Using Excel to Analyze Experimental Data, Part II

Tips and Tricks that Simplify Handling Large Amounts of Data

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NASA Advanced Supercomputing Division

Preface

- The webinar assumes basic knowledge of Excel
- The advice here is somewhat unconventional and is influenced by:
  - The author’s computer science background
  - The author’s experiences with large workbooks for analyzing
    - Benchmarking data
    - PBS usage data
- There is a lot of material here
  - You may need to invest some time after the talk to experiment with the techniques described
  - To help with that there is an accompanying workbook:
    - Excel_Webinar_Examples.xlsx
- Some of the techniques here are Excel-specific
  - Some will not work with OpenOffice, Numbers (Apple), or Google Tools

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Recap of first webinar

1. Useful to think of Excel as a <u>functional</u> programming language
2. Large tables of similar records a useful paradigm
   - Columns with computations can be constructed with copy & paste
3. Pivot tables are useful for assigning data records into buckets and then performing a data reduction operation on each bucket
4. A useful technique to improve reliability and facilitate maintenance is to use multiple sheets to separate data from formulas
   - Can "copy" data into formula sheet with **=INDIRECT(ADDRESS(…))**
   - For identical analysis of multiple datasets:
     - For each dataset, one sheet for each of:
       - Experimental data, organized as a table of records with a header
       - Parameter sheet for analysis parameters (optional)
       - Formula sheet that pulls data values and per-experiment parameters
     - Sheets are named using a pattern
       - Allows data & parameter sheet names to be calculated on formula sheet
       - (see sheets with names beginning with "Exp" in examples workbook)

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Q & A from Part I

1. When separating data from formulas, what's the best way to modify multiple formula sheets?
   - From Part I: delete all but one; make changes; make copies
   - Alternative (if not making changes to graphs or pivot tables):
     - Select all formula sheet tabs
     - Make editing changes; changes will occur on each selected sheet
       - Assumes all formula sheets are identical
2. ?

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Looking up Values in a Table

- Suppose you have a table of data values, e.g.,

day_id	job_id	uid	gid	queue	MAUs	SBUs
20110701	1068006	11127	40836	normal	8	11.6
20110701	1068007	11127	40836	normal	8	11.6
20110701	1068102	11127	40836	normal	8	0.3
…	…	…	…	…	…	…

and you want to lookup items there for another table:

host	PBS	gid	nodes	jobname	mem(k)	wait hrs	run hrs	job_id	queue
columbia22	1121693.pbs1.0	s0836	128	nbody	970,915,904	0	45.93	1121693	vlong
columbia24	1121703.pbs1.0	s0836	128	nbody	926,170,816	0	10.35	1121703	vlong
columbia22	1091589.pbs1.0	s0836	128	nbody	916,032,832	139.65	100.1	1091589	vlong
…	…	…	…	…	…	…	…	…	…

- Use the **VLOOKUP(*x, table, c, approx*)** function
  - lookup **x** in 1st column of table
  - return item in column **c**

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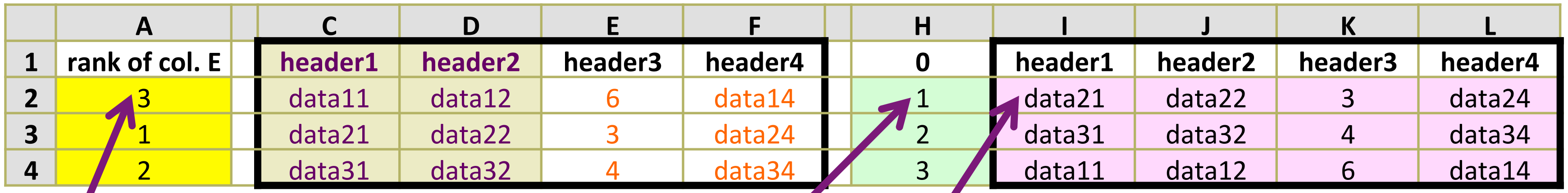
Trick #5: Sorting as a Functional Operation

- Not talking about **Data:Sort** (that is *imperative*); instead:
  - Have unsorted data, say on experimental data sheet
  - Want formulas to produced sorted copy of that data:



	A		C	D	E	F		H	I	J	K	L
1	rank of col. E		header1	header2	header3	header4		0	header1	header2	header3	header4
2	3		data11	data12	6	data14		1	data21	data22	3	data24
3	1		data21	data22	3	data24		2	data31	data32	4	data34
4	2		data31	data32	4	data34		3	data11	data12	6	data14

Table to sort using Column E

Table sorted using column E (K)

H2 is **=H1+1**

A2 is **=RANK.EQ(E2,E$2:E$4,1)**

I2 is **=VLOOKUP($H2,$A$2:$F$4,COLUMN()-COLUMN($F2), FALSE)**

  - Where:
    - **RANK.EQ(*x*,*range*,*order*)** is the rank of ***x*** in ***range*** (***order***=1 for ascending)
  - Other cells in same color region can be pasted from **A2**, **H2**, and **I2**
  - (See “Sort” sheet of examples workbook)

Reductions across Multiple Sheets

- Excel sheets are (obviously) 2-dimensional
- You can get 3-D "arrays" by using multiple sheets
- (Some) functions allow 3-D ranges to be supplied
  - **SUM('Sheet1:Sheet3'!A1:D4)**
  - Similarly: **PRODUCT**, **MAX**, **MIN**, **AVERAGE**
- Suppose you have a collection of experiments on sheets named:

  Exp1 Exp2 … Exp*N*

  - Tip: put in empty "sentinel" sheets on either side:

    AllExp< Exp1 Exp2 … Exp*N* >

  - Can *average* location D3 across all experiments with:

    =AVERAGE('AllExp<:>'!D3)

    (the empty cells don't cause a problem)
  - Adding new experiment sheets between the sentinels will cause update
  - (see "Sum over Sheets" in example workbook)

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Array Formulas

- Suppose you want to compute a weighed average:

	A	B	C	D
1		weight	case I	case II
2	A	1.0	2	2
3	B	2.0	0	
4	C	1.0	4	4
5	weighted average		1.50	3.00

- Could compute **C5** with:

  =SUMPRODUCT(B2:B4,C2:C4) / SUM(B2:B4)

- But if we want to ignore blank values (e.g. **D3**):

  {=SUMPRODUCT(B2:B4,D2:D4) / SUM(IF(ISNUMBER(D2:D4),B2:B4,0))}

  - An “Array Formula”
  - Type *control-shift-return* instead of *return* when entering
  - (see “Array Formulas” in examples workbook)
  - Note: **IF(condition, then-value, else-value)** is a conditional expression; e.g. **IF(A1=A2, 1, 0)**

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Approaching the Dark Side: Visual Basic

- Visual Basic for Applications (VBA)
  - Imperative-style programming in a BASIC-like language
  - Can simplify very complicated formulas
  - Can provide functionality not available otherwise
    - E.g. “name of worksheet #n”
- Recommendations:
  - In general, stick to functional programming style
    - I.e., no side effects in the VBA code!
  - Exception might be to provide macro-like support for administering workbook
    - E.g., updating program sheets from a template when changes have been made
- Note: workbook will need to be .xlsm file (it has “macros”)

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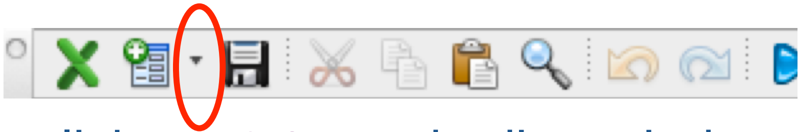
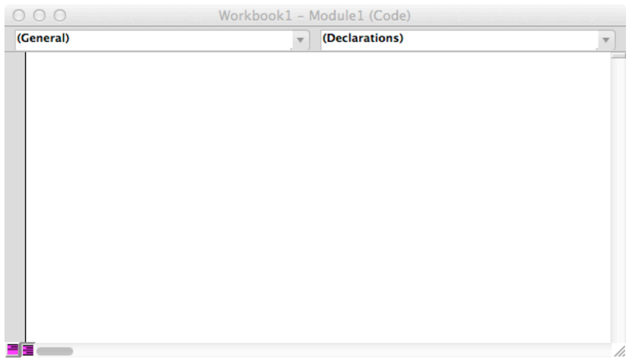
Adding User-Defined Functions in VBA

- Enable **Developer** ribbon items
  - (Mac) **Preferences:Ribbon** check **Developer** box in list
- Click **Developer** ribbon item
- Click **Editor** item
- Click 
  - Then click **Module** and editor window pops up: 

- Type VB code in window, e.g.

```
Public Function WorksheetName(num As Long) As String
   If Worksheets.Count < num Then
      WorksheetName = ""
   Else
      WorksheetName = Worksheets(num).Name
   End If
End Function
```

  - Use in formula as: **=WorksheetName(7)** which returns name of 7th sheet

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Issue: Graphs & Pivot Tables on Formula Sheets

- Issue with copying a formula sheet with a graph or a pivot table
  - Graph/table will copy, but will refer to data on original sheet not the new sheet ☹
- Workaround:
  - Copy the template worksheet to a new workbook
  - Copy the new worksheet back to original book
    - Repeat as needed to get all the copies you need
  - Rename the new sheets as appropriate
  - With a pivot table: must also "**Change Source**" to refer to new sheet name

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