

Escaping Excel Hell with Python & Pandas

MinneBar 11 - April 23, 2016

Chris Moffitt



What this presentation is not about....



<http://deadline.com/2016/01/oriental-dreamworks-kung-fu-panda-3-producer-melissa-cobb-head-of-studio-1201691805/>

What will we cover?

Session Overview

- My background
- What is Excel Hell?
- What are python and pandas?
- Short demo (time permitting)
- What are the benefits (and drawbacks) of using python?
- Tips to get started on the journey

Excel Hell

“A place of torment or misery caused by trying to use Excel as your primary data manipulation tool.”

- Paraphrased from dictionary.com

The Road to Excel Hell is paved with good intentions...

People end up in Excel Hell by trying to solve a real problem by using the only tool they have at hand.

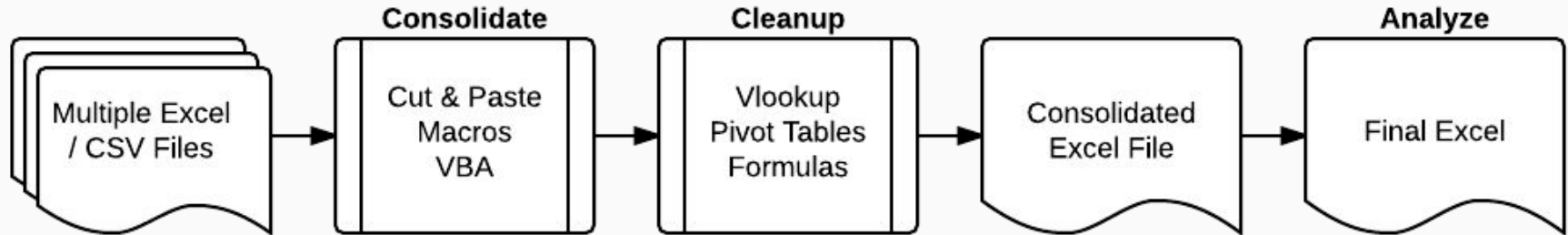


Rob Unreall

Data Wrangling = Gateway to Excel Hell

Data munging or **data wrangling** is loosely the process of manually converting or mapping **data** from one "raw" form into another format that allows for more convenient consumption of the **data** with the help of semi-automated tools.

-wikipedia



















What does Excel Hell look like?

No Version Control

- How do you know which file contains the latest code?
- What changed between versions?
- Why did you make changes?

Look Familiar?

Documents library				Arrange by: 
TPS				
Name	Date modified	Type	Size	
 Final-TPS-Report-A.xlsx	3/15/2016 12:40 PM	Microsoft Excel ...	567 KB	
 Report-TPS-VPv2.xlsx	2/26/2016 11:33 A...	Microsoft Excel ...	757 KB	
 TPS_Rpt-v4.xlsx	6/17/2015 5:03 PM	Microsoft Excel ...	109 KB	
 TPS-Report-2-3-2016.xlsx	2/3/2016 4:09 PM	Microsoft Excel ...	726 KB	
 TPS-Report-5-2015v1.xlsx	5/29/2015 1:50 PM	Microsoft Excel ...	611 KB	
 TPS-Report-Final-Final.xlsx	12/10/2015 3:40 PM	Microsoft Excel ...	541 KB	
 TPS-Report-Final-Finalv2.xlsx	12/9/2015 9:23 PM	Microsoft Excel ...	73 KB	
 TPS-Report-Jun-2015v2.xlsx	7/17/2015 3:52 PM	Microsoft Excel ...	53 KB	
 TPS-Report-revc.xlsx	7/17/2015 4:08 PM	Microsoft Excel ...	50 KB	
 TPS-Report-v3.1.xlsx	5/27/2015 10:53 A...	Microsoft Excel ...	283 KB	
 TPS-Report-v3.xlsx	5/31/2015 8:24 PM	Microsoft Excel ...	875 KB	
 TPS-report-v8.xlsx	7/15/2015 7:23 PM	Microsoft Excel ...	46 KB	
 TPS-Report-v9.xlsx	12/11/2015 8:27 A...	Microsoft Excel ...	413 KB	
 TPSv10.xlsx	12/8/2015 4:04 PM	Microsoft Excel ...	87 KB	
 TPS-v11-Dec.xlsx	12/2/2015 3:55 PM	Microsoft Excel ...	80 KB	

FOMC

Fear of Making Changes

- No single “flow” to the sheet
- How are formulas and VBA tied together?
- What underlying assumptions does the worksheet expect?

Looks like this

	B	C	D	J	K	L	M	N	O	P	Q	R
1	\$1,000	Face Value of One Bond			Mar-30-12	Date of WSJ Quotes					0	<- Purchase
2	\$30,000	Desired Annual Real Amount			226.60094	Ref CPI on WSJ Quote Date						
3	\$839,046	Calculated Total Cost of Ladder										
4												
5												
6	Feb-15-42	0.750%	30.0	96.18750	1,002.83	0.900%	2042	1	-	-	30.0	28,938
7	Feb-15-41	2.125%	30.0	132.34375	1,034.75	0.858%	2041	1	-	-	28.0	38,344
8	Feb-15-40	2.125%	30.0	131.90625	1,048.40	0.839%	2037-2040	4	3	-	107.0	147,971
9	Apr-15-32	3.375%	30.5	152.59375	1,276.63	0.588%	2032-2036	5	-	4	103.0	200,650
10	Apr-15-29	3.875%	30.0	154.37500	1,378.41	0.532%	2029-2031	3	-	2	48.0	102,140
11	Jan-15-29	2.500%	20.0	132.21875	1,055.43	0.497%		-	-	-	-	-
12	Apr-15-28	3.825%	30.0	147.81250	1,401.02	0.515%	2028	1	-	-	14.0	28,992
13	Jan-15-28	1.750%	20.0	119.53125	1,081.65	0.465%		-	-	-	-	-
14	Jan-15-27	2.375%	20.0	128.56250	1,123.65	0.385%	2027	1	-	-	17.0	24,558
15	Jan-15-26	2.000%	20.0	122.81250	1,141.70	0.308%	2026	1	-	-	16.0	22,434
16	Jan-15-25	2.375%	20.5	127.37500	1,202.15	0.204%	2025	1	-	-	15.0	22,969
36	Jul-15-14	2.000%	10.0	109.03125	1,202.15	-1.844%		-	-	-	-	-
37	Apr-15-14	1.250%	5.0	106.12500	1,070.73	-1.693%	2014	1	-	-	15.0	17,045
38	Jan-15-14	2.000%	10.0	106.90625	1,226.37	-1.785%		-	-	-	-	-
39	Jul-15-13	1.875%	10.0	105.28125	1,233.78	-2.143%		-	-	-	-	-
40	Apr-15-13	0.625%	5.0	102.65625	1,072.08	-1.899%	2013	1	-	-	15.0	16,508
41												
42	Weighted Average Real YTM, Total Cost, and Real (Apr-01-20)					0.251%		30	3	8	575.0	839,046

Feels like this

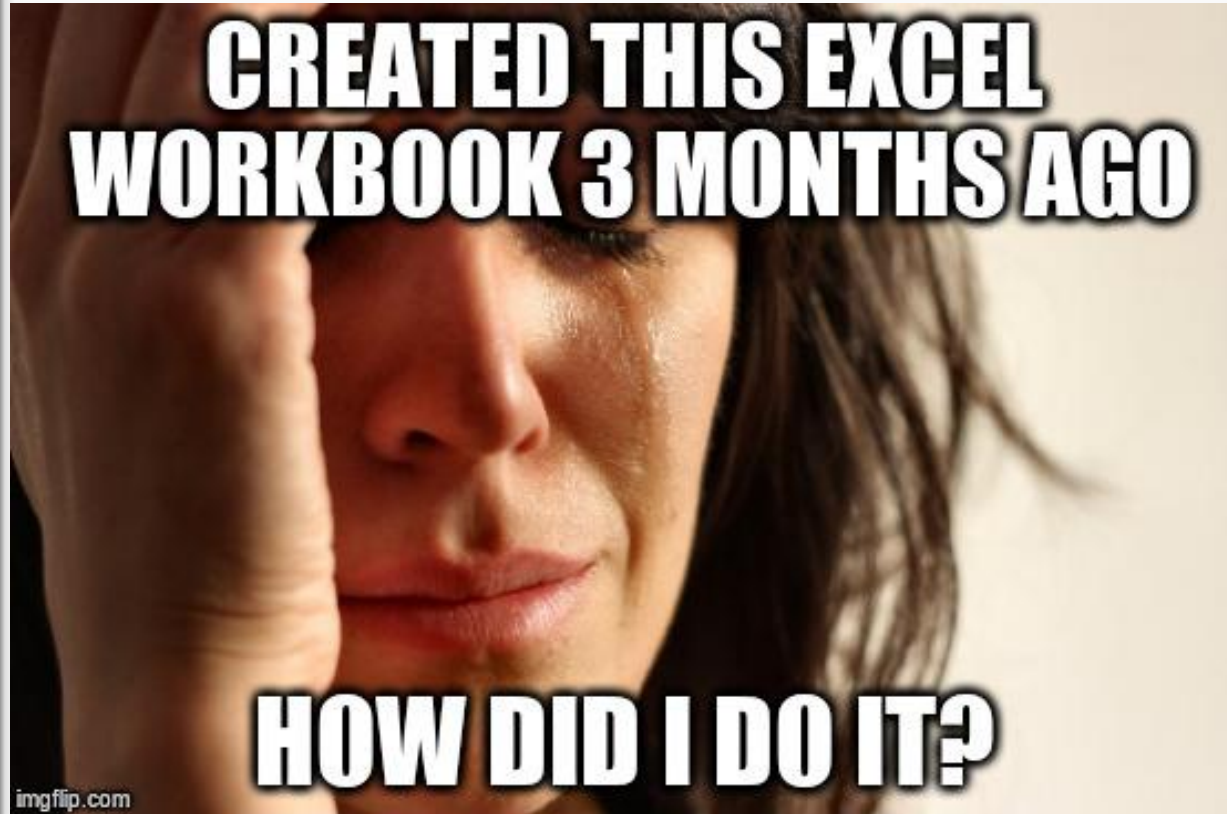


“Big Data” = Big Problems

- Excel Max = 1M rows by 16K columns
- Even if you can import that much data, can you do anything with it?
- Even much smaller data sets are difficult to manipulate at scale

Difficult to document

- How can you replicate your workbook?
- What manual steps did you (or someone else take)?
- Where did the data come from?
- Ultimately the only option is a Word document with screenshots and detailed descriptions.



Is the workbook giving you the “right” results?



Dilbert.com @ScottAdamsSays



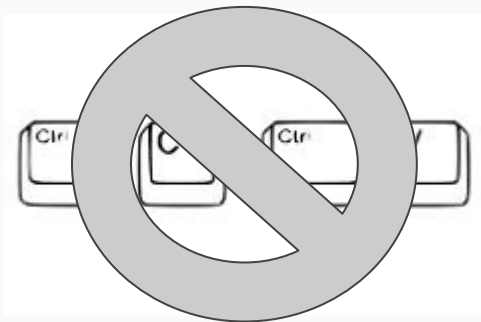
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<http://dilbert.com/strip/2016-01-07>

Additional Challenges

- Ctrl+c Ctrl+v is not a scalable ETL solution



- Difficult to bring in other data (web, SQL, json, etc)
- Challenging to debug complex formulas

```
=IF(ISBLANK($D$3),"",IF(ISERROR(VALUE($D$3)),SUMIF(Qty!$B:$B,$D$3,Qty!$H:$H),SUMIF(Qty!$A:$A,$D$3,Qty!$H:$H)))
```

**YOU'RE GOING TO FIX
ALL MY EXCEL PROBLEMS?**



PLEASE TELL ME MORE

Introduction to the Technology

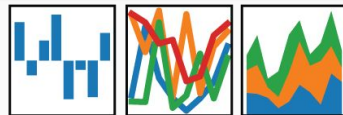


- Free, Open Source dynamic language
- Used by many large organizations
- Rich ecosystem of libraries
- Strong usage within scientific computing & data science communities
- Friendly user community
- Runs on all major OS'
- Original development started in 1989
- Good balance between ease and power

General purpose language

pandas

$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$



- Free, Open Source library for analysis and manipulation of structured data
- Started in 2008
- Designed to be fast for many data calculations
- Scalable to very large data sets
- Easy to transfer data. Works well with Excel
- Supports complex visualization of data
- Originally developed for financial users but also compares favorably to R for stats

Specifically designed library

Sounds great but this will not work for me...

1. Excel is not going away
2. In any sufficiently large group of Excel users, there will be an “Alpha User”
3. The “Alpha User” can be trained to start building python-based solutions
 - a. Start small
 - b. Save time
 - c. Increase accuracy
 - d. Rinse and repeat

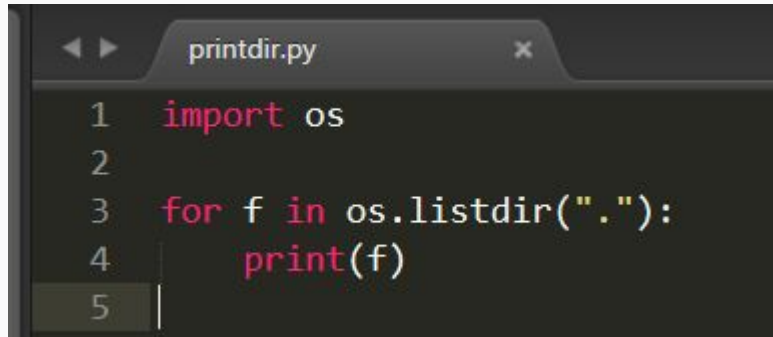
If you can write a nested Excel IF statement



You can write python code

Python 101 - Simple Development Flow

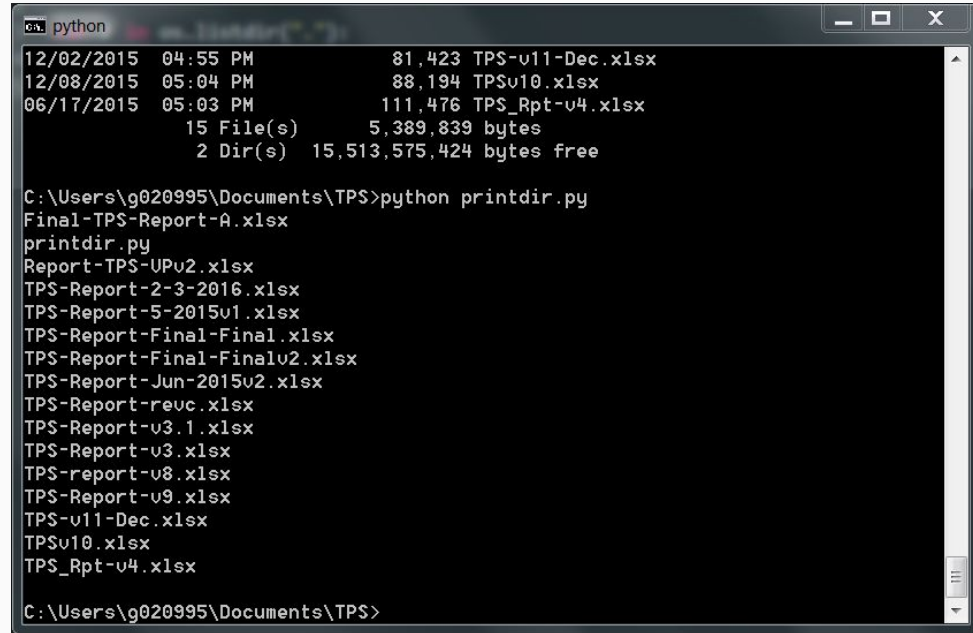
Create script in editor



```
1 import os
2
3 for f in os.listdir("."):
4     print(f)
5
```

Assuming python installed on system
Will give pointers at the end of presentation

Execute on the command line



```
python
12/02/2015 04:55 PM      81,423 TPS-v11-Dec.xlsx
12/08/2015 05:04 PM      88,194 TPSv10.xlsx
06/17/2015 05:03 PM      111,476 TPS_Rpt-v4.xlsx
          15 File(s)      5,389,839 bytes
          2 Dir(s)  15,513,575,424 bytes free

C:\Users\g020995\Documents\TPS>python printdir.py
Final-TPS-Report-A.xlsx
printdir.py
Report-TPS-UPv2.xlsx
TPS-Report-2-3-2016.xlsx
TPS-Report-5-2015v1.xlsx
TPS-Report-Final-Final.xlsx
TPS-Report-Final-Finalv2.xlsx
TPS-Report-Jun-2015v2.xlsx
TPS-Report-revc.xlsx
TPS-Report-v3.1.xlsx
TPS-Report-v3.xlsx
TPS-report-v8.xlsx
TPS-Report-v9.xlsx
TPS-v11-Dec.xlsx
TPSv10.xlsx
TPS_Rpt-v4.xlsx

C:\Users\g020995\Documents\TPS>
```

Pandas DataFrame

- Most common data structure in Pandas
- 2 dimensional table - like a spreadsheet
- Goal: Get your data into a DataFrame and manipulate using pandas + python

Index →

	account number	name	sku	quantity	unit price	ext price	date
0	740150	Barton LLC	B1-20000	39	86.69	3380.91	2014-01-01 07:21:51
1	714466	Trantow-Barrows	S2-77896	-1	63.16	-63.16	2014-01-01 10:00:47
2	218895	Kulas Inc	B1-69924	23	90.70	2086.10	2014-01-01 13:24:58
3	307599	Kassulke, Ondricka and Metz	S1-65481	41	21.05	863.05	2014-01-01 15:05:22
4	412290	Jerde-Hilpert	S2-34077	6	83.21	499.26	2014-01-01 23:26:55

← Columns

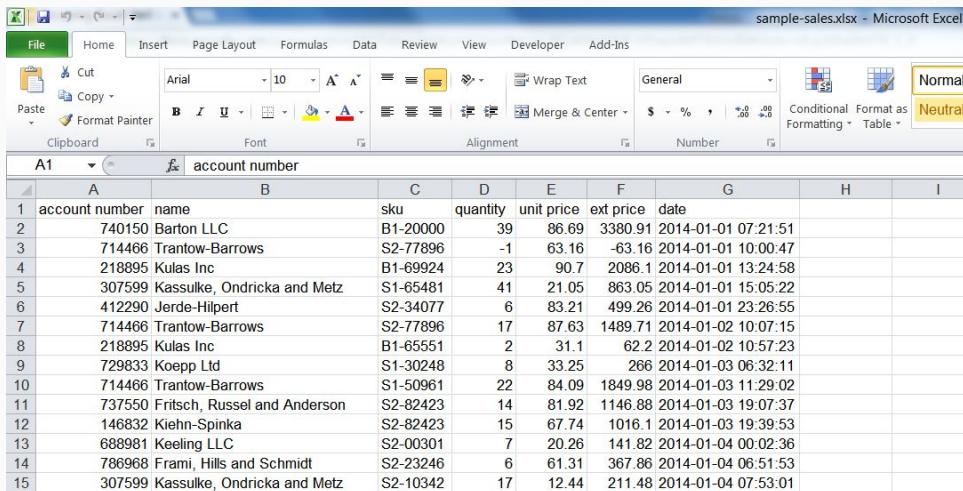
Numbers Text Dates

Once your data is in a DataFrame, you can:

- Combine with other DataFrames
- Add additional columns
- Perform mathematical operations
- Clean up the data
- Group and summarize data
- Work with time series
- Plot
- Just about anything you can do in Excel...

Example Data Manipulation: Excel vs. Pandas

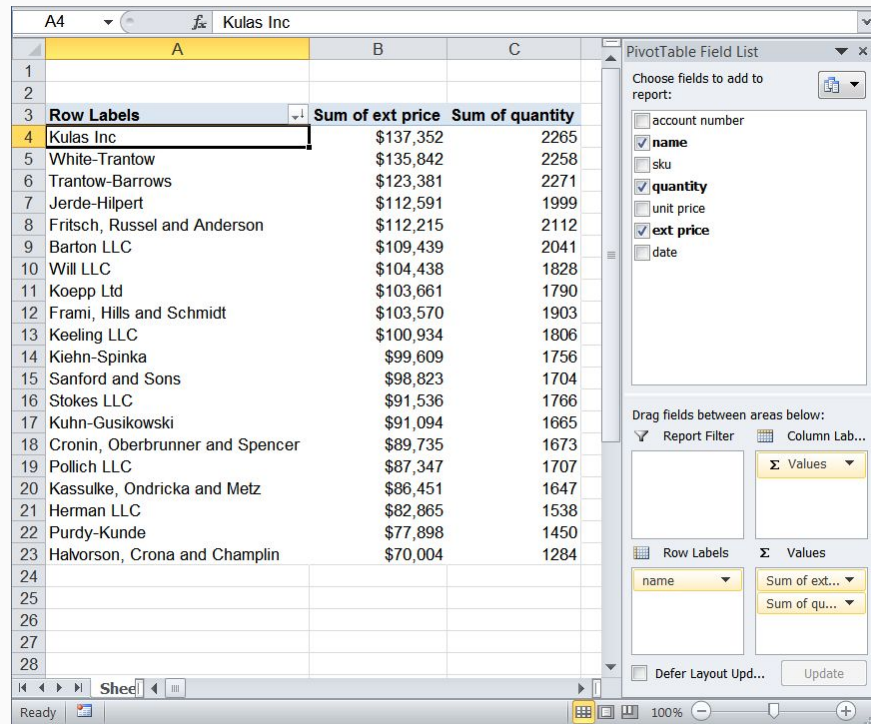
Determine Total Sales By Customer



The screenshot shows the Microsoft Excel interface with the 'sample-sales.xlsx' file open. The ribbon includes File, Home, Insert, Page Layout, Formulas, Data, Review, View, Developer, and Add-Ins. The 'Home' ribbon is active, showing options for Font, Paragraph, Styles, and Editing. The data table is visible in the background, with columns A through I. The table contains 15 rows of sales data, including account numbers, names, SKUs, quantities, unit prices, extended prices, and dates.

	A	B	C	D	E	F	G	H	I
1	account number	name	sku	quantity	unit price	ext price	date		
2	740150	Barton LLC	B1-20000	39	86.69	3380.91	2014-01-01 07:21:51		
3	714466	Trantow-Barrows	S2-77896	-1	63.16	-63.16	2014-01-01 10:00:47		
4	218895	Kulas Inc	B1-69924	23	90.7	2086.1	2014-01-01 13:24:58		
5	307599	Kassulke, Ondricka and Metz	S1-65481	41	21.05	863.05	2014-01-01 15:05:22		
6	412290	Jerde-Hilpert	S2-34077	6	83.21	499.26	2014-01-01 23:26:55		
7	714466	Trantow-Barrows	S2-77896	17	87.63	1489.71	2014-01-02 10:07:15		
8	218895	Kulas Inc	B1-65551	2	31.1	62.2	2014-01-02 10:57:23		
9	729833	Koepp Ltd	S1-30248	8	33.25	266	2014-01-03 06:32:11		
10	714466	Trantow-Barrows	S1-50961	22	84.09	1849.98	2014-01-03 11:29:02		
11	737550	Fritsch, Russel and Anderson	S2-82423	14	81.92	1146.88	2014-01-03 19:07:37		
12	146832	Kiehn-Spinka	S2-82423	15	67.74	1016.1	2014-01-03 19:39:53		
13	688981	Keeling LLC	S2-00301	7	20.26	141.82	2014-01-04 00:02:36		
14	786968	Frami, Hills and Schmidt	S2-23246	6	61.31	367.86	2014-01-04 06:51:53		
15	307599	Kassulke, Ondricka and Metz	S2-10342	17	12.44	211.48	2014-01-04 07:53:01		

- Mock sales transaction data for customers
- Summarize sales by customer
- Generate a simple pivot table to analyze



The screenshot shows the Microsoft Excel interface with a PivotTable created from the sales data. The PivotTable is located in the range A4:C28. The PivotTable Field List is visible on the right side of the screen, showing the fields available for the PivotTable. The PivotTable has two columns: 'Sum of ext price' and 'Sum of quantity'. The rows are labeled with customer names. The PivotTable Field List shows that the 'name' field is selected for the Row Labels, and the 'ext price' and 'quantity' fields are selected for the Values area.

Row Labels	Sum of ext price	Sum of quantity
Kulas Inc	\$137,352	2265
White-Trantow	\$135,842	2258
Trantow-Barrows	\$123,381	2271
Jerde-Hilpert	\$112,591	1999
Fritsch, Russel and Anderson	\$112,215	2112
Barton LLC	\$109,439	2041
Will LLC	\$104,438	1828
Koepp Ltd	\$103,661	1790
Frami, Hills and Schmidt	\$103,570	1903
Keeling LLC	\$100,934	1806
Kiehn-Spinka	\$99,609	1756
Sanford and Sons	\$98,823	1704
Stokes LLC	\$91,536	1766
Kuhn-Gusikowski	\$91,094	1665
Cronin, Oberbrunner and Spencer	\$89,735	1673
Pollich LLC	\$87,347	1707
Kassulke, Ondricka and Metz	\$86,451	1647
Herman LLC	\$82,865	1538
Purdy-Kunde	\$77,898	1450
Halvorson, Crona and Champlin	\$70,004	1284

- Build pivot table and sort values

Equivalent Pandas Example

simple_report.py

```
simple_report.py x
1 import pandas as pd
2
3 # Read in the input file from finance
4 df = pd.read_excel("sample-sales.xlsx")
5
6 # Summarize sales data by customer
7 summary = (df.groupby("name")["ext price", "quantity"].sum().round(0)
8            .sort_values(["ext price", "quantity"], ascending=[False, False]))
9
10 # Save to output file
11 summary.to_excel("report.xlsx")
```

- Create simple_report.py file
- Execute at the command line

report.xlsx

	A	B	C
1	name	ext price	quantity
2	Kulas Inc	137352	2265
3	White-Trantow	135842	2258
4	Trantow-Barrows	123381	2271
5	Jerde-Hilpert	112591	1999
6	Fritsch, Russel and Anderson	112215	2112
7	Barton LLC	109438	2041
8	Will LLC	104438	1828
9	Koepp Ltd	103661	1790
10	Frami, Hills and Schmidt	103570	1903
11	Keeling LLC	100934	1806
12	Kiehn-Spinka	99609	1756
13	Sanford and Sons	98823	1704
14	Stokes LLC	91536	1766
15	Kuhn-Gusikowski	91094	1665
16	Cronin, Oberbrunner and Spencer	89735	1673
17	Pollich LLC	87347	1707
18	Kassulke, Ondricka and Metz	86451	1647
19	Herman LLC	82865	1538
20	Purdy-Kunde	77898	1450
21	Halvorson, Crona and Champlin	70004	1284
22			

Pandas Demo

**NOT SURE IF THIS WILL
WORK**

**OR JUST WASTE MORE
TIME**

Python “program” is just text... And this is good

- Use version control
 - Safety net for changes
 - Bread crumbs to understand history
 - Back everything up
- Use comments
 - State business reasons
 - Links to Stack Overflow solutions
 - “Notes to your future self”
- Follows a process flow
 - Some hope of figuring it out in the future
 - Less chance of Excel-like spaghetti logic

chris1610 / pbpython

<> Code

Issues 0

Pull requests 0

Wiki

Pulse

Graphs

History for pbpython / code / advanced_excel.py

Commits on Dec 7, 2015



Determine table size based on the size of the incoming dataframe

chris1610 committed on Dec 7, 2015



Advanced excel code example

chris1610 committed on Dec 7, 2015

git commit -m "changes"



Writing

Useless Git
Commit Messages

ORLY?

@ThePracticalDev

30 code/advanced_excel.py

View

```
@@ -4,10 +4,13 @@
4 4
5 5
6 6
7 7
8 8
9 9
10 10
11 11
12 12
13 13
14 14
15 15
16 16
17 17
18 18
19 19
20 20
21 21
22 22
23 23
24 24
25 25
26 26
27 27
28 28
29 29
30 30

"""
from __future__ import print_function
import pandas as pd
+from xlswriter.utility import xl_rowcol_to_cell

-def format_excel(writer):
+def format_excel(writer, df_size):
    """ Add Excel specific formatting to the workbook
    + df_size is a tuple representing the size of the dataframe - typically called
    + by df.shape -> (20,3)
    """
    # Get the workbook and the summary sheet so we can add the formatting
    workbook = writer.book

    @@ -16,15 +19,20 @@ def format_excel(writer):
16 19
17 20
18 21
19 19
20 20
21 21
22 22
23 23
24 24
25 25
26 26
27 27
28 28
29 29
30 30

money_fmt = workbook.add_format({'num_format': '42', 'align': 'center'})
worksheet.set_column('A:A', 20)
worksheet.set_column('B:C', 15, money_fmt)

- worksheet.add_table('A1:C22', {'columns': [{'header': 'account',
-                                     'total_string': 'Total',
-                                     'header': 'Total Sales',
-                                     'total_function': 'sum',
-                                     'header': 'Average Sales',
-                                     'total_function': 'average'}],
-                               'autofilter': False,
-                               'total_row': True,
-                               'style': 'Table Style Medium 20'})
+
+ # Add 1 to row so we can include a total
+ # subtract 1 from the column to handle because we don't care about index
+ table_end = xl_rowcol_to_cell(df_size[0] + 1, df_size[1] - 1)
+ # This assumes we start in the left hand corner
+ table_range = 'A1:{}'.format(table_end)
```

<https://twitter.com/ThePracticalDev>

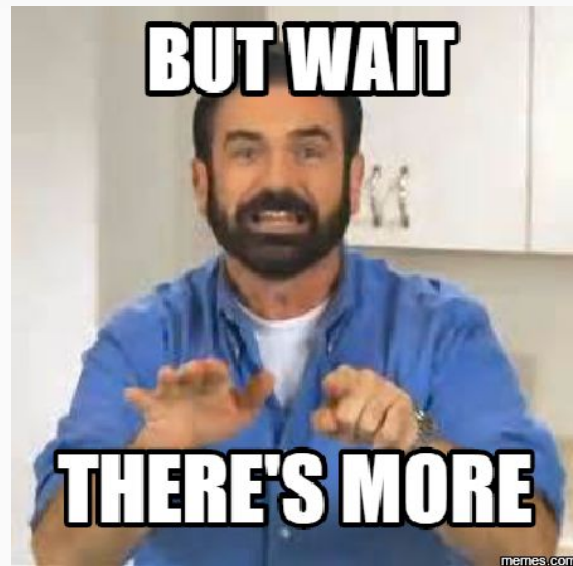
Pandas - It Slices! It Dices!

- Easy to get data into and out of a DataFrame
 - (Excel, CSV, SQL, json, HDF, HTML, Latex, msgpack)
- Optimized and designed for speed
 - Easy to read/write multi-MB files
 - Portions compiled to C for improved performance
 - Vectorized functions (look mom no loops)!
- Scalable as your data grows
- Handles missing data well
- Supports complex merging and joining
- Excellent time-series support



Python

- Generally regarded as easy to learn
- Rich ecosystem
 - (web, db, text, science, system admin and more)
- Runs well on windows
- Mature, widely adopted language but continues to evolve
- “Glue Language” - handy for data manipulation
 - Useful for moving, renaming files, web scraping etc.



There are other benefits too

- Learn how to think about data
 - Stack, unstack, melt, tidy data
- Learn as little or as much as you need
 - Could do 10-20 line scripts or build 100+ lines
- Build a library of components
 - Leverage small wins for bigger success
- New skill

How to actually learn any new programming concept



Essential

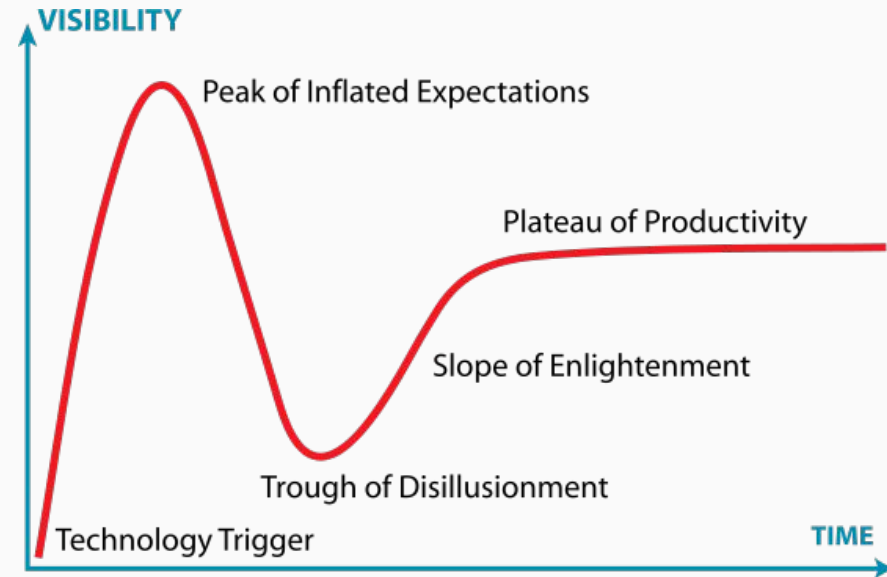
Changing Stuff and
Seeing What Happens

O RLY?

@ThePracticalDev

Despite all the upside, there are challenges

- Need to learn a new language
 - takes time, slower than doing it the old way
- Deploying solution to others
- Formatting of Excel
- Mental gymnastics to learn new paradigm



But it is worth it!

Next Steps & Resources

Python Notes:

- python 3.5+
- [Anaconda](#) or [miniconda](#) for your environment

Start with a decent text editor

- Sublime, Atom, etc.

Use Version Control!

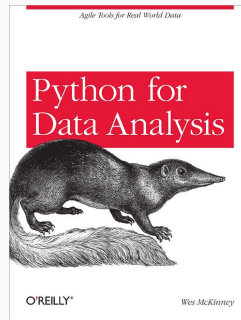
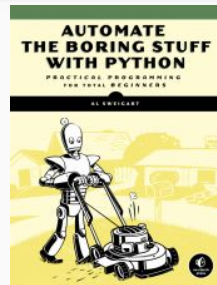
- git, hg or even svn (if you have to)

Resources:

[Automate The Boring Stuff with Python](#)

[Practical Business Python](#) :)

[Pandas](#)



Thank you!

Chris Moffitt <chris@moffitts.net>
@chris1610
pbpython.com