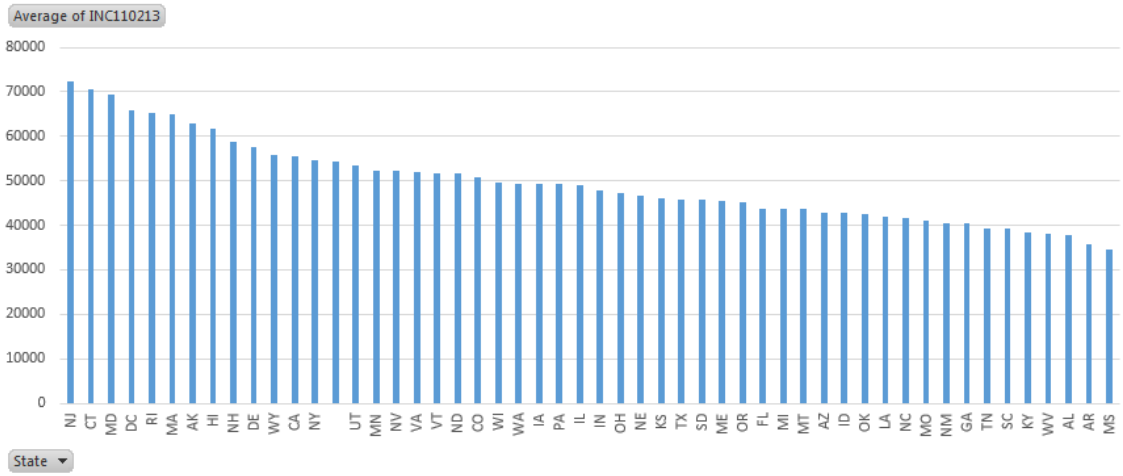
SUMMARIES AND VISUALIZATIONS

The notion of income inequality has received considerable attention in recent years. The gap between those that have a lot of money and those that don't continues to increase in the United States.

Income inequality refers to the extent to which **income** is distributed in an uneven manner among a population. In the United States, **income inequality**, or the **gap** between the rich and everyone else, has been growing markedly, by every major statistical measure, for some 30 years.

The United States Census Bureau releases aggregated data on a regular basis for states and counties in the United States. Consider the following graph that shows Median Household Income (for years 2009-2013) by State. We see that NJ has the highest household income and Mississippi has the lowest at about $35,000.



Forbes has recently published several articles centered on whether or not a college education is worth it. For many, a college education is necessary to find their first job. However, other graduates are over qualified for their job and are hampered by a substantial amount of student loan debt. The following table suggest that when a large percentage of county residents have a bachelor's degree or more, the typical household income is over $50,000. When this percentage is low, the typical income level drops to $38,000 per household.

Percent with Bachelor +	Average Income
High	$54,045
Medium	$44,689
Low	$38,074
Grand Total	**$45,937**

The data from this handout is provided by the United States Census Bureau. This data will need to be imported into Excel. The information needed for our analysis is not contained in a single file, but two different files. The auxiliary information contained in the FIPS Codes dataset will need to be merged with the dataset before summaries and visualization can be constructed.

Procedural Steps

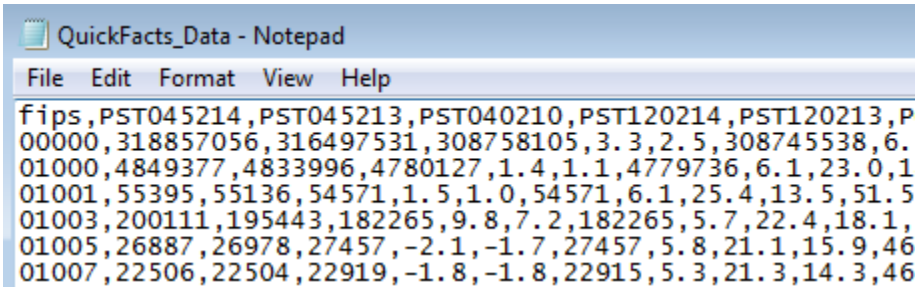
1. Download data and FIP Codes files from the US QuickFacts website
2. Merge the FIPS Code information with the data
3. Create new variables for County and State
4. Construct various summaries and visualizations in Excel

Data Technologies

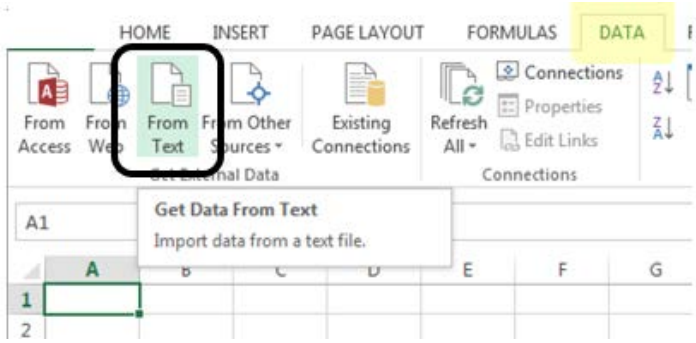
1. Import file into Excel
2. Summaries and Visualizations through PivotTables

Data Source	
Address	http://quickfacts.census.gov/qfd/download_data.html
Description	US QuickFacts The US QuickFacts dataset contains aggregate information for several variables at the County and State level. The variable Median Household Income (2009-2013) will be the focus of this investigation. Download Data Dictionary

First, let us consider the DataSet.txt file from their website. This data may not appear to have much structure. This data has been provided to us in a format known as a comma delimited or comma separated value format, i.e. csv format.

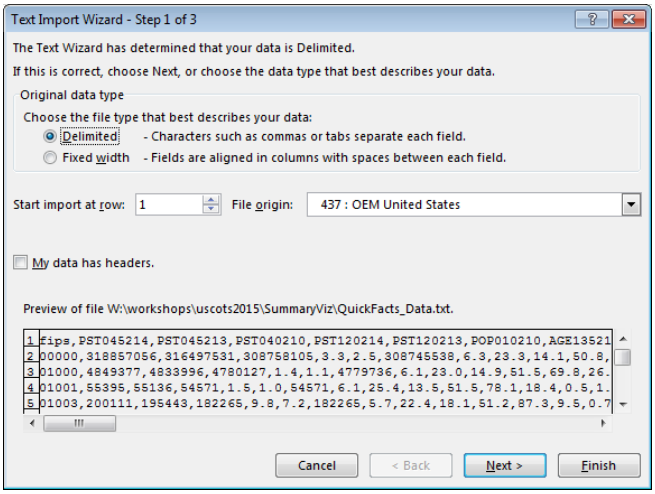


Excel has the ability to directly import this type of file. This process is started by selecting Data > From Text.

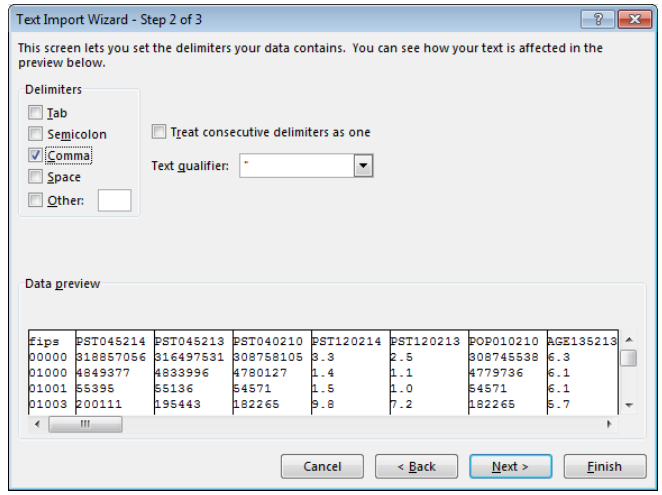


A Text Import Wizard window will show up. Proceed through this wizard by specifying the following in each step.

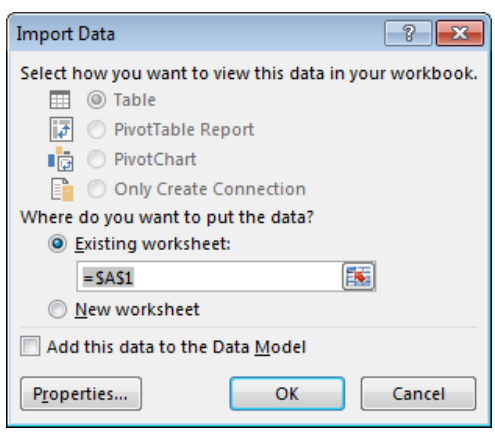
In Step 1 of 3, select Delimited



Specify that the Delimiter is Comma and click Finish



The last step is to tell Excel where you'd like the dataset to be placed. You can specify the cell location in an existing workshop or select New Worksheet.



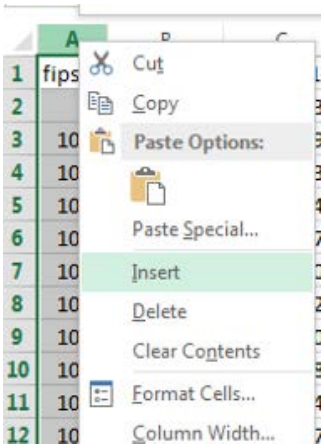
Click OK and the contents of the DataSet.txt should be successfully imported into Excel. The following snippet is given for reference.

	A	B	C	D	E	F	G	H	I	J
1	fips	PST045214	PST045213	PST040210	PST120214	PST120213	POP010210	AGE135213	AGE295213	AGE775213
2	0	318857056	316497531	308758105	3.3	2.5	308745538	6.3	23.3	14.
3	1000	4849377	4833996	4780127	1.4	1.1	4779736	6.1	23	14.
4	1001	55395	55136	54571	1.5	1	54571	6.1	25.4	13.
5	1003	200111	195443	182265	9.8	7.2	182265	5.7	22.4	18.
6	1005	26887	26978	27457	-2.1	-1.7	27457	5.8	21.1	15.
7	1007	22506	22504	22919	-1.8	-1.8	22915	5.3	21.3	14.
8	1009	57719	57720	57322	0.7	0.7	57322	6.1	23.8	16.
9	1011	10764	10605	10915	1.4	2.8	10914	6.3	21	14.

Unfortunately the only reference to county is through the Federal Information Processing Standard (FIPS) code provided in Column A. A FIPS codes is a five-digit code which uniquely identifies counties and county equivalents in the United States. States are given FIPS codes as well.

The FIPS_CountyName.txt file contains the information necessary to relate a FIPS code to a county or state name. Before the file is imported, we must insert a column for the contents of this file.

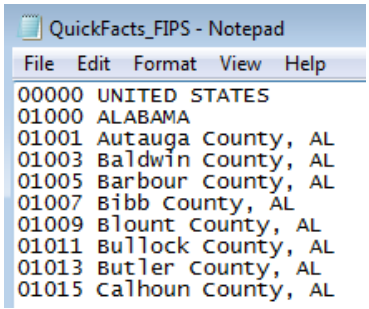
Right click on Column A and select Insert



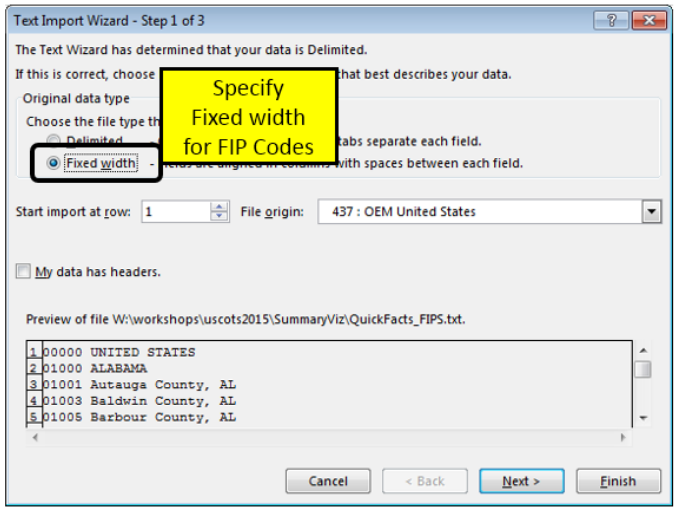
An empty column should be provided

	A	B	C	D
1		fips	PST045214	PST045
2		0	318857056	31649
3		1000	4849377	483
4		1001	55395	5
5		1003	200111	19
6		1005	26887	2
7		1007	22506	2
8		1009	57719	5

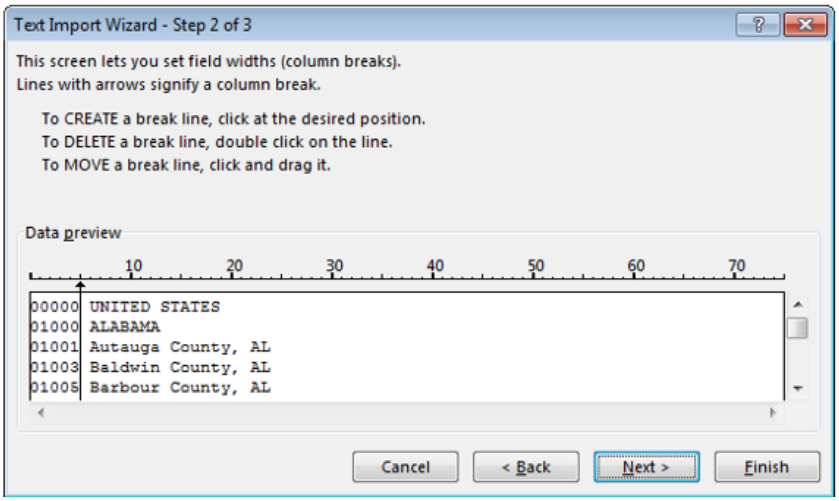
The FIPS_CountyName.txt file format is a different format than file containing the data. In particular, the first 5 digits contain the FIPS code. A comma is used to separate the County Name from the State Name.



In Step 1 of the Text Import Wizard, Fixed width should be selected.



In Step 2, specify that the first five column of each row should be separated from the remaining information. Click Next.

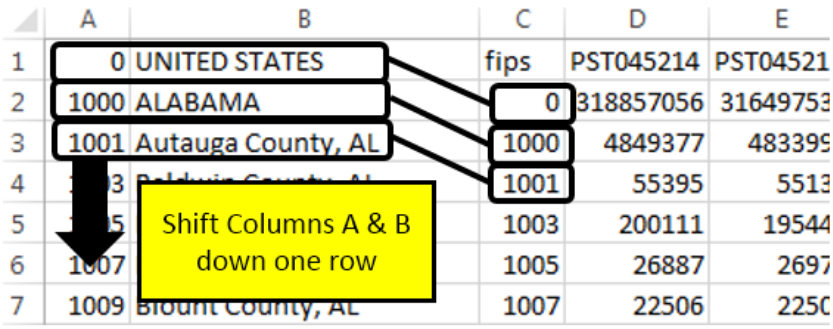


In the Import Window, specify you want the information placed in cell A1.

The information from the FIPS_CountyName.txt file should now be placed into the first two columns.

	A	B	C	D	E
1	0	UNITED STATES	fips	PST045214	PST045213
2	1000	ALABAMA	0	318857056	316497531
3	1001	Autauga County, AL	1000	4849377	4833996
4	1003	Baldwin County, AL	1001	55395	55136
5	1005	Barbour County, AL	1003	200111	195443
6	1007	Bibb County, AL	1005	26887	26978
7	1009	Blount County, AL	1007	22506	22504

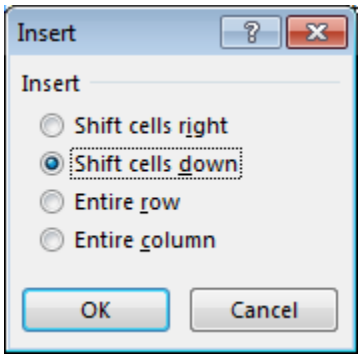
Unfortunately, the FIPS_CountyName.txt file did not contain a header row like the DataSet.txt file did. Thus, all rows in columns A and B will need to be shifted down one row.



	A	B	C	D	E
1	0	UNITED STATES	fips	PST045214	PST04521
2	1000	ALABAMA	0	318857056	31649753
3	1001	Autauga County, AL	1000	4849377	483399
4	1003	Baldwin County, AL	1001	55395	5513
5	1005	[illegible]	1003	200111	19544
6	1007	[illegible]	1005	26887	2697
7	1009	Blount County, AL	1007	22506	2250

Note: You could import the FIPS_CountyName.txt file a second time and specify the locations in the Import Window to be A2 instead of A1.

To add a row for only Columns A and B, highlight cells A1 and B1, right click, and select Insert. Specify Shift cells down to insert a row at the top of columns A and B.



Specify variable names for these new columns. FIPS2 and Location were used in my dataset.

	A	B	C	D	E	F	G
1	FIPS2	Location	fips	PST045214	PST045213	PST040210	PST120214
2	0	UNITED STATES	0	318857056	316497531	308758105	3.3
3	1000	ALABAMA	1000	4849377	4833996	4780127	1.4
4	1001	Autauga County, AL	1001	55395	55136	54571	1.5
5	1003	Baldwin County, AL	1003	200111	195443	182265	9.8
6	1005	Barbour County, AL	1005	26887	26978	27457	2.1

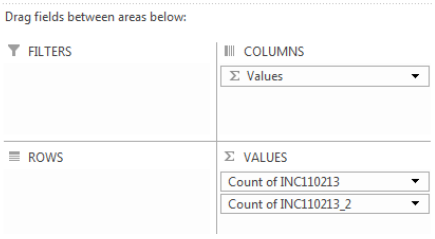
Getting Summaries Using PivotTables

This dataset contains several variable or fields. The names of these fields are abbreviated substantially as is often the case. A **data dictionary** is often provided with complex datasets. This dictionary contains detailed information about each variable. The dictionary for this data is provided in the DataDict.txt file. A review of this file informs us that INC110213 contains the Median Household Income, which is the variable of interest here.

```
HSG495213 Median value of owner-occupied housing units, 2009-2013
HSD410213 Households, 2009-2013
HSD310213 Persons per household, 2009-2013
INC910213 Per capita money income in past 12 months (2013 dollars), 2009-2013
INC110213 Median household income, 2009-2013
PVY020213 Persons below poverty level, percent, 2009-2013
BZA010213 Private nonfarm establishments, 2013
```

Select Insert > PivotTable (Data > PivotTable on a MAC). Construct a pivot table using the following structure.

Structure for PivotTable



Outcome

Average Income	Count
46060.55	3195

It appears the average median household income value is a little over $46,000. The count identifies that there were 3,195 observations used when computing this average.

However, the value for the United States, the other States, and Washington DC have been incorrectly included in this average.

If summaries are to be computed only on county level data, then a new variable should be created to identify whether or not the information provide in that row from a country.

FIPS Code	Location	Description
0	UNITED STATES	FIPS code for US is 0
1000	ALABAMA	FIPS code for AL
1001	Autauga County, AL	1st county in AL
1003	Baldwin County, AL	2nd count in AL
1099	Monroe County, AL	
skipped		*1100 is skipped as hundreds denotes a state for most instances (see note below)*
1101	Montgomery County, AL	
1133	Winston County, AL	
2000	ALASKA	FIPS code for AK
2013	Aleutians East Borough, AK	1st county equivalent in AK
Note: Four exceptions include: 2100 Haines Borough, AK; 51600 Fairfax City, VA; 51600 Newport News City, VA; 51800 Suffolk City, VA		

<u>Creating a New Variable for County</u>

The following will be used to create a new variable to identify whether or not the row contains information for a county.

Insert a new column after Location. Type the following formula into cell C2.

Cell C2: =MOD(A2,100)

Modular arithmetic is used because it is know that for all but four counties this function will produce a nonzero value. After this formula is entered, place the cursor back into cell C2 and double click on the lower-right corner. This will autofill the formula for all remaining rows.

In cell D2 enter the following formula which simply checks whether or not the value in Cell C2 is 0. If this value is 0, then we know that for all but four FIPS codes this value will not be a county. "No" is returned when the condition being checked is TRUE and "Yes" when the condition is False.

Cell D2: =IF(C2=0,"No","Yes")

	A	B	C	D
1	FIPS2	Location	Mod MATH	County
2	0	UNITED STATES	=MOD(A2,100)	=IF(C2=0,"No","Yes")
3	1000	ALABAMA		
4	1001	Autauga County, AL		
5	1003	Baldwin County, AL		
6	1005	Barbour County, AL		

Before proceeding, the four exceptions to the rule that "hundreds denotes state FIPS code" should be fixed. This can be done by applying a filter to the FIPS code column and select values 2100, 51600, 51700, and 51800. Simply change the value in Column C to a non-zero value, e.g. change them to 1.

	A	B	C	D
1	FIPS2	Location	Mod MATH	County
80	2100	Haines Borough, AK	0	No
2975	51600		0	No
2988	51700		0	No
2999	51800		0	No

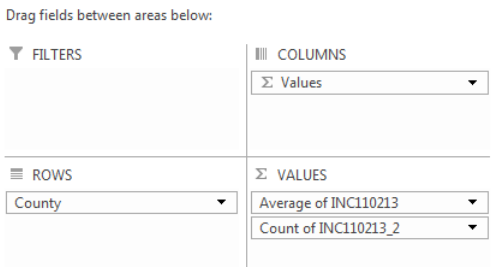
Change to nonzero value
Exceptions noted above

	A	B	C	D
1	FIPS2	Location	Mod MATH	County
80	2100	Haines Borough, AK	1	Yes
2975	51600	Fairfax city, VA	1	Yes
2988	51700	Newport News city, VA	1	Yes
2999	51800	Suffolk city, VA	1	Yes

Questions

1. Use PivotTables to verify that the average median household income across all counties in the United States is about $46,000.

PivotTable structure



Outcomes

County ?	Average Income	Count
No	53520.96	52
Yes	45937.12	3143
Grand Total	**46060.55**	**3195**

2. There is a Wikipedia page that lists information regarding all counties and county equivalents in the United State. The following text is from this Wikepedia page. Note: The table provided on the Wikipedia page is missing one entry. FIPS Code 51515 Bedford City, VA is missing. Please don't ask how I discovered this!

This is a complete list of the 3,143 counties and county equivalents of the United States of America as of July 1, 2013. For more detailed information, see the individual state lists shown below.

Source: http://en.wikipedia.org/wiki/List_of_United_States_counties_and_county_equivalents

Does it appear that the average computed above is using the correct number of rows? Discuss.

3. The County = No has 52 entries; however, there are only 50 states. Determine why there are 52 rows labeled as "No" by our procedure.

Creating a New Variable for State

A process similar to labeling Counties can be used to create a new variable for State abbreviations, i.e. AL, AK, etc. This abbreviation is present in Column B when the row consists of a county. In fact, this abbreviation is always the last two digits in the string. The =RIGHT() function will be used to pull off the last two digits, when appropriate, from column B.

Cell E2: =IF(C2=0 , ”” , RIGHT(B2,2))

- IF statement used to check whether or not column C contains a 0
- IF cell C2 is zero, then an empty string is returned, i.e. nothing is returned
- IF cell C2 is non-zero, then use the =RIGHT() function to pull off the last two digits

The following snippet is provided for reference.

	A	B	C	D	E
1	FIPS2	Location	Mod MATH	County	State
2	0	UNITED STATES	0	No	=IF(C2=0,"",RIGHT(B2,2))
3	1000	ALABAMA	0	No	
4	1001	Autauga County, AL	1	Yes	AL
5	1003	Baldwin County, AL	3	Yes	AL
6	1005	Barbour County, AL	5	Yes	AL

Verify the content is correct for the new variable State for several rows.

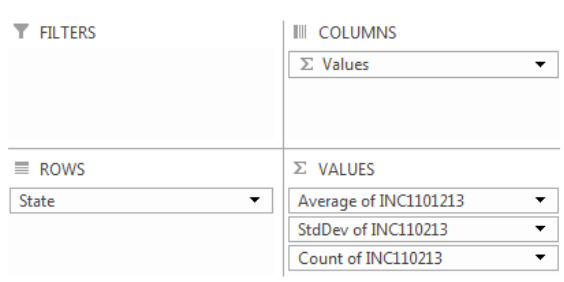
	A	B	C	D	E
1	FIPS2	Location	Mod MAT	Count	State
2	0	UNITED STATES	0	No	=IF(C2=0,"",RIGHT(B2,2))
3	1000	ALABAMA	0	No	
4	1001	Autauga County, AL	1	Yes	AL
5	1003	Baldwin County, AL	3	Yes	AL
53	1099	Monroe County, AL	99	Yes	AL
54	1101	Montgomery County, AL	1	Yes	AL
70	1133	Winston County, AL	33	Yes	AL
71	2000	ALASKA	0	No	
72	2013	Aleutians East Borough, AK	13	Yes	AK

After this new variable is created, PivotTables can be used to create summaries by State.

Summary Statistics by State

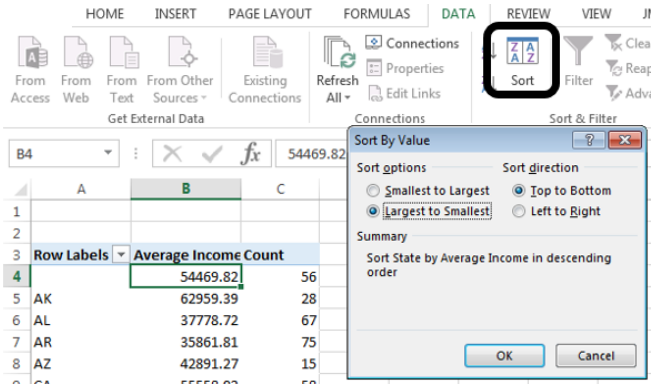
State	Average Income	Std Dev Income	Count
	53521	8694	52
AK	62611	13090	29
AL	37779	8451	67
AR	35862	6242	75
AZ	42891	6118	15
CA	55558	14046	58
CO	50853	14203	64

Structure used for PivotTable to the left



The PivotTable can be sorted by any column – simply place your cursor in the column to be sorted and select Data > Sort.

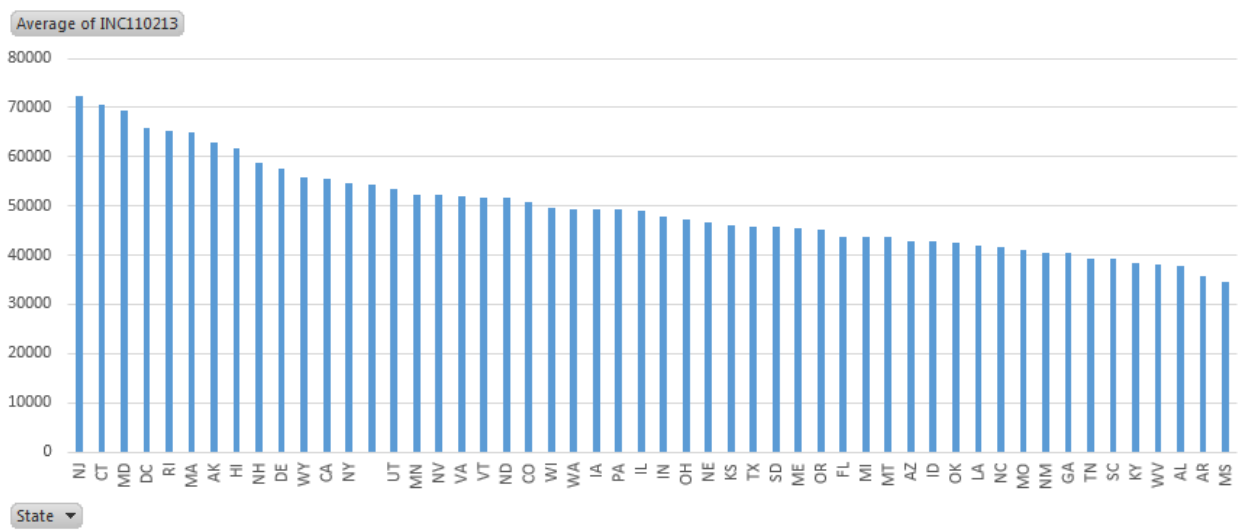
Sort inside a PivotTable



Average Household Income sorted from largest to smallest.

State	Average Income	Std Dev Income	Count
NJ	72387	16298	21
CT	70503	8662	8
MD	69404	20872	24
DC	65830	#DIV/0!	1
RI	65333	9853	5
MA	64871	12806	14
AK	62611	13090	29
HI	61791	7752	5
MN	52327	9429	87
PA	49213	9396	67
KY	38526	10050	120
WV	38216	6782	55
AL	37779	8451	67
AR	35862	6242	75
MS	34600	7542	82

Place your cursor in the PivotTable. A variety of charts can be created from the Charts menu. The following pareto-type graphic displays the average household income from largest to smallest.



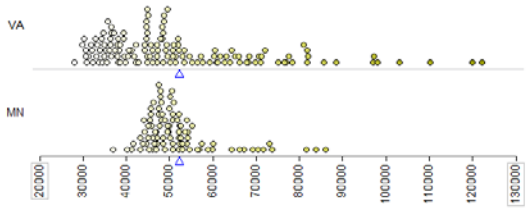
Questions

4. What is the average median household income for the state you live in? How does this value compare to others states?

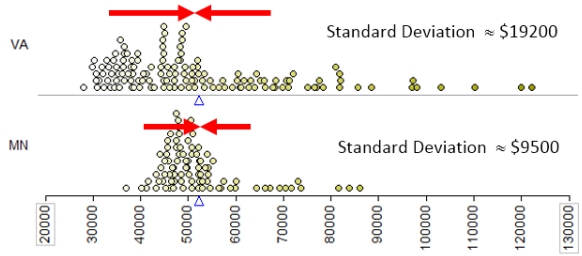
5. Why is there a blank state label on the graphic above? Discuss.

6. Consider the following graphics. Why would standard deviation of median household income be a better measure for income disparity than an average? Discuss.

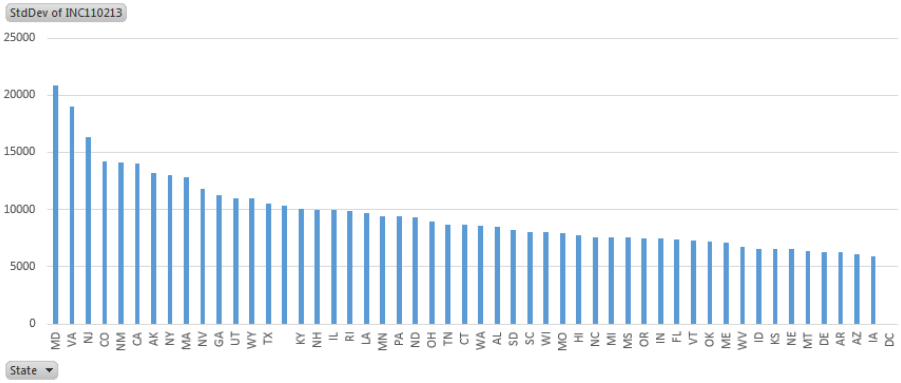
Averages for MN and VA are similar



Standard deviation, i.e. average distance from data point to mean is considerably larger for VA.



7. The pareto-type chart below show the standard deviation of incomes from highest to lowest. Identify states that appear to have low income disparity, i.e. incomes are similar across counties. What states appear to have high income disparity?



8. Notice, DC, i.e. Washington DC, on the chart above has no standard deviation. Why is this the case? Explain.

Task #1

For this task, the average income levels will be separated on a new variable called BachelorPlus Levels. This variable should be setup using the existing variable EDU685213 and with the following structure.

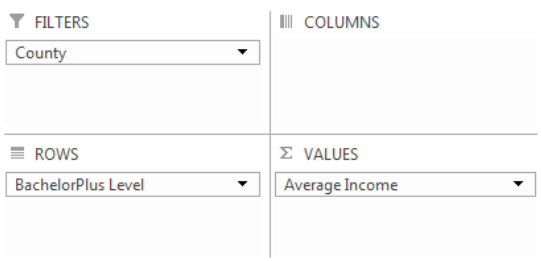
```
EDU685213 Bachelor's degree or higher, percent of persons age 25+, 2009-2013
```

- About 1/3 of counties have EDUC685213 less than 15, label these counties as Low
- About 1/3 of counties have EDUC685213 greater than 20, label these counties as High
- Label the remaining counties as Medium

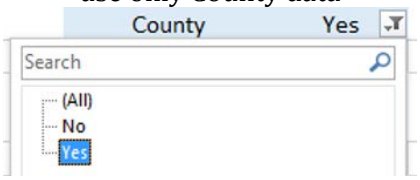
	AA	AB	AC
1	EDU635213	EDU685213	BachelorPlus Levels
2	86	28.8	=IF(AB2<15,"Low",IF(AB2>20,"High","Medium"))
3	83.1	22.6	High
4	85.6	20.9	High
5	89.1	27.7	High
6	73.7	13.4	Low
7	77.5	12.1	Low

Next, use this new variable to create the following PivotTable.

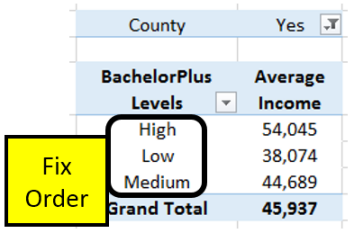
PivotTable structure



Select County = Yes from the Filter to use only County data



Default order is incorrect. Right click on Low and select Move > Down



Finished PivotTable

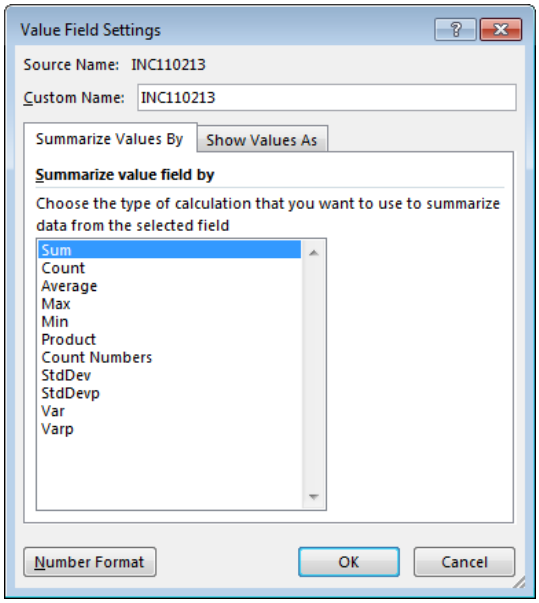
County	Yes
BachelorPlus Levels	**Average Income**
High	54,045
Medium	44,689
Low	38,074
Grand Total	**45,937**

Questions

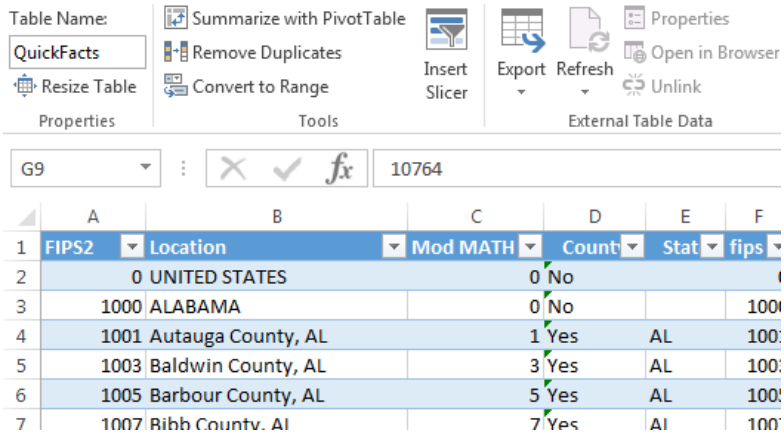
9. Does average income increase as the proportion of residents who have a Bachelors or higher increases? If so, discuss to what degree.

Using =AGGREGATE() and SLICER

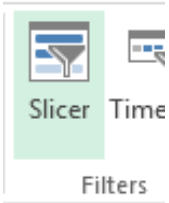
There are limitation to what PivotTables is able to compute. The list of functions available can be found under the Summarize values By tab. Notable exceptions from this list include median or more generally percentiles. The =AGGREGATE() function and the SLICER feature in Excel can be used as an alternative to PivotTables.



To invoke the SLICER feature in Excel, convert the dataset to an Excel Table. Give the Table a name, e.g. QuickFacts.

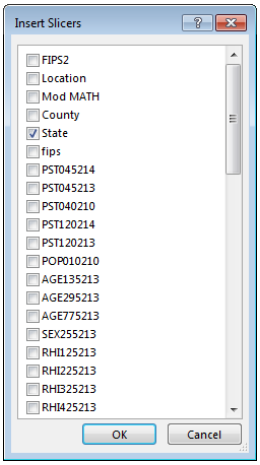


To specify a SLICER, select Insert > Slicer.

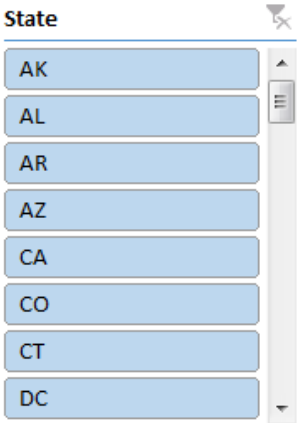


The following can be used to setup a SLICER for State.

In the Insert Slicers window, specify the field (or fields) from which to construct the slicer.



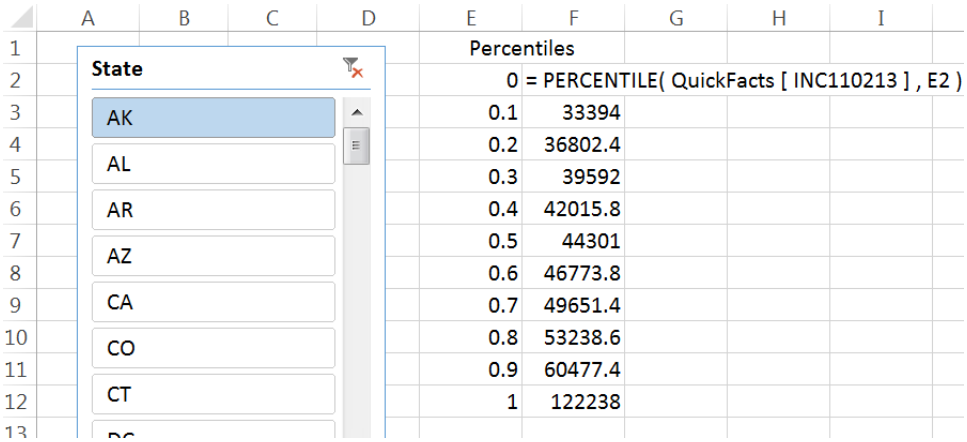
If State is specified, then the following window is displayed



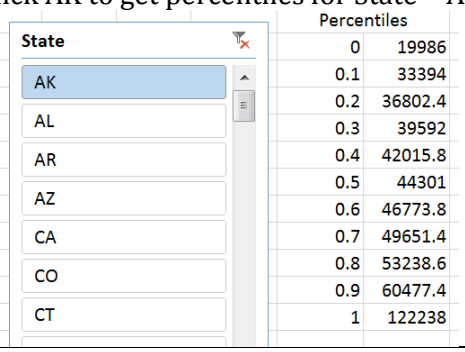
In an empty column, enter a sequence of values from 0 to 1 by increments of 0.1. These will be used to compute percentiles for income.

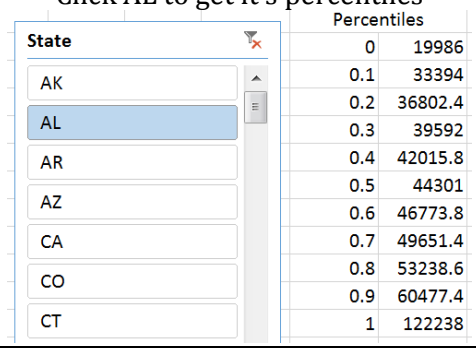
Cell F2: =PERCENTILE(QuickFacts[INC110213] , E2)

Enter this =PERCENTILE() function into cell F2 as shown. Copy this down for the remaining cells.



Try the Slicer	
Click AK to get percentiles for State = AK	Click AL to get it's percentiles





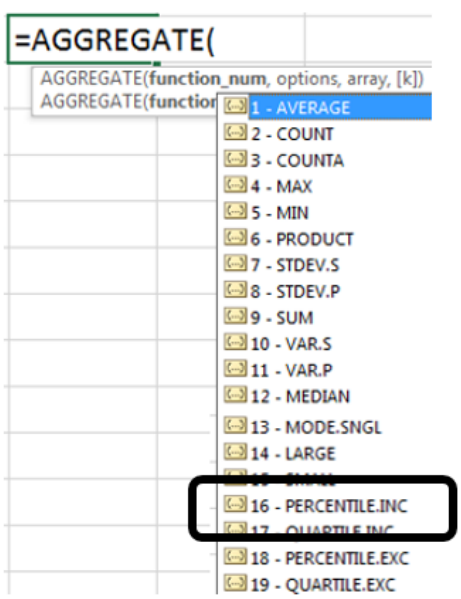
Note: The Slicer fails to produce the desired because =PERCENTILE ignores the fact that some rows should be excluded from it's calcuations.

The =AGGREGATE() function in Excel should be used in Excel when certain rows should be excluded from the requested calculations. =AGGREGATE() is a more complete version of the =COUNTIF() functions used in the previous handout.

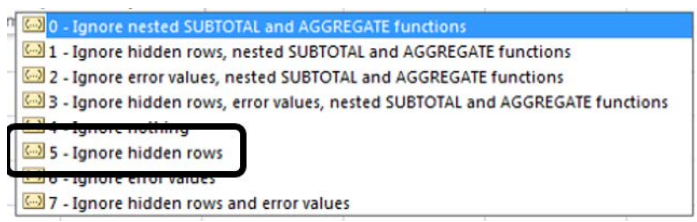
A explanation of the required arguments for the =AGGREGATE() function are briefly discussed here.

=AGGREGATE(function_num, options, array, [k])

The function_num is a number from the following list. 16 should be used for percentiles



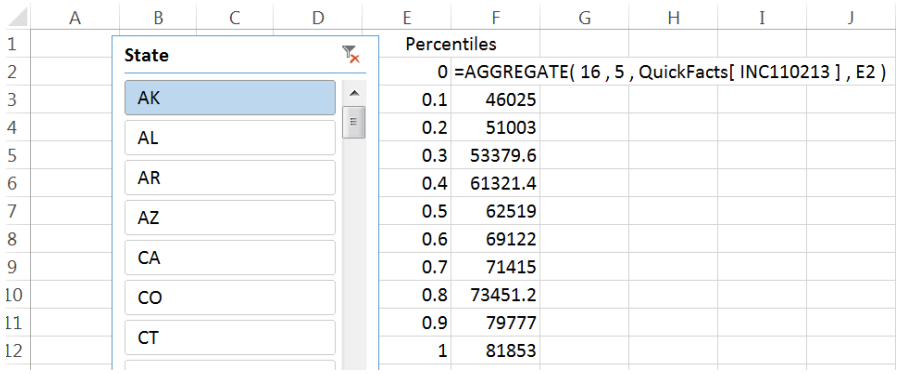
The options value should be selected from the following list. 5 will ignore hidden rows in it's calcuations.



Replace the =PERCENTILE() function used above with the following function.

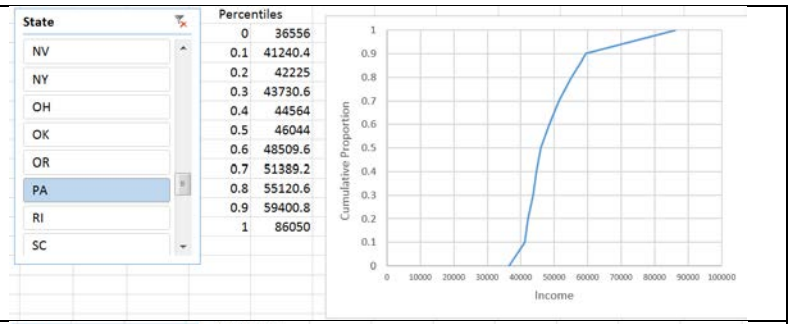
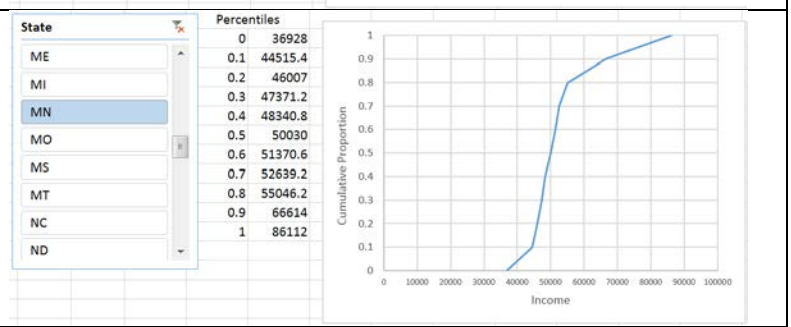
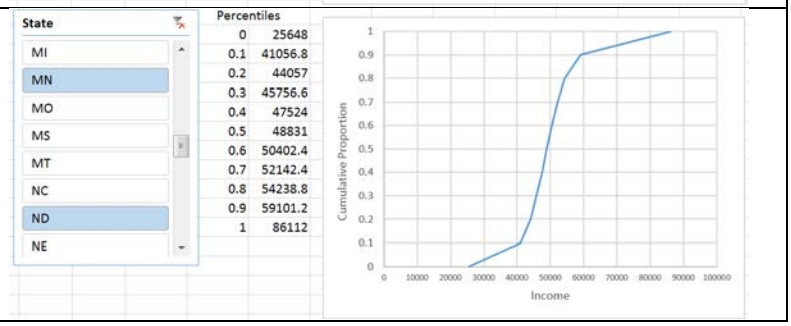
Cell F2: =AGGREGATE(16, 5,QuickFacts[INC110213],E2)

Copy this down for the remaining percentiles.



	A	B	C	D	E	F	G	H	I	J
1		State			Percentiles					
2					0	=AGGREGATE(16 , 5 , QuickFacts[INC110213] , E2)				
3		AK			0.1	46025				
4		AL			0.2	51003				
5		AR			0.3	53379.6				
6		AZ			0.4	61321.4				
7		CA			0.5	62519				
8		CO			0.6	69122				
9		CT			0.7	71415				
10					0.8	73451.2				
11					0.9	79777				
12					1	81853				

The slicer can be used to specify any state or a collection of states.

Selecting State = PA	
Selecting State = MN	
Use Ctrl to select multiple States, i.e. neighboring states to MN shown here {IA, MN, ND, SD, WI}	

Task #2

For this task, apply a SLICER on the median household income, i.e. variable INC110213. Use the slicer to verify that the following 5 counties in United States have the highest and lowest median household income.

Counties with highest median income

	A	B
1	FIPS2	Location
1229	24027	Howard County, MD
1845	35028	Los Alamos County, NM
2898	51059	Fairfax County, VA
2922	51107	Loudoun County, VA
2976	51610	Falls Church city, VA

Counties with lowest median income

	A	B
1	FIPS2	Location
430	13061	Clay County, GA
1039	21051	Clay County, KY
1087	21147	McCreary County, KY
1108	21189	Owsley County, KY
2593	48047	Brooks County, TX

Questions

10. What are the median household income values for each set of counties listed above?

11. There are 3143 counties, so the richest 31 counties would represent the top 1%. How many of the top 31 counties are from VA? How about MD?

Task #3

There are seven counties surrounding the Twin Cities that are known locally as the "metro counties." A map of these counties is provided here.

Map of Metro Counties surrounding the Twin Cities, i.e. Minneapolis - St. Paul

List of Metro Counties

Anoka County, MN
Carver County, MN
Dakota County, MN
Hennepin County, MN
Ramsey County, MN
Scott County, MN
Washington County, MN

Create necessary variables and then use PivotTables to find the average median household income for Metro = No and Metro = Yes counties in MN. How does the average income compare across these two geographic regions? Discuss.