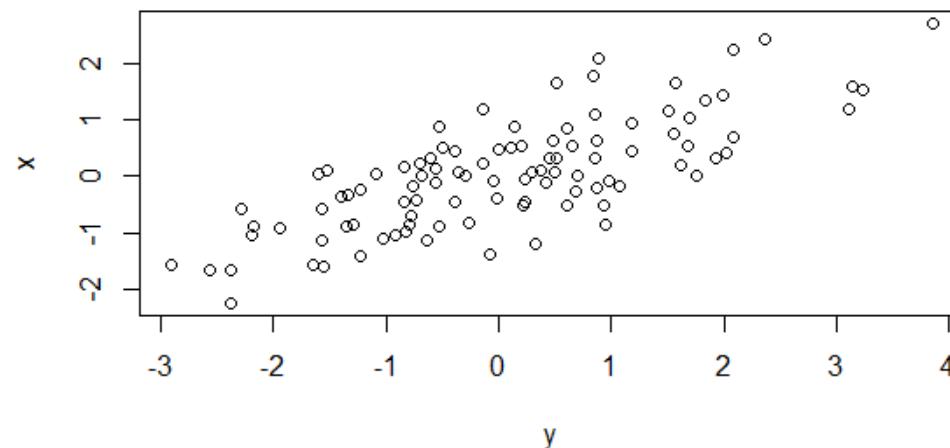
```
> sample(1:54, 4) # default is no replacement
```

```
[1] 27 5 10 29
```



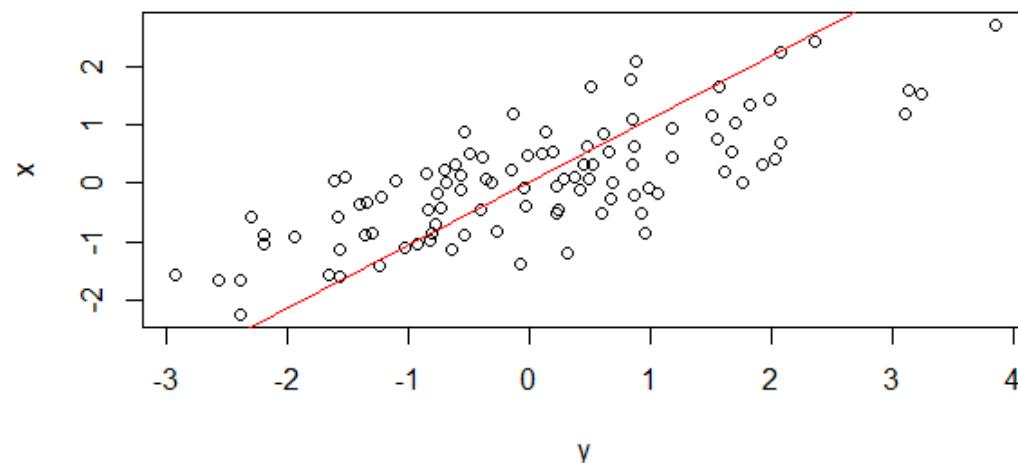
Scatter plot of two variables

```
> x <- rnorm(100)  
> y <- x + rnorm(100)  
> plot( x ~ y)
```



Add a Regression Line

```
> x <- rnorm(100)  
> y <- x + rnorm(100)  
> plot( x ~ y)  
> abline( lm(y ~ x), col = "red" )
```



Sharing Data with Excel

Data sharing with Excel, SPSS

```
# Reading excel csv data files  
sales <- read.csv( file.choose() )  
prices <- read.csv("prices-2012.csv")
```

```
# Load the foreign package  
library(foreign)  
# Import the spss data file  
read.spss("newData.sav")
```

Data frame (excel sheet)

```
# 3 columns: a, b c  
> x <- data.frame(a=1:3, b=5:7,  
c=11:13 )  
> x  
      a b c  
1    1 5 11  
2    2 6 12  
3    3 7 13  
> x$a    # Get column 'a' of x, same as x[['a']]  
1 2 3
```

Columns of a data frame

```
> x$c <- NULL # delete column c.  
> x$d <- 21:23 # add new column d.  
> x  
   a  b  d  
1  1  5 21  
2  2  6 22  
3  3  7 23
```

cbind to Combine two sheets

```
> y <- 31:33  
> cbind( x, y )  
      a  b  d  y  
1 1 5 21 31  
2 2 6 22 32  
3 3 7 23 33
```

Omit rows with NA data

```
> x <- c(1,2,NA,4)
> d <- data.frame(x, y=rev(x))
> d
      x     y
1   1     4
2   2    NA
3   NA    2
4   4     1
> na.omit(d)      # Remove rows with NA
      x     y
1   1     4
2   4     1
```

Matrix

```
> m <- matrix( c(1,2,3,4), nrow=2)
```

```
> m
```

| | [,1] | [,2] | |
|------|------|------|---------|
| [1,] | 1 | 3 | # Row 1 |
| [2,] | 2 | 4 | # Row 2 |

```
> det(m) # Determinant of m=1x4-2x4
```

```
-2
```

Define your own function

Create a function.

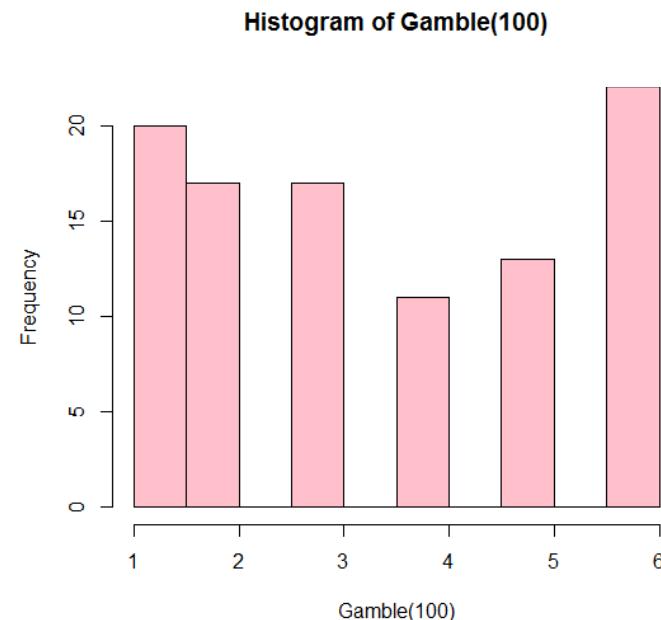
```
> Gamble = function(n)  
sample(1:6, n, replace=T)
```

Call Gamble with n=4

```
> Gamble(4)  
[1] 3 4 3 6
```

Plot Gamble

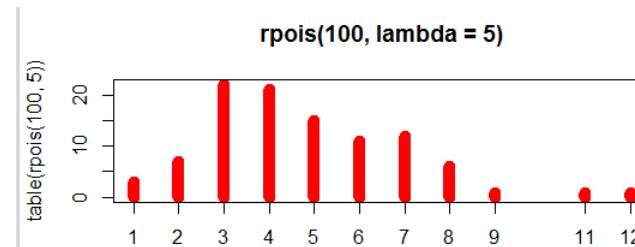
```
> hist( Gamble(100),  
       col="pink")
```



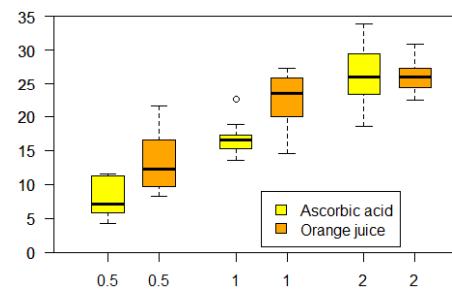
Builtin Examples

Try these examples in R

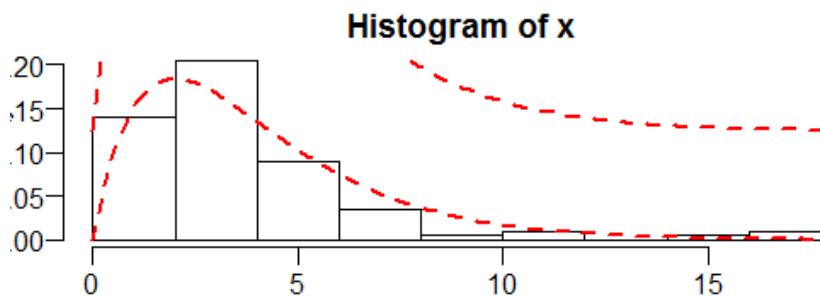
```
> example(plot)
```



```
> example(boxplot)
```



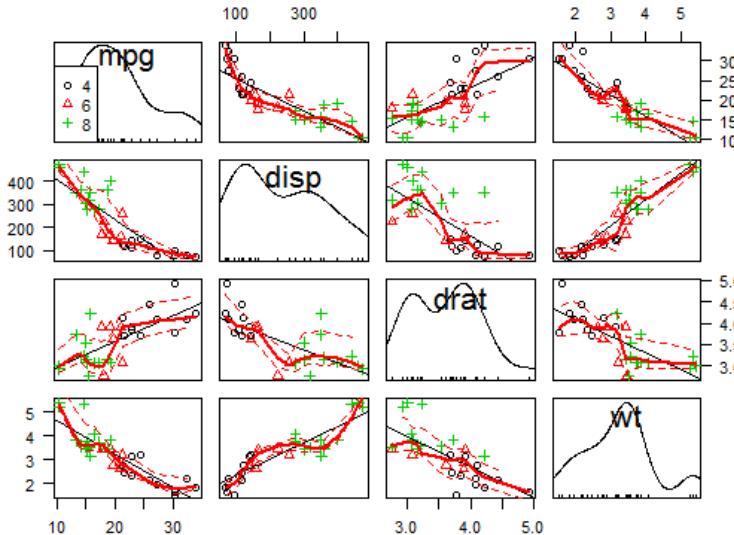
```
> example(hist)
```



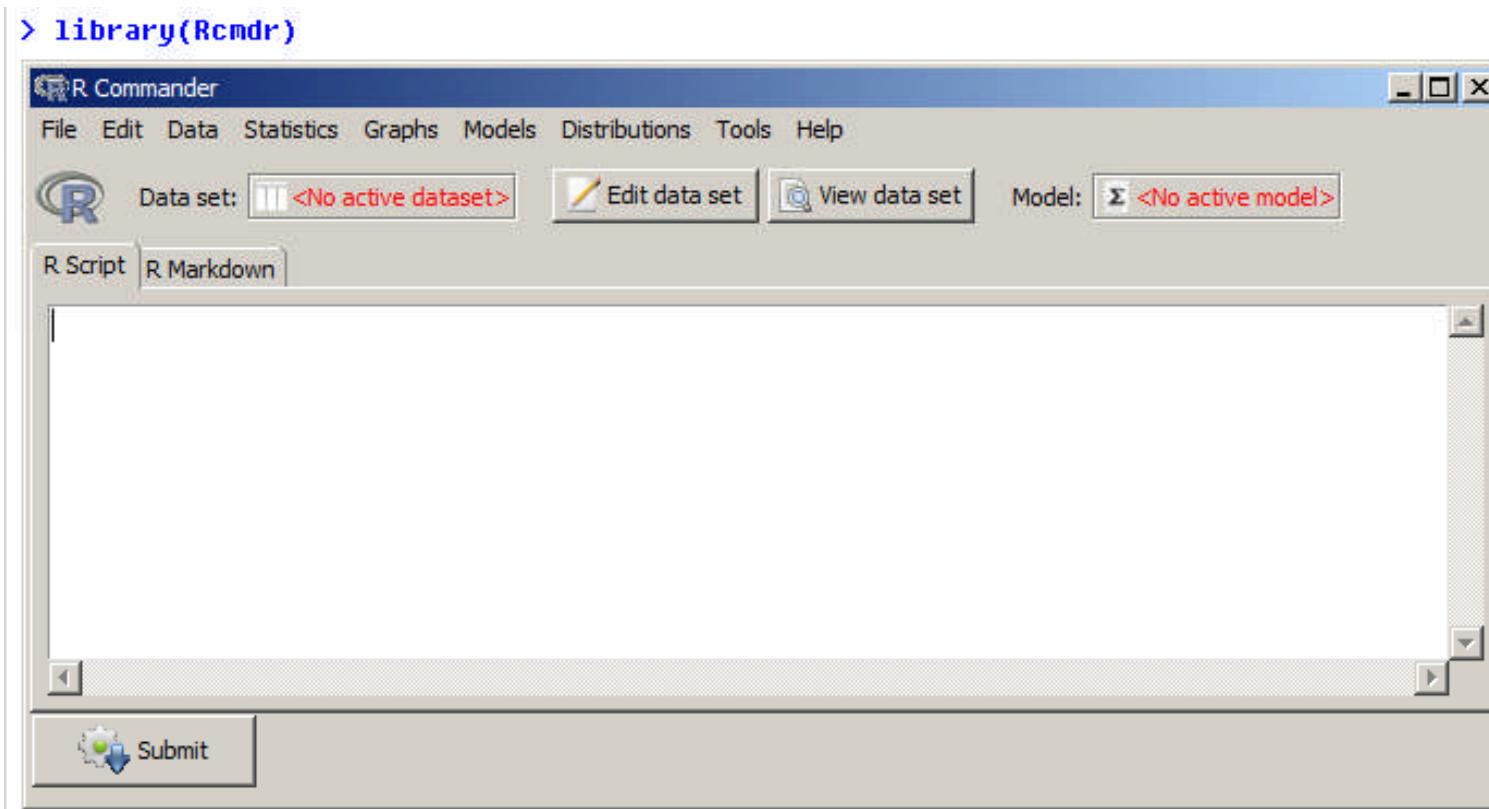
Playing with Builtin Data

Scatterplot Matrices from the car Package

```
> library(car)  
> scatterplotMatrix(~mpg +disp +drat +wt |cyl,  
+ data=mtcars)
```

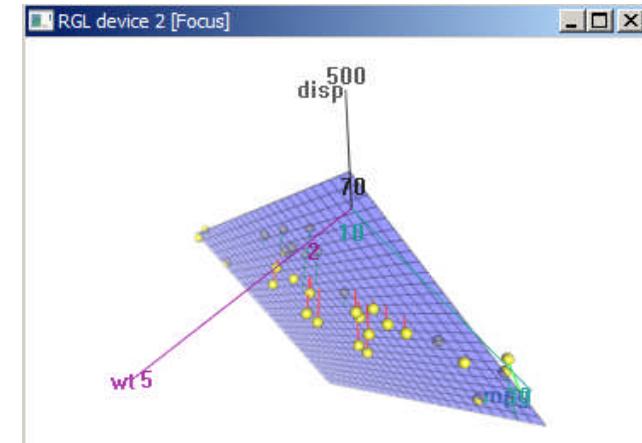


R Commander: Rcmdr



3D graphs

```
> library(Rcmdr)  
> attach(mtcars)          # see ?mtcars  
> scatter3d(wt, disp, mpg)
```



References

1. Intro to R, Venables and Smith, <http://cran.r-project.org/doc/manuals/R-intro.pdf>
<http://cran.r-project.org/manuals.html>
2. Basic Statistics tests in R,
<http://www.statmethods.net/stats/index.html>
3. Advanced Probability/Statistics in R,
http://zoonek2.free.fr/UNIX/48_R/all.html
4. More Statistics tests in R,
<http://www.ats.ucla.edu/stat/r/whatstat/whatstat.htm>
5. 7 lectures on Financial Trading with R,
<http://www.rfortraders.com/>

Section: _____ Roll Number: _____

Or Name: _____, Date 2014/03/____

Course: Creative Thinking,

First do all the questions alone in your notebook and Excel. If you have doubts work in group.

Draw the graphs for following and shade the region if any:

1. $x == 1 \ \& \ y == 1$
2. $x < 1 \ \& \ y < 2$
3. $x > 1 \ \& \ x < 2$
4. $x < 2 \ \& \ x > 1 \ \& \ y < 3 \ \& \ y > 2$

5. $x + y = 0$
6. $x + y < 0$
7. $x + y > 0$
8. $x + y > 2$

9. $x - y = 0$
10. $x - y = 2$
11. $x - y > 2$
12. $x - y < 2$
13. $x < y$
14. $x > y \ \& \ x > 0$.
15. $y < x \ \& \ x > 1 \ \& \ y > 1$.

First list the slope and intercept of the graph, and then draw the graph and shade the region for inequalities:

16. $y = 2x$
17. $y > 2x$
18. $2y > 4x$
19. $2y > x$
20. $y = 2x + 1$
21. $y = 3x + 1$
22. $y = 1 - x$
23. $y = 1 - 2x$
24. $x + y = 10$
25. $2x + 3y = 10$
26. $3x - 2x = 7$.
27. $3x - 3y = 0$

28. $x > 1$ or $y > 1$.
29. $x + y > 1$ or $x + y < -1$
30. $2x + 2y > 2$ or $2x - 2y < 2$

Using Excel

Q31. Write this as an LP optimization problem: A store sells three brands of stereo systems: brands A, B, and C.

It can sell a total of 100 stereo systems per month.

Brands A, B, and C take up, respectively, 5, 4, and 4 cubic feet of warehouse space and a maximum of 480 cubic feet of warehouse space is available.

Brands A, B, and C generate sales commissions of Rs40, Rs20, and Rs30, respectively, and Rs3200 is available to pay the sale commissions.

The profit generated from the sale of each brand is Rs70, Rs210, and Rs140, respectively.

How many of each brand of stereo system should be sold to maximize profit?

- A. What are the variables?
- B. What are we optimizing (give equation for the objective function)?
- C. What are the constraints (give the equations)?
- D. Type Q31 in Excel. And solve it.

Q32. Farmer wants to grow Apples, Banana, Chiko. He wrote the equations below to describe his situation.

Now help him use Excel to maximize his profit: $z = 3 * A + B + 2 * C$; With these constraints:

$$\begin{aligned} A + B + 3*C &= < 30; \\ 2*A + 2*B + 5*C &= < 24; \\ 4*A + B + 2*C &= < 36; \end{aligned}$$

All variables are non negative.

Q33. Farmer wants to grow x apples and y oranges; he has following linear constraints:

$$\begin{aligned} 6 \text{ acres of land: } 3x + y &= < 6 \\ 6 \text{ tons of fertilizer: } 2x + 3y &= < 6 \\ 8 \text{ hour work day: } x + 5y &= < 8 \end{aligned}$$

Apples sell for twice as much as oranges Production is positive: $x \geq 0, y \geq 0$. Maximize his profit using Excel.

Q 34. Help Samson, formulate this as an LP and solve using Excel.

Samson TV has to decide on the number of x1 and x2 sets to be produced at one of its factories. Market research indicates that at most 40 of the x1 sets and 10 of the x2 sets can be sold per month. The maximum number of work-hours available is 500 per month.

A x1 set requires 20 work-hours and a x2 set requires 10 work-hours. Each x1 set sold produces a profit of \$120 and each x2 set produces a profit of \$80.

Q 35 Help Gotiya save money, by solving his problem with excel:

Gotiya has a goat farm. He is trying to decide what to feed his goats. He is considering using a combination of goat feeds available from local suppliers.

He would like to feed the goats at minimum cost while also making sure each goat receives an adequate supply of calories and vitamins.

The cost, calorie content, and vitamin content of each feed are given in the table below.

| Contents | Feed A | Feed B |
|------------------|--------|--------|
| Calories/kg | 800 | 1000 |
| Vitamins unit/Kg | 140 | 70 |
| Cost/kg Rs | 0.40 | 0.80 |

Each goat requires at least 8,000 calories per day and at least 700 units of vitamins. A further constraint is that no more than one-third of the diet (by weight) can consist of Feed A.

Q36. A dietitian is asked to design a special diet supplement using two different foods X and Y containing:

| | X | Y | Requirement |
|------------|-----|----|-------------|
| Calcium | 20 | 10 | 300 |
| Iron | 15 | 10 | 150 |
| Vitamin B | 10 | 20 | 20 |
| Cost Rs/Kg | 111 | 99 | Total Cost |
| How much? | | | |

Q. What are the variables? What are we optimizing, write the equation. What are the constraints, write the equations. Use Excel to solve it.

--- COCONUT BRAND ---

Q 37. Jackie.Shine is opening a coconut drink shop. There are 3 popular brands: A, B, C (L-neer, Cocosip, Cocojal).

The costs of A,B,C is Rs. 10, 12, 15. She can sell them at Rs 20, 23, 26. The municipal charges Rs 1 to dispose coconut shell.

From market survey, she estimates maximum demand at 500, 400, 300 coconuts per month. There are some loyal student customers, who want 60 of each brand every month.

She has balance Rs 15,000 for paying the suppliers in advance. She can stock 1000 coconuts per month in the small shop.

How many of each should she order every month to maximize her profits and keep all the customers happy?

Q38 . She decides to increases profit by increasing price to Rs 25, 28, 35. But that means the demand will fall to maximum 200, 200, 100 per month.

Should she raise the price? What is the new profit?

Q39. It is summer time, the demand may increase to 400, 400, 600, if she reduces the prices to 18, 22, 25. Should she lower the price? What is the profit now?

Q40. Going back to the original excel sheet in Q37. The brand C has a lockout in their plant for a month (no supplies from C), and Brand A, B take advantage and raise cost price by Rs 10 each because of labour shortage.

What is the new optimal? What should be done?

Solutions

Q31. Write this as an LP optimization problem: A store sells three brands of stereo systems: brands A, B, and C.

It can sell a total of 100 stereo systems per month.

Brands A, B, and C take up, respectively, 5, 4, and 4 cubic feet of warehouse space and a maximum of 480 cubic feet of warehouse space is available.

Brands A, B, and C generate sales commissions of Rs40, Rs20, and Rs30, respectively, and Rs3200 is available to pay the sale commissions.

The profit generated from the sale of each brand is Rs70, Rs210, and Rs140, respectively.

How many of each brand of stereo system should be sold to maximize profit?

A. What are the variables?

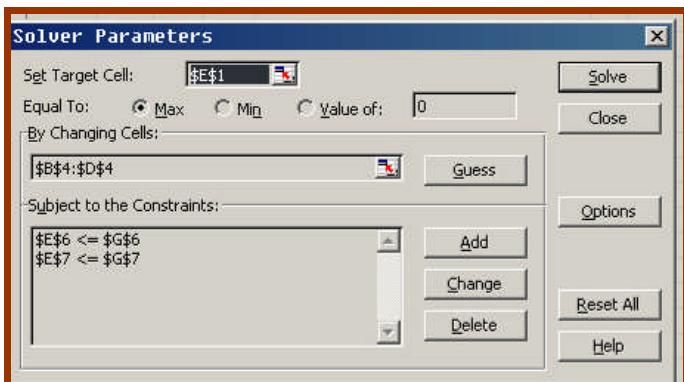
B. What are we optimizing (give equation for the objective function)?

C. What are the constraints (give the equations)?

D. Type Q31 in Excel. And solve it.

A31. Variables are (x1,x2,x3) quantity of A,B,C sold. maximizing profit = 25200, with (x1,x2,x3)=(0,120,0).

| | | | | fx limit | | | |
|---|--------|----|-----|----------|----------------------------------|---------|-------|
| | A | B | C | D | E | F | G |
| 1 | | | | | maxz =SUMPRODUCT(B3:D3,B4:D4) | | |
| 2 | var | x1 | x2 | x3 | | | |
| 3 | profit | 70 | 210 | 140 | | | |
| 4 | values | 0 | 0 | 0 | | | |
| 5 | | | | | total | | limit |
| 6 | c1 | 5 | 4 | 4 | =SUMPRODUCT(B6:D6,\$B\$4:\$D\$4) | <= 480 | |
| 7 | c2 | 40 | 20 | 30 | =SUMPRODUCT(B7:D7,\$B\$4:\$D\$4) | <= 3200 | |



| | | | | fx =SUMPRODUCT(B3:D3,B4:D4) | | | |
|---|--------|----|-----|-----------------------------|-------|---------|-------|
| | A | B | C | D | E | F | G |
| 1 | | | | | maxz | 25200 | |
| 2 | var | x1 | x2 | x3 | | | |
| 3 | profit | 70 | 210 | 140 | | | |
| 4 | values | 0 | 120 | 0 | | | |
| 5 | | | | | total | | limit |
| 6 | c1 | 5 | 4 | 4 | 480 | <= 480 | |
| 7 | c2 | 40 | 20 | 30 | 2400 | <= 3200 | |

Q32.

Farmer wants to grow Apples, Banana, Chiko. He wrote the equations below to describe his situation.

Now help him use Excel to maximize his profit: $z = 3 * A + B + 2*C$; With these constraints:

$$A + B + 3*C \leq 30;$$

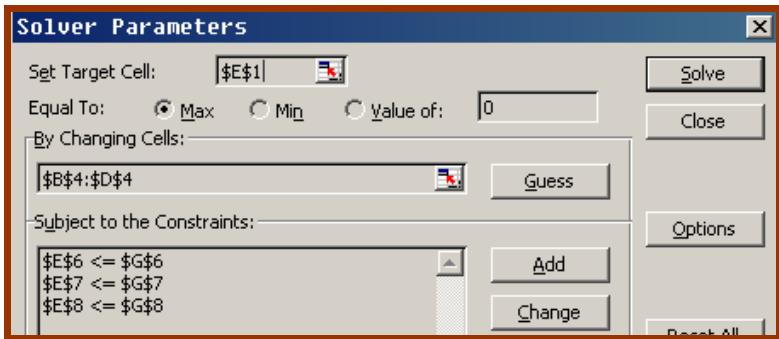
$$2*A + 2*B + 5*C \leq 24;$$

$$4*A + B + 2*C \leq 36;$$

All variables are non negative.

A32.

| | A | B | C | D | E | F | G |
|---|--------|----|----|----|--|----|----|
| 1 | | | | | =SUMPRODUCT(\$B\$3:\$D\$3,\$B\$4:\$D\$4) | | |
| 2 | var | x1 | x2 | x3 | | | |
| 3 | profit | 3 | 1 | 2 | | | |
| 4 | values | 0 | 0 | 0 | | | |
| 5 | | | | | total | | |
| 6 | c1 | 1 | 1 | 3 | =SUMPRODUCT(B6:D6,\$B\$4:\$D\$4) | <= | 30 |
| 7 | c2 | 2 | 2 | 5 | =SUMPRODUCT(B7:D7,\$B\$4:\$D\$4) | <= | 24 |
| 8 | c3 | 4 | 1 | 2 | =SUMPRODUCT(B8:D8,\$B\$4:\$D\$4) | <= | 36 |
| 9 | | | | | | | |



| | A | B | C | D | E | F | G |
|---|------|----|----|----|-------|-------|----|
| 1 | | | | | maxz | 28 | |
| 2 | var | x1 | x2 | x3 | | | |
| 3 | ofit | 3 | 1 | 2 | | | |
| 4 | ues | 8 | 4 | 0 | | | |
| 5 | | | | | total | limit | |
| 6 | c1 | 1 | 1 | 3 | 12 | = | 30 |
| 7 | c2 | 2 | 2 | 5 | 24 | = | 24 |
| 8 | c3 | 4 | 1 | 2 | 36 | = | 36 |

Q33.

Farmer wants to grow x apples and y oranges; he has following linear constraints:

6 acres of land: $3x + y \leq 6$

6 tons of fertilizer: $2x + 3y \leq 6$

8 hour work day: $x + 5y \leq 8$

Apples sell for twice as much as oranges

Production is positive: $x \geq 0, y \geq 0$.

Maximize his profit using Excel.

A33

The screenshot shows the Excel interface with three main components:

- Excel Worksheet:** A grid of cells containing data and formulas. Key entries include:
 - Cell D1: `=SUMPRODUCT(B3:C3,B4:C4)`
 - Cell D6: `=SUMPRODUCT(B6:C6,B4:C4)` with constraint ≤ 6
 - Cell D7: `=SUMPRODUCT(B7:C7,B4:C4)` with constraint ≤ 6
 - Cell D8: `=SUMPRODUCT(B8:C8,B4:C4)` with constraint ≤ 8
- Solver Parameters Dialog:** A window titled "Solver Parameters" with the following settings:
 - Set Target Cell: `profit` (Max selected)
 - Equal To: `Max`
 - By Changing Cells: `B4:C4`
 - Subject to the Constraints: `D6 <= F6`, `D7 <= F7`, `D8 <= F8`
- Resulting Worksheet:** The same grid as the first, but with calculated values:
 - Cell B1: `maxz` with value **4.286**
 - Cell B4: `values` with values **1.714** and **0.85714**

Q 34. Help Samson, formulate this as an LP and solve using Excel.

Samson TV has to decide on the number of x_1 and x_2 sets to be produced at one of its factories. Market research indicates that at most 40 of the x_1 sets and 10 of the x_2 sets can be sold per month. The maximum number of work-hours available is 500 per month.

A x_1 set requires 20 work-hours and a x_2 set requires 10 work-hours. Each x_1 set sold produces a profit of \$120 and each x_2 set produces a profit of \$80.

A34

| | A | B | C | D | E | F |
|---|--------|-------|-------|--|----|-------|
| 1 | | | | =SUMPRODUCT(\$B\$3:\$C\$3,\$B\$4:\$C\$4) | | |
| 2 | var | x_1 | x_2 | | | |
| 3 | profit | 120 | 80 | | | |
| 4 | values | 0 | 0 | | | |
| 5 | | | | total | | limit |
| 6 | c1 | 1 | 0 | =SUMPRODUCT(B6:C6,\$B\$4:\$C\$4) | <= | 40 |
| 7 | c2 | 0 | 1 | =SUMPRODUCT(B7:C7,\$B\$4:\$C\$4) | <= | 10 |
| 8 | c3 | 20 | 10 | =SUMPRODUCT(B8:C8,\$B\$4:\$C\$4) | <= | 500 |

| | A | B | C | D | E | F |
|---|--------|-------|-------|-------|------|-------|
| 1 | | | | maxz | 3200 | |
| 2 | var | x_1 | x_2 | | | |
| 3 | profit | 120 | 80 | | | |
| 4 | values | 20 | 10 | | | |
| 5 | | | | total | | limit |
| 6 | c1 | 1 | 0 | 20 | <= | 40 |
| 7 | c2 | 0 | 1 | 10 | <= | 10 |
| 8 | c3 | 20 | 10 | 500 | <= | 500 |

Q 35 Help Gotiya save money, by solving his problem with excel:

Gotiya has a goat farm. He is trying to decide what to feed his goats. He is considering using a combination of goat feeds available from local suppliers.

He would like to feed the goats at minimum cost while also making sure each goat receives an adequate supply of calories and vitamins. The cost, calorie content, and vitamin content of each feed are given in the table below.

| Contents | Feed A | Feed B | Min Required | | |
|------------------|--------|--------|--------------|--|--|
| Calories/kg | 800 | 1000 | 8000 | | |
| Vitamins unit/Kg | 140 | 70 | 700 | | |
| Cost/kg Rs | 0.40 | 0.80 | | | |

Each goat requires at least 8,000 calories per day and at least 700 units of vitamins.

A further constraint is that no more than one-third of the diet (by weight) can consist of Feed A.

That is, constraint $A \leq 1/3 (A+B)$, which reduces to $2/3 A - 1/3 B \leq 0$.

A35

| | A | B | C | D | E | F |
|---|--------|-------|--------|----------------------------------|---------|---|
| 1 | | | | | | |
| 2 | var | A | B | | | |
| 3 | profit | 0.4 | 0.8 | | | |
| 4 | values | 0 | 0 | | | |
| 5 | | | total | | limit | |
| 6 | c1 | 800 | 1000 | =SUMPRODUCT(B6:C6,\$B\$4:\$C\$4) | >= 8000 | |
| 7 | c2 | 140 | 70 | =SUMPRODUCT(B7:C7,\$B\$4:\$C\$4) | >= 700 | |
| 8 | c3 | 0.667 | -0.333 | =SUMPRODUCT(B8:C8,\$B\$4:\$C\$4) | <= 0 | |

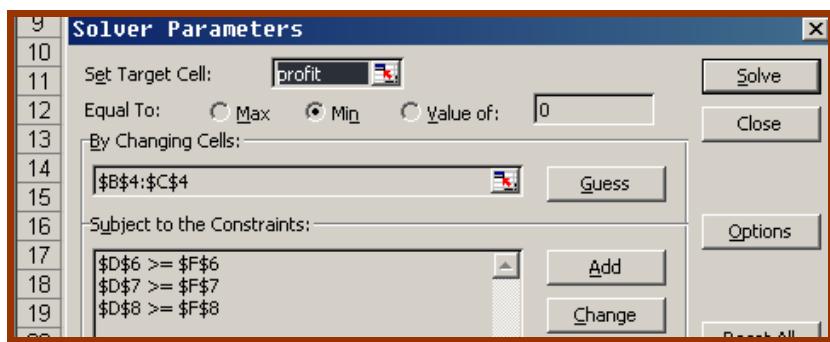
Q36. A dietitian is asked to design a special diet supplement using two different foods X and Y containing:

| | X | Y | Requirement |
|------------|-----|----|-------------|
| Calcium | 20 | 10 | 300 |
| Iron | 15 | 10 | 150 |
| Vitamin B | 10 | 20 | 20 |
| Cost Rs/Kg | 111 | 99 | Total Cost |
| How much? | | | |

Q. What are the variables? What are we optimizing, write the equation. What are the constraints, write the equations. Use Excel to solve it.

A36.

| | B | C | D | E | F |
|---|--------|-----|--|----------------------------------|--------|
| 1 | | | =SUMPRODUCT(\$B\$3:\$C\$3,\$B\$4:\$C\$4) | | |
| 2 | var | x | y | | |
| 3 | profit | 111 | 99 | | |
| 4 | values | 0 | 0 | | |
| 5 | | | total | | limit |
| 6 | c1 | 20 | 10 | =SUMPRODUCT(B6:C6,\$B\$4:\$C\$4) | >= 300 |
| 7 | c2 | 15 | 10 | =SUMPRODUCT(B7:C7,\$B\$4:\$C\$4) | >= 150 |
| 8 | c3 | 10 | 20 | =SUMPRODUCT(B8:C8,\$B\$4:\$C\$4) | >= 20 |

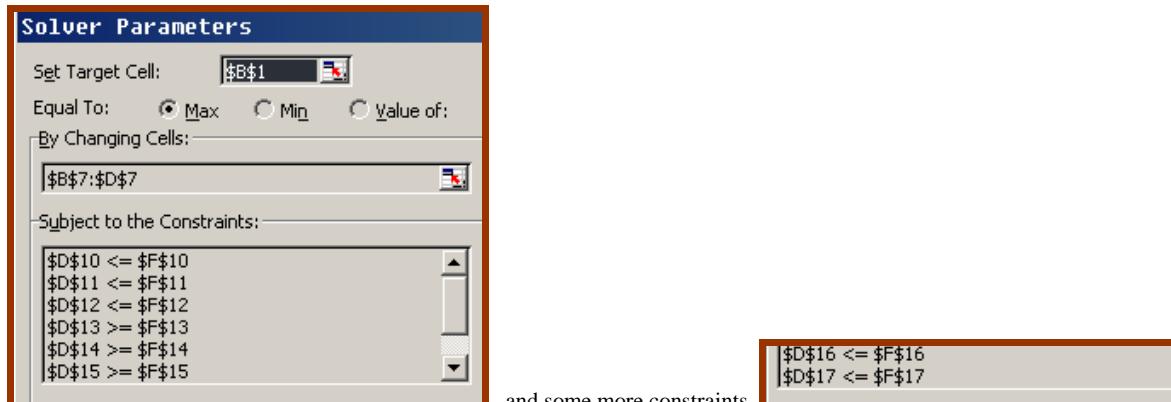


| | A | B | C | D | E | F |
|---|--------|-----|-------|-------|-------|---|
| 1 | | | minz | 1665 | | |
| 2 | var | x | y | | | |
| 3 | profit | 111 | 99 | | | |
| 4 | values | 15 | 0 | | | |
| 5 | | | total | | limit | |
| 6 | c1 | 20 | 10 | 300 = | 300 | |
| 7 | c2 | 15 | 10 | 225 = | 150 | |
| 8 | c3 | 10 | 20 | 150 = | 20 | |

Q 37. Jackie.Shine is opening a coconut drink shop. There are 3 popular brands: A, B, C (L-neer, Cocosip, Cocojal). The costs of A,B,C is Rs. 10, 12, 15. She can sell them at Rs 20, 23, 26. The municipal charges Rs 1 to dispose coconut shell. From market survey, she estimates maximum demand at 500, 400, 300 coconuts per month. There are some loyal student customers, who want 60 of each brand every month. She has balance Rs 15,000 for paying the suppliers in advance. She can stock 1000 coconuts per month in the small shop. How many of each should she order every month to maximize her profits and keep all the customers happy?

A37.

| B1 | fx =SUMPRODUCT(B6:D6,B7:D7) | | | | | | |
|----|-----------------------------|------------|-----------|------------------------------------|----|-------|--------|
| | A | B | C | D | E | F | G |
| 1 | maximize | =SUMPRODUC | | | | | |
| 2 | var | | A | B | | | |
| 3 | Sell price | 20 | 23 | 26 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | =B3-B4-B5 | =C3-C4-C5 | =D3-D4-D5 | | | |
| 7 | values | 0 | 0 | 0 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | | limit | |
| 10 | 1 | 0 | 0 | =SUMPRODUCT(A10:C10,\$B\$7:\$D\$7) | <= | 500 | demand |
| 11 | 0 | 1 | 0 | =SUMPRODUCT(A11:C11,\$B\$7:\$D\$7) | <= | 400 | |
| 12 | 0 | 0 | 1 | =SUMPRODUCT(A12:C12,\$B\$7:\$D\$7) | <= | 300 | |
| 13 | 1 | 0 | 0 | =SUMPRODUCT(A13:C13,\$B\$7:\$D\$7) | >= | 60 | Loyal |
| 14 | 0 | 1 | 0 | =SUMPRODUCT(A14:C14,\$B\$7:\$D\$7) | >= | 60 | |
| 15 | 0 | 0 | 1 | =SUMPRODUCT(A15:C15,\$B\$7:\$D\$7) | >= | 60 | |
| 16 | 10 | 12 | 15 | =SUMPRODUCT(A16:C16,\$B\$7:\$D\$7) | <= | 15000 | Cash |
| 17 | 1 | 1 | 1 | =SUMPRODUCT(A17:C17,\$B\$7:\$D\$7) | <= | 1000 | Space |



| | A | B | C | D | E | F | G |
|----|------------|------|-----|-------|----------|-------|--------|
| 1 | maximize | 9700 | | | | | |
| 2 | var | A | B | C | | | |
| 3 | Sell price | 20 | 23 | 26 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | 9 | 10 | 10 | | | |
| 7 | values | 300 | 400 | 300 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | | limit | |
| 10 | | 1 | 0 | 0 | 300 <= | 500 | demand |
| 11 | | 0 | 1 | 0 | 400 <= | 400 | |
| 12 | | 0 | 0 | 1 | 300 <= | 300 | |
| 13 | | 1 | 0 | 0 | 300 >= | 60 | Loyal |
| 14 | | 0 | 1 | 0 | 400 >= | 60 | |
| 15 | | 0 | 0 | 1 | 300 >= | 60 | |
| 16 | | 10 | 12 | 15 | 12300 <= | 15000 | Cash |
| 17 | | 1 | 1 | 1 | 1000 <= | 1000 | Space |

Q38. She decides to increases profit by increasing price to Rs 25, 28, 35. But that means the demand will fall to maximum 200, 200, 100 per month. Should she raise the price? What is the new profit?

A38

| profit | | | | | | | =SUMPRODUCT(B6:D6,B7:D7) |
|--------|------------|------|-----|---------|---|-------|--------------------------|
| | A | B | C | D | E | F | G |
| 1 | maximize | 7700 | | | | | |
| 2 | var | A | B | C | | | |
| 3 | Sell price | 25 | 28 | 35 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | 14 | 15 | 19 | | | |
| 7 | values | 200 | 200 | 100 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | | limit | |
| 10 | 1 | 0 | 0 | 200 <= | | 200 | demand |
| 11 | 0 | 1 | 0 | 200 <= | | 200 | |
| 12 | 0 | 0 | 1 | 100 <= | | 100 | |
| 13 | 1 | 0 | 0 | 200 >= | | 60 | Loyal |
| 14 | 0 | 1 | 0 | 200 >= | | 60 | |
| 15 | 0 | 0 | 1 | 100 >= | | 60 | |
| 16 | 10 | 12 | 15 | 5900 <= | | 15000 | Cash |
| 17 | 1 | 1 | 1 | 500 <= | | 1000 | Space |

Q39. It is summer time, the demand may increase to 400, 400, 600, if she reduces the prices to 18, 22, 25. Should she lower the price? What is the profit now?

A39.

| profit | | | | | | | =SUMPRODUCT(B6:D6,B7:D7) |
|--------|------------|------|-----|----------|---|-------|--------------------------|
| | A | B | C | D | E | F | G |
| 1 | maximize | 8880 | | | | | |
| 2 | var | A | B | C | | | |
| 3 | Sell price | 18 | 22 | 25 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | 7 | 9 | 9 | | | |
| 7 | values | 60 | 400 | 540 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | | limit | |
| 10 | 1 | 0 | 0 | 60 <= | | 500 | demand |
| 11 | 0 | 1 | 0 | 400 <= | | 400 | |
| 12 | 0 | 0 | 1 | 540 <= | | 600 | |
| 13 | 1 | 0 | 0 | 60 >= | | 60 | Loyal |
| 14 | 0 | 1 | 0 | 400 >= | | 60 | |
| 15 | 0 | 0 | 1 | 540 >= | | 60 | |
| 16 | 10 | 12 | 15 | 13500 <= | | 15000 | Cash |
| 17 | 1 | 1 | 1 | 1000 <= | | 1000 | Space |

Q40. Going back to the original excel sheet in Q37. The brand C has a lockout in their plant for a month (no supplies from C), and Brand A, B take advantage and raise cost price by Rs 10 each because of labour shortage. What is the new optimal? What should be done?

A40.

| | B1 | $=\text{SUMPRODUCT}(\text{B6:D6}, \text{B7:D7})$ | | | | | |
|----|------------|--|----|-------|----------|------------|--|
| 1 | maximize | 0 | | | | | |
| 2 | var | A | B | C | | | |
| 3 | Sell price | 20 | 23 | 26 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | 9 | 10 | 10 | | | |
| 7 | values | 0 | 0 | 0 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | | limit | |
| 10 | 1 | 0 | 0 | 0 | $0 \leq$ | 500 demand | |
| 11 | 0 | 1 | 0 | 0 | $0 \leq$ | 400 | |
| 12 | 0 | 0 | 1 | 0 | $0 \leq$ | 0 lockout | |
| 13 | 1 | 0 | 0 | 0 | $0 \geq$ | 60 Loyal | |
| 14 | 0 | 1 | 0 | 0 | $0 \geq$ | 60 | |
| 15 | 0 | 0 | 1 | 0 | $0 \geq$ | 0 lockout | |
| 16 | 10 | 12 | 15 | 0 | $0 \leq$ | 15000 Cash | |
| 17 | 1 | 1 | 1 | 0 | $0 \leq$ | 1000 Space | |

| | B1 | $=\text{SUMPRODUCT}(\text{B6:D6}, \text{B7:D7})$ | | | | | |
|----|------------|--|-----|--------------|------------|------------|--|
| 1 | maximize | 8500 | | | | | |
| 2 | var | A | B | C | | | |
| 3 | Sell price | 20 | 23 | 26 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | 9 | 10 | 10 | | | |
| 7 | values | 500 | 400 | -2.72905E-10 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | | limit | |
| 10 | 1 | 0 | 0 | 0 | $500 \leq$ | 500 demand | |
| 11 | 0 | 1 | 0 | 0 | $400 \leq$ | 400 | |
| 12 | 0 | 0 | 1 | -2.72905E-10 | ≤ 0 | 0 | |
| 13 | 1 | 0 | 0 | 0 | $500 \geq$ | 60 Loyal | |
| 14 | 0 | 1 | 0 | 0 | $400 \geq$ | 60 | |
| 15 | 0 | 0 | 1 | -2.72905E-10 | ≥ 0 | 0 | |
| 16 | 10 | 12 | 15 | 9800 | \leq | 15000 Cash | |
| 17 | 1 | 1 | 1 | 900 | \leq | 1000 Space | |
| 18 | | | | | | | |

Section: _____ Roll Number: _____
 Or Name: _____, Date 2014/03/
 Course: Creative Thinking,
 Do all the question alone in your
 notebook.

Draw the graph for following
 and shade the region if any:

- 1. $x = 1 \text{ & } y = 1$
- 2. $x < 1 \text{ & } y < 2$
- 3. $x > 1 \text{ & } x < 2$
- 4. $x < 2 \text{ & } x > 1 \text{ & } y < 3 \text{ & } y > 2$
- 5. $x + y = 0$
- 6. $x + y < 0$
- 7. $x + y > 0$
- 8. $x + y > 2$
- 9. $x - y = 0$
- 10. $x - y = 2$
- 11. $x - y > 2$
- 12. $x - y < 2$
- 13. $x < y$
- 14. $x > y \text{ & } x > 0$
- 15. $y < x \text{ & } x > 1 \text{ & } y > 1$.

First list the slope and intercept of the graph, and then draw the graph and shade the region for inequalities:

- 16. $y = 2x$
- 17. $y > 2x$
- 18. $2y > 4x$
- 19. $2y > x$
- 20. $y = 2x + 1$
- 21. $y = 3x + 1$
- 22. $y = 1 - x$
- 23. $y = 1 - 2x$
- 24. $x + y = 10$
- 25. $2x + 3y = 10$
- 26. $3x - 2x = 7$.
- 27. $3x - 3y = 0$
- 28. $x > 1 \text{ or } y > 1$.
- 29. $x + y > 1 \text{ or } x + y < -1$
- 30. $2x + 2x > 2 \text{ or } 2x - 2y < 2$

Q31. Write as LP optimization problem:

A store sells three brands of stereo systems: brands A, B, and C.
 It can sell a total of 100 stereo systems per month.
 Brands A, B, and C take up, respectively, 5, 4, and 4 cubic feet of warehouse space and a maximum of 480 cubic feet of warehouse space is available.
 Brands A, B, and C generate sales commissions of Rs40, Rs20, and Rs30, respectively, and Rs3200 is available to pay the sale commissions.
 The profit generated from the sale of each brand is Rs70, Rs210, and Rs140, respectively.
 How many of each brand of stereo system should be sold to maximize profit?

- A. What are the variables?
- B. What are we optimizing (give equation for the objective function)?
- C. What are the constraints (give the equations)?

Using Excel:

- Q 32. Type Q31 in excel.
 Q 33. Solve Q32 in excel

Q34. Farmer wants to grow Apples, Banana, Chiko. He wrote the equations below to describe his situation. Now help him use Excel to maximize his profit: $z = 3 * A + B + 2*C$; with these constraints:

$$\begin{aligned} A + B + 3*C &\leq 30; \\ 2*A + 2*B + 5*C &\leq 24; \\ 4*A + B + 2*C &\leq 36; \end{aligned}$$

All variables are non negative.

Q 35. Help Samson, formulate this as an LP and solve using Excel.

Samson TV has to decide on the number of x_1 and x_2 sets to be produced at one of its factories. Market research indicates that at most 40 of the x_1 sets and 10 of the x_2 sets can be sold per month. The maximum number of work-hours available is 500 per month.

A x_1 set requires 20 work-hours and a x_2 set requires 10 work-hours. Each x_1 set sold produces a profit of \$120 and each x_2 set produces a profit of \$80.

Q 36 Help Gotiya save money, by solving his problem with excel:

Gotiya has a goat farm. He is trying to decide what to feed his goats. He is considering using a combination of goat feeds available from local suppliers. He would like to feed the goats at minimum cost while also making sure each goat receives an adequate supply of calories and vitamins. The cost, calorie content, and vitamin content of each feed are given in the table below.

| Contents | Feed A | Feed B |
|-------------|-----------|----------|
| Calories/kg | 800 | 1,000 |
| Vitamins/kg | 140 units | 70 units |
| Cost/kg | Rs 0.40 | Rs 0.80 |

Each goat requires at least 8,000 calories per day and at least 700 units of vitamins. A further constraint is that no more than one-third of the diet (by weight) can consist of Feed A.

Q37. A dietitian is asked to design a special diet supplement using two different foods, X costs Rs 111/kg, and Y costs Rs 99/kg.

Each gm of food X contains 20 units of calcium, 15 units of iron, and 10 units of vitamin B.

Each gm of food Y contains 10 units of calcium, 10 units of iron, and 20 units of vitamin B.

The minimum daily requirements in the diet are 300 units of calcium, 150 units of iron, and 20 units of vitamin

- A. What are the variables?
- B. What are we optimizing, give the equation.
- C. What are the constraints, give the equations.

Q41. Nifty Nitte Nitya, a MBA student has debated on “FDI in retail”, read about “Economies of scale in Ballmart” and studied QT. He wants to be an knowledge Entrepreneur.

He finds out there are 2000 coconut vendors in Udupi region, who have never used excel to optimize their profits.

He offers to be the “management consultant”, charging Rs 1000 for month. Of which Rs 300 he must pay as taxes, and Rs 200 is cost of operating his office.

He claims his QT analysis will increase the profit of each shop by Rs 5000 per month.

Analysing the QT data of each shop takes 1 hour (including entering data and talking to the shopkeeper on phone).

Assuming Nitya can work 8 hours a day for 20 days a week.

Q. How many shops can he consult for?

Q. How much will be take home income of Nitya?

Q. How much extra profits will his consulting shop keepers make?

More shopkeepers want his services, but he has no time. So he finds 10 more MBA students who know QT and financial analysis. Since Nitya is expanding his office, he has no time for excel, but 10 new people are doing QT analysis.

Q. How much is the new profit (after taxes and operating costs)?

Under his profit sharing scheme,

He keeps 40% of the profit, and the rest is divided among his MBA workers.

Q. How much is Nitya's take home income with 20 employees?

Q. How much is take home income of his MBA employees?

Q. How much will Nitya's income be with 10 employees?

Q. What are the constraints on expanding Nitya's business in real life?

Example for Section 3.1

The Apex Television Company has to decide on the number of 27- and 20-inch sets to be produced at one of its factories. Market research indicates that at most 40 of the 27-inch sets and 10 of the 20-inch sets can be sold per month. The maximum number of work-hours available is 500 per month. A 27-inch set requires 20 work-hours and a 20-inch set requires 10 work-hours. Each 27-inch set sold produces a profit of \$120 and each 20-inch set produces a profit of \$80. A wholesaler has agreed to purchase all the television sets produced if the numbers do not exceed the maxima indicated by the market research.

(a) Formulate a linear programming model for this problem.

The decisions that need to be made are the number of 27-inch and 20-inch TV sets to be produced per month by the Apex Television Company. Therefore, the decision variables for the model are

x_1 = number of 27-inch TV sets to be produced per month,
 x_2 = number of 20-inch TV sets to be produced per month.

Also let Z = total profit per month.

The model now can be formulated in terms of these variables as follows.

The total profit per month is $Z = 120x_1 + 80x_2$.

The resource constraints are:

- (1) Number of 27-inch sets sold per month: $x_1 \leq 40$
- (2) Number of 20-inch sets sold per month: $x_2 \leq 10$
- (3) Work-hours availability: $20x_1 + 10x_2 \leq 500$.

Nonnegativity constraints on TV sets produced: $x_1 \geq 0$ and $x_2 \geq 0$

With the objective of maximizing the total profit per month, the LP model for this problem is

Maximize $Z = 120x_1 + 80x_2$,
 subject to

$$\begin{array}{rcl} x_1 & \leq & 40 \\ x_2 & \leq & 10 \\ 20x_1 + 10x_2 & \leq & 500 \end{array}$$

and

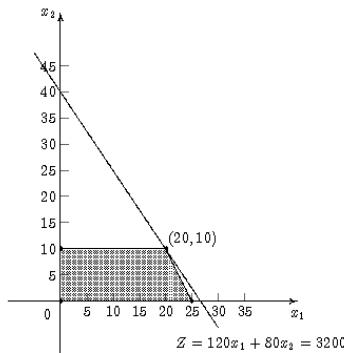
$$x_1 \geq 0, \quad x_2 \geq 0.$$

(b) Use the graphical method to solve this model.

The constraint, $x_1 \leq 40$, has a constraint boundary at $x_1 = 40$. Similarly, the constraint, $x_2 \leq 10$, has a constraint boundary at $x_2 = 10$.

The constraint boundary for the constraint, $20x_1 + 10x_2 \leq 500$, intercepts the x_1 -axis at $20x_1 + 10(0) = 500$, so at $x_1 = 25$. Similarly, this constraint boundary intercepts the x_2 -axis at $20(0) + 10x_2 = 500$, so at $x_2 = 50$. This constraint boundary lies well within the constraint boundary for the first constraint, $x_1 \leq 40$, so the first constraint is redundant and can be ignored.

For a sample value of Z , say, $Z = 2,400$, the corresponding objective function line, $Z = 2,400 = 120x_1 + 80x_2$, intercepts the x_1 -axis at $120x_1 + 80(0) = 2,400$, so at $x_1 = 20$. It intercepts the x_2 -axis at $120(0) + 80x_2 = 2,400$, so at $x_2 = 30$. The corresponding objective function lines for other values of Z are parallel to this line. Pushing these lines up as much as possible while still passing through a point in the feasible region reveals that the optimal solution is $(x_1, x_2) = (20, 10)$ with $Z = 3,200$, as depicted in the following graph.



Example for Section 3.4

Dwight is an elementary school teacher who also raises pigs for supplemental income. He is trying to decide what to feed his pigs. He is considering using a combination of pig feeds available from local suppliers. He would like to feed the pigs at minimum cost while also making sure each pig receives an adequate supply of calories and vitamins. The cost, calorie content, and vitamin content of each feed are given in the table below.

| Contents | Feed Type A | Feed Type B |
|----------------------|-------------|-------------|
| Calories (per pound) | 800 | 1,000 |
| Vitamins (per pound) | 140 units | 70 units |
| Cost (per pound) | \$0.40 | \$0.80 |

Each pig requires at least 8,000 calories per day and at least 700 units of vitamins. A further constraint is that no more than one-third of the diet (by weight) can consist of Feed Type A, since it contains an ingredient which is toxic if consumed in too large a quantity.

(a) Formulate a linear programming model for this problem.

Let A and B be the quantity (pounds) of Feed Type A and Feed Type B, respectively, used per day. Also let Z be the total daily cost of the feed per pig. Then, the daily cost is $Z = \$0.4 A + \$0.8 B$.

The constraints on the minimum daily requirements of calories and vitamins are

- (1) Calories requirement: $800 A + 1000 B \geq 8,000$.
- (2) Vitamins requirement: $140 A + 70 B \geq 700$.

Also, Dwight needs to avoid using too much of Feed Type A because of the toxic ingredient in it.

The toxic constraint is $A \leq 1/3(A+B)$, which reduces to $2/3 A - 1/3 B \leq 0$.

Nonnegativity constraints:

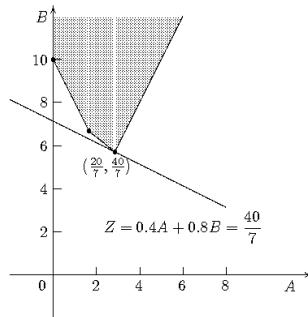
$$A \geq 0, B \geq 0.$$

The resulting linear programming model for this problem is

$$\begin{aligned} \text{Minimize } Z &= 0.4 A + 0.8 B, \\ \text{subject to } 800 A + 1000 B &\geq 8000 \\ 140 A + 70 B &\geq 700 \\ 2/3 A - 1/3 B &\leq 0 \\ \text{And } A &\geq 0, B \geq 0. \end{aligned}$$

(b) Use the graphical method to solve this model. What is the resulting daily cost per pig?

As shown below, the optimal solution is $(A, B) = (20/7, 40/7)$. The resulting daily cost per pig is $Z = 40/7 = \$5.71$.



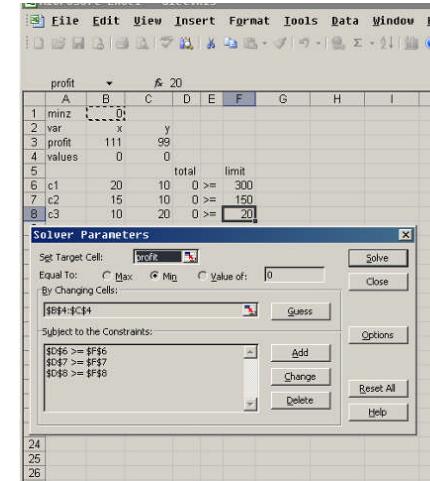
Cormen 29.3

| profit | | $\max z = \text{SUMPRODUCT}(B3:D)$ | | | | | |
|--------|--------|------------------------------------|-------|-------|-------|--------|----|
| A | B | C | D | E | F | G | H |
| 1 | maxz | 0 | | | | | |
| 2 | var | x_1 | x_2 | x_3 | | | |
| 3 | profit | 3 | 1 | 2 | | | |
| 4 | values | 0 | 0 | 0 | | | |
| 5 | | | | total | limit | | |
| 6 | c1 | 1 | 1 | 3 | 0 | \leq | 30 |
| 7 | c2 | 2 | 2 | 5 | 0 | \leq | 24 |
| 8 | c3 | 4 | 1 | 2 | 0 | \leq | 36 |
| 9 | | | | | | | |

Stereo nitk

| profit | | $\max z = 3200$ | | | | | |
|--------|--------|-----------------|-------|-------|-------|--------|------|
| A | B | C | D | E | F | G | H |
| 1 | maxz | 0 | | | | | |
| 2 | var | x_1 | x_2 | x_3 | | | |
| 3 | profit | 70 | 210 | 140 | | | |
| 4 | values | 0 | 0 | 0 | | | |
| 5 | | | | total | limit | | |
| 6 | c1 | 5 | 4 | 4 | 0 | \leq | 480 |
| 7 | c2 | 40 | 20 | 30 | 0 | \leq | 3200 |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| 21 | | | | | | | |
| 22 | | | | | | | |
| 23 | | | | | | | |
| 24 | | | | | | | |
| 25 | | | | | | | |
| 26 | | | | | | | |

Diet



Roll Number/Name: _____

Date 2015/01/13, JKSHIM, NITTE

Q1. A store sells three brands of stereo systems: brands A, B, and C. It can sell a total of 100 stereo systems per month.

Brands A, B, and C take up, respectively, 5, 4, and 4 cubic feet of warehouse space and a maximum of 480 cubic feet of warehouse space is available. Brands A, B, and C generate sales commissions of Rs40, Rs20 and Rs30, respectively, and Rs3200 is available to pay the sale commissions.

The profit generated from the sale of each brand is Rs70, Rs210, and Rs140, respectively.

How many of each brand of stereo system should be sold to maximize profit?

Q2. Farmer wants to grow Apples, Banana, Chiko. He wrote the equations below to describe his situation.

Maximize his profit: $z = 3 * A + B + 2*C$ with these constraints:

$$A + B + 3*C \leq 30;$$

$$2*A + 2*B + 5*C \leq 24;$$

$$4*A + B + 2*C \leq 36;$$

All variables are non negative.

Q3. Farmer wants to grow x apples and y oranges; he has following linear constraints:

$$6 \text{ acres of land: } 3x + y \leq 6$$

$$6 \text{ tons of fertilizer: } 2x + 3y \leq 6$$

$$8 \text{ hour work day: } x + 5y \leq 8$$

Apples sell for twice as much as oranges

Production is positive: $x \geq 0, y \geq 0$.

Maximize his profit.

Q4. Help Samson, formulate this as an LP and solve it using Excel.

Samson TV has to decide on the number of x_1 and x_2 sets to be produced at one of its factories. Market research indicates that at most 40 of the x_1 sets and 10 of the x_2 sets can be sold per month. The maximum number of work-hours available is 500 per month.

x_1 set requires 20 work-hours and a x_2 set requires 10 work-hours. Each x_1 set sold produces a profit of \$120 and each x_2 set produces a profit of \$80.

Q 5 Help Gotiya save money, by solving his problem:

Gotiya has a goat farm. He is trying to decide what to feed his goats. He is considering using a combination of goat feeds available from local suppliers.

He would like to feed the goats at minimum cost while also making sure each goat receives an adequate supply of calories and vitamins. Solve it.

The cost, calorie content, and vitamin content of each feed are given in the table below.

| Contents | Feed 1 | Feed 2 |
|-----------------|--------|--------|
| Calories/kg | 800 | 1000 |
| Vitamins unit/K | 140 | 70 |
| Cost/kg Rs | 0.40 | 0.80 |

Each goat requires at least 8,000 calories per day and at least 700 units of vitamins. A further constraint is that no more than one-third of the diet (by weight) can consist of Feed A.

Q6. A dietitian is asked to design a special diet supplement using two different foods X and Y containing:

| | X | Y | Requirement |
|------------|----|---|-------------|
| Calcium | 20 | 1 | 300 |
| Iron | 15 | 1 | 150 |
| Vitamin B | 10 | 2 | 20 |
| Cost Rs/Kg | 11 | 9 | Total Cost |
| How much | | | |

Use Excel to find the cheapest solution that satisfies all the requirements.

--- COCONUT BRAND ---

Q7. Jackie Shine is opening a coconut drink shop. There are 3 popular brands: A, B, C (L-neer, Cocosip, Cocojal).

The costs of A,B, C is Rs. 10, 12, 15. She can sell them at Rs 20, 23, 26. The municipal charges Rs 1 to dispose coconut shell.

From market survey, she estimates maximum demand at 500, 400, 300 coconuts per month. There are some loyal student customers, who want 60 of each brand every month.

She has balance Rs 15,000 for paying the suppliers in advance. She can stock 1000 coconuts per month in the small shop.

How many of each should she order every month to maximize her profits and keep all the customers happy?

Q8. She decides to increase profit by increasing price to Rs 25, 28, and 35. But that means the demand will fall to maximum 200, 200, and 100 per month. Should she raise the price? What is the new profit?

Q9. It is summer time, the demand may increase to 400, 400, 600, if she reduces the prices to 18, 22, and 25. Should she lower the price? What is the profit now?

Q10. Going back to Q7. The brand C has a lockout in their plant for a month (no supplies from C), and Brand A, B take advantage and raise cost price by Rs 10 each because of labour shortage.

What is the new optimal? What should be done?

Solutions

Q1. Write this as an LP optimization problem: A store sells three brands of stereo systems: brands A, B, and C. It can sell a total of 100 stereo systems per month.

Brands A, B, and C take up, respectively, 5, 4, and 4 cubic feet of warehouse space and a maximum of 480 cubic feet of warehouse space is available.

Brands A, B, and C generate sales commissions of Rs40, Rs20, and Rs30, respectively, and Rs3200 is available to pay the sale commissions.

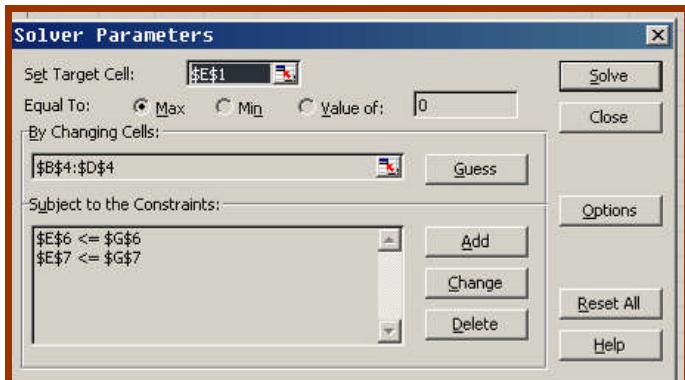
The profit generated from the sale of each brand is Rs70, Rs210, and Rs140, respectively.

How many of each brand of stereo system should be sold to maximize profit?

- A. What are the variables?
- B. What are we optimizing (give equation for the objective function)?
- C. What are the constraints (give the equations)?
- D. Type Q31 in Excel. And solve it.

A1. Variables are (x1,x2,x3) quantity of A,B,C sold. maximizing profit = 25200, with (x1,x2,x3)=(0,120,0).

| G5 | | | | | | |
|----|--------|----|-----|-----|----------------------------------|---------|
| | A | B | C | D | E | F |
| 1 | | | | | maxz =SUMPRODUCT(B3:D3,B4:D4) | G |
| 2 | var | x1 | x2 | x3 | | |
| 3 | profit | 70 | 210 | 140 | | |
| 4 | values | 0 | 0 | 0 | | |
| 5 | | | | | total | limit |
| 6 | c1 | 5 | 4 | 4 | =SUMPRODUCT(B6:D6,\$B\$4:\$D\$4) | <= 480 |
| 7 | c2 | 40 | 20 | 30 | =SUMPRODUCT(B7:D7,\$B\$4:\$D\$4) | <= 3200 |
| 8 | | | | | | |



| E1 | | | | | | |
|----|--------|----|-----|-----|-------|---------|
| | A | B | C | D | E | F |
| 1 | | | | | maxz | 25200 |
| 2 | var | x1 | x2 | x3 | | |
| 3 | profit | 70 | 210 | 140 | | |
| 4 | values | 0 | 120 | 0 | | |
| 5 | | | | | total | limit |
| 6 | c1 | 5 | 4 | 4 | 480 | <= 480 |
| 7 | c2 | 40 | 20 | 30 | 2400 | <= 3200 |
| 8 | | | | | | |

Q32. Farmer wants to grow Apples, Banana, Chiko. He wrote the equations below to describe his situation.
Now help him use Excel to maximize his profit: $z = 3 * A + B + 2 * C$; With these constraints:

$$A + B + 3 * C \leq 30;$$

$$2 * A + 2 * B + 5 * C \leq 24;$$

$$4 * A + B + 2 * C \leq 36;$$

All variables are non negative.

A2.

| | A | B | C | D | E | F | G |
|---|--------|----|----|----|---|----|-------|
| 1 | | | | | maxz =SUMPRODUCT(\$B\$3:\$D\$3,\$B\$4:\$D\$4) | | |
| 2 | var | x1 | x2 | x3 | | | |
| 3 | profit | 3 | 1 | 2 | | | |
| 4 | values | 0 | 0 | 0 | | | |
| 5 | | | | | total | | limit |
| 6 | c1 | 1 | 1 | 3 | =SUMPRODUCT(B6:D6,\$B\$4:\$D\$4) | <= | 30 |
| 7 | c2 | 2 | 2 | 5 | =SUMPRODUCT(B7:D7,\$B\$4:\$D\$4) | <= | 24 |
| 8 | c3 | 4 | 1 | 2 | =SUMPRODUCT(B8:D8,\$B\$4:\$D\$4) | <= | 36 |
| 9 | | | | | | | |



| | A | B | C | D | E | F | G |
|---|------|----|----|----|-------|----|-------|
| 1 | | | | | maxz | 28 | |
| 2 | var | x1 | x2 | x3 | | | |
| 3 | ofit | 3 | 1 | 2 | | | |
| 4 | ues | 8 | 4 | 0 | | | |
| 5 | | | | | total | | limit |
| 6 | c1 | 1 | 1 | 3 | 12 | = | 30 |
| 7 | c2 | 2 | 2 | 5 | 24 | = | 24 |
| 8 | c3 | 4 | 1 | 2 | 36 | = | 36 |

Q3. Farmer wants to grow x apples and y oranges; he has following linear constraints:

6 acres of land: $3x + y \leq 6$

6 tons of fertilizer: $2x + 3y \leq 6$

8 hour work day: $x + 5y \leq 8$

Apples sell for twice as much as oranges

Production is positive: $x \geq 0, y \geq 0$.

Maximize his profit using Excel.

A33

The screenshot shows an Excel spreadsheet with the following data and solver setup:

| | A | B | C | D | E |
|---|--------|---|---|----------------------------------|----------|
| 1 | | | | max =SUMPRODUCT(B3:C3,B4:C4) | |
| 2 | var | x | y | | |
| 3 | profit | 2 | 1 | | |
| 4 | values | 0 | 0 | | |
| 5 | | | | total | limit |
| 6 | c1 | 3 | 1 | =SUMPRODUCT(B6:C6,\$B\$4:\$C\$4) | ≤ 6 |
| 7 | c2 | 2 | 3 | =SUMPRODUCT(B7:C7,\$B\$4:\$C\$4) | ≤ 6 |
| 8 | c3 | 1 | 5 | =SUMPRODUCT(B8:C8,\$B\$4:\$C\$4) | ≤ 8 |

Solver Parameters dialog box:

- Set Target Cell: profit
- Equal To: Max
- By Changing Cells: \$B\$4:\$C\$4
- Subject to the Constraints:
 - \$D\$6 <= \$F\$6
 - \$D\$7 <= \$F\$7
 - \$D\$8 <= \$F\$8

Results table:

| | A | B | C | D | E | F | G |
|---|--------|-------|---------|-------|--------|---|---|
| 1 | maxz | 4.286 | | | | | |
| 2 | var | x | y | | | | |
| 3 | profit | 2 | 1 | | | | |
| 4 | values | 1.714 | 0.85714 | | | | |
| 5 | | | | total | limit | | |
| 6 | c1 | 3 | 1 | 6 | \leq | 6 | |
| 7 | c2 | 2 | 3 | 6 | \leq | 6 | |
| 8 | c3 | 1 | 5 | 6 | \leq | 8 | |

Q 4. Help Samson, formulate this as an LP and solve using Excel.

Samson TV has to decide on the number of x1 and x2 sets to be produced at one of its factories. Market research indicates that at most 40 of the x1 sets and 10 of the x2 sets can be sold per month. The maximum number of work-hours available is 500 per month.

A x1 set requires 20 work-hours and a x2 set requires 10 work-hours. Each x1 set sold produces a profit of \$120 and each x2 set produces a profit of \$80.

A4

| | A | B | C | D | E | F |
|---|--------|-----|----|--|----|-------|
| 1 | | | | =SUMPRODUCT(\$B\$3:\$C\$3,\$B\$4:\$C\$4) | | |
| 2 | var | x1 | x2 | | | |
| 3 | profit | 120 | 80 | | | |
| 4 | values | 0 | 0 | | | |
| 5 | | | | total | | limit |
| 6 | c1 | 1 | 0 | =SUMPRODUCT(B6:C6,\$B\$4:\$C\$4) | <= | 40 |
| 7 | c2 | 0 | 1 | =SUMPRODUCT(B7:C7,\$B\$4:\$C\$4) | <= | 10 |
| 8 | c3 | 20 | 10 | =SUMPRODUCT(B8:C8,\$B\$4:\$C\$4) | <= | 500 |

| | A | B | C | D | E | F |
|---|--------|-----|----|-------|------|-------|
| 1 | | | | maxz | 3200 | |
| 2 | var | x1 | x2 | | | |
| 3 | profit | 120 | 80 | | | |
| 4 | values | 20 | 10 | | | |
| 5 | | | | total | | limit |
| 6 | c1 | 1 | 0 | 20 | <= | 40 |
| 7 | c2 | 0 | 1 | 10 | <= | 10 |
| 8 | c3 | 20 | 10 | 500 | <= | 500 |

Q5 Help Gotiya save money, by solving his problem with excel:

Gotiya has a goat farm. He is trying to decide what to feed his goats. He is considering using a combination of goat feeds available from local suppliers.

He would like to feed the goats at minimum cost while also making sure each goat receives an adequate supply of calories and vitamins.

The cost, calorie content, and vitamin content of each feed are given in the table below.

| Contents | Feed A | Feed B | Min Required | | |
|------------------|--------|--------|--------------|--|--|
| Calories/kg | 800 | 1000 | 8000 | | |
| Vitamins unit/Kg | 140 | 70 | 700 | | |
| Cost/kg Rs | 0.40 | 0.80 | | | |

Each goat requires at least 8,000 calories per day and at least 700 units of vitamins.

A further constraint is that no more than one-third of the diet (by weight) can consist of Feed A.

That is, constraint $A \leq 1/3(A+B)$, which reduces to $2/3A - 1/3B \leq 0$.

A5

| | A | B | C | D | E | F |
|---|--------|-------|--------|--|---------|---|
| 1 | | | | =SUMPRODUCT(\$B\$3:\$C\$3,\$B\$4:\$C\$4) | | |
| 2 | var | A | B | | | |
| 3 | profit | 0.4 | 0.8 | | | |
| 4 | values | 0 | 0 | | | |
| 5 | | | total | | limit | |
| 6 | c1 | 800 | 1000 | =SUMPRODUCT(B6:C6,\$B\$4:\$C\$4) | >= 8000 | |
| 7 | c2 | 140 | 70 | =SUMPRODUCT(B7:C7,\$B\$4:\$C\$4) | >= 700 | |
| 8 | c3 | 0.667 | -0.333 | =SUMPRODUCT(B8:C8,\$B\$4:\$C\$4) | <= 0 | |

Q6. A dietitian is asked to design a special diet supplement using two different foods X and Y containing:

| | X | Y | Requirement |
|------------|-----|----|-------------|
| Calcium | 20 | 10 | 300 |
| Iron | 15 | 10 | 150 |
| Vitamin B | 10 | 20 | 20 |
| Cost Rs/Kg | 111 | 99 | Total Cost |
| How much? | | | |

Q. What are the variables? What are we optimizing, write the equation. What are the constraints, write the equations. Use Excel to solve it.

A6.

| | B | C | D | E | F |
|---|----------|-----|-------|----------------------------------|--------|
| 1 | Name Box | | | | |
| 2 | var | x | y | | |
| 3 | profit | 111 | 99 | | |
| 4 | values | 0 | 0 | | |
| 5 | | | total | | limit |
| 6 | c1 | 20 | 10 | =SUMPRODUCT(B6:C6,\$B\$4:\$C\$4) | >= 300 |
| 7 | c2 | 15 | 10 | =SUMPRODUCT(B7:C7,\$B\$4:\$C\$4) | >= 150 |
| 8 | c3 | 10 | 20 | =SUMPRODUCT(B8:C8,\$B\$4:\$C\$4) | >= 20 |

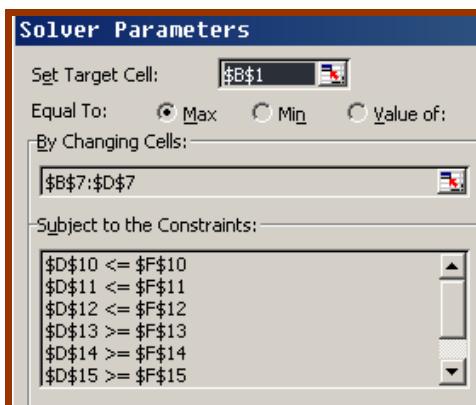


| | A | B | C | D | E | F |
|---|--------|-----|-------|-------|-------|---|
| 1 | | | minz | 1665 | | |
| 2 | var | x | y | | | |
| 3 | profit | 111 | 99 | | | |
| 4 | values | 15 | 0 | | | |
| 5 | | | total | | limit | |
| 6 | c1 | 20 | 10 | 300 = | 300 | |
| 7 | c2 | 15 | 10 | 225 = | 150 | |
| 8 | c3 | 10 | 20 | 150 = | 20 | |

Q 7. Jackie Shine is opening a coconut drink shop. There are 3 popular brands: A, B, C (L-neer, Cocosip, Cocojal). The costs of A,B,C is Rs. 10, 12, 15. She can sell them at Rs 20, 23, 26. The municipal charges Rs 1 to dispose coconut shell. From market survey, she estimates maximum demand at 500, 400, 300 coconuts per month. There are some loyal student customers, who want 60 of each brand every month. She has balance Rs 15,000 for paying the suppliers in advance. She can stock 1000 coconuts per month in the small shop. How many of each should she order every month to maximize her profits and keep all the customers happy?

A37.

| B1 | =SUMPRODUCT(B6:D6,B7:D7) | | | D | E | F | G | |
|----|--------------------------|------------|-----------|------------------------------------|----|-------|--------|--|
| 1 | maximize | =SUMPRODUC | A | B | C | | | |
| 2 | var | | A | B | C | | | |
| 3 | Sell price | 20 | 23 | 26 | | | | |
| 4 | Cost | 10 | 12 | 15 | | | | |
| 5 | Disposal | 1 | 1 | 1 | | | | |
| 6 | profit | =B3-B4-B5 | =C3-C4-C5 | =D3-D4-D5 | | | | |
| 7 | values | 0 | 0 | 0 | | | | |
| 8 | | | | | | | | |
| 9 | A | B | C | total | | | | |
| 10 | 1 | 0 | 0 | =SUMPRODUCT(A10:C10,\$B\$7:\$D\$7) | <= | 500 | demand | |
| 11 | 0 | 1 | 0 | =SUMPRODUCT(A11:C11,\$B\$7:\$D\$7) | <= | 400 | | |
| 12 | 0 | 0 | 1 | =SUMPRODUCT(A12:C12,\$B\$7:\$D\$7) | <= | 300 | | |
| 13 | 1 | 0 | 0 | =SUMPRODUCT(A13:C13,\$B\$7:\$D\$7) | >= | 60 | Loyal | |
| 14 | 0 | 1 | 0 | =SUMPRODUCT(A14:C14,\$B\$7:\$D\$7) | >= | 60 | | |
| 15 | 0 | 0 | 1 | =SUMPRODUCT(A15:C15,\$B\$7:\$D\$7) | >= | 60 | | |
| 16 | 10 | 12 | 15 | =SUMPRODUCT(A16:C16,\$B\$7:\$D\$7) | <= | 15000 | Cash | |
| 17 | 1 | 1 | 1 | =SUMPRODUCT(A17:C17,\$B\$7:\$D\$7) | <= | 1000 | Space | |



and some more constraints

\$D\$16 <= \$F\$16
\$D\$17 <= \$F\$17

| B1 | A | B | C | D | E | F | G |
|----|------------|------|-----|-------|----------------|--------|---|
| 1 | maximize | 9700 | | | | | |
| 2 | var | A | B | C | | | |
| 3 | Sell price | 20 | 23 | 26 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | 9 | 10 | 10 | | | |
| 7 | values | 300 | 400 | 300 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | limit | | |
| 10 | | 1 | 0 | 0 | 300 <= 500 | demand | |
| 11 | | 0 | 1 | 0 | 400 <= 400 | | |
| 12 | | 0 | 0 | 1 | 300 <= 300 | | |
| 13 | | 1 | 0 | 0 | 300 >= 60 | Loyal | |
| 14 | | 0 | 1 | 0 | 400 >= 60 | | |
| 15 | | 0 | 0 | 1 | 300 >= 60 | | |
| 16 | | 10 | 12 | 15 | 12300 <= 15000 | Cash | |
| 17 | | 1 | 1 | 1 | 1000 <= 1000 | Space | |

Q8. She decides to increases profit by increasing price to Rs 25, 28, 35. But that means the demand will fall to maximum 200, 200, 100 per month. Should she raise the price? What is the new profit?

A8

| | A | B | C | D | E | F | G |
|----|------------|------|-----|-------|-------|-------|--------|
| 1 | maximize | 7700 | | | | | |
| 2 | var | A | B | C | | | |
| 3 | Sell price | 25 | 28 | 35 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | 14 | 15 | 19 | | | |
| 7 | values | 200 | 200 | 100 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | limit | | |
| 10 | 1 | 0 | 0 | 200 | <= | 200 | demand |
| 11 | 0 | 1 | 0 | 200 | <= | 200 | |
| 12 | 0 | 0 | 1 | 100 | <= | 100 | |
| 13 | 1 | 0 | 0 | 200 | >= | 60 | Loyal |
| 14 | 0 | 1 | 0 | 200 | >= | 60 | |
| 15 | 0 | 0 | 1 | 100 | >= | 60 | |
| 16 | 10 | 12 | 15 | 5900 | <= | 15000 | Cash |
| 17 | 1 | 1 | 1 | 500 | <= | 1000 | Space |

Q9. It is summer time, the demand may increase to 400, 400, 600, if she reduces the prices to 18, 22, 25. Should she lower the price? What is the profit now?

A9.

| | A | B | C | D | E | F | G |
|----|------------|------|-----|-------|-------|-------|--------|
| 1 | maximize | 8880 | | | | | |
| 2 | var | A | B | C | | | |
| 3 | Sell price | 18 | 22 | 25 | | | |
| 4 | Cost | 10 | 12 | 15 | | | |
| 5 | Disposal | 1 | 1 | 1 | | | |
| 6 | profit | 7 | 9 | 9 | | | |
| 7 | values | 60 | 400 | 540 | | | |
| 8 | | | | | | | |
| 9 | A | B | C | total | limit | | |
| 10 | 1 | 0 | 0 | 60 | <= | 500 | demand |
| 11 | 0 | 1 | 0 | 400 | <= | 400 | |
| 12 | 0 | 0 | 1 | 540 | <= | 600 | |
| 13 | 1 | 0 | 0 | 60 | >= | 60 | Loyal |
| 14 | 0 | 1 | 0 | 400 | >= | 60 | |
| 15 | 0 | 0 | 1 | 540 | >= | 60 | |
| 16 | 10 | 12 | 15 | 13500 | <= | 15000 | Cash |
| 17 | 1 | 1 | 1 | 1000 | <= | 1000 | Space |

Q10. Going back to the original excel sheet in Q37. The brand C has a lockout in their plant for a month (no supplies from C), and Brand A, B take advantage and raise cost price by Rs 10 each because of labour shortage. What is the new optimal? What should be done?

A10.

| B1 | | | | | | |
|----|------------|----|----|-------|----------|------------|
| | A | B | C | D | E | F |
| 1 | maximize | 0 | | | | |
| 2 | var | A | B | C | | |
| 3 | Sell price | 20 | 23 | 26 | | |
| 4 | Cost | 10 | 12 | 15 | | |
| 5 | Disposal | 1 | 1 | 1 | | |
| 6 | profit | 9 | 10 | 10 | | |
| 7 | values | 0 | 0 | 0 | | |
| 8 | | | | | | |
| 9 | A | B | C | total | | limit |
| 10 | 1 | 0 | 0 | 0 | $0 \leq$ | 500 demand |
| 11 | 0 | 1 | 0 | 0 | $0 \leq$ | 400 |
| 12 | 0 | 0 | 1 | 0 | $0 \leq$ | 0 lockout |
| 13 | 1 | 0 | 0 | 0 | $0 \geq$ | 60 Loyal |
| 14 | 0 | 1 | 0 | 0 | $0 \geq$ | 60 |
| 15 | 0 | 0 | 1 | 0 | $0 \geq$ | 0 lockout |
| 16 | 10 | 12 | 15 | 0 | $0 \leq$ | 15000 Cash |
| 17 | 1 | 1 | 1 | 0 | $0 \leq$ | 1000 Space |

| B1 | | | | | | |
|----|------------|------|-----|--------------|--------------|------------|
| | A | B | C | D | E | F |
| 1 | maximize | 8500 | | | | |
| 2 | var | A | B | C | | |
| 3 | Sell price | 20 | 23 | 26 | | |
| 4 | Cost | 10 | 12 | 15 | | |
| 5 | Disposal | 1 | 1 | 1 | | |
| 6 | profit | 9 | 10 | 10 | | |
| 7 | values | 500 | 400 | -2.72905E-10 | | |
| 8 | | | | | | |
| 9 | A | B | C | total | | limit |
| 10 | 1 | 0 | 0 | 0 | $500 \leq$ | 500 demand |
| 11 | 0 | 1 | 0 | 0 | $400 \leq$ | 400 |
| 12 | 0 | 0 | 1 | -2.72905E-10 | ≤ 0 | 0 |
| 13 | 1 | 0 | 0 | 0 | $500 \geq$ | 60 Loyal |
| 14 | 0 | 1 | 0 | 0 | $400 \geq$ | 60 |
| 15 | 0 | 0 | 1 | -2.72905E-10 | ≥ 0 | 0 |
| 16 | 10 | 12 | 15 | 9800 | ≤ 15000 | Cash |
| 17 | 1 | 1 | 1 | 0 | $900 \leq$ | 1000 Space |
| 18 | | | | | | |