

AQS110 – Introduction to Quality and Metrology – Fall 2015

LABORATORY EXERCISE #7

DATA ANALYSIS**Purpose**

The purpose of this lab is to evaluate the data collected in Lab #4 – measurement.

Format

- The spreadsheet containing the raw data is posted on blackboard.
- Analysis and graphs shall be completed in Excel®.

Due Date

November 9, 2016 at beginning of class

Printed graphs, statistical summary and post-lab review questions

Laboratory Exercise

The data collected for machined washer and 90° bracket in Laboratory #4 will be analyzed. The prints for these parts have been included on page(s)

The data for the materials exercise (ID measurements on steel, plastic and tubing) will be used as examples.

PROCEDURE**A. Excel Set-up**

Completing this step initially will ensure the data analysis tools are available when they're needed. Screen shots of the actions below are located at the end of the lab. (pages

1. Excel contains a data analysis tool pack; however, this requires installation
2. With a worksheet open:
 - a. Click on File tab
 - b. Click on Options (far left, near the bottom of list)
 - c. Click on "Add-ins" (far left, near the bottom of list)
 - d. Click on "Analysis ToolPak" (main screen, at top of list)
Be sure "analysis toolpak" is highlighted in blue; this indicates it has been selected.
 - e. *Click on "Go" at the bottom of the list and then click on "OK" in the bottom right corner.*
 - f. *Return to the Data tab and "data analysis" should now be visible on the ribbon.*

B. Reviewing the data

The purpose of reviewing the data prior to beginning any analysis is to ensure the values have been entered as numbers (rather than text); get a visual picture of whether the results are in or out of specification.

1. Is all data entered as a number
2. Are the measurement units all the same
3. Highlight values that are out of specification
 - a. The filter tool can be helpful here

C. Statistical Summary

1. For each dimension and tool used, determine the following
 - a. Mean, median, mode
 - b. Minimum, Maximum, range
 - c. Standard Deviation

The Excel functions (formula's) are as follows

the "=" must be the first character, this tells Excel that a calculation or function will follow format is important, there are no spaces between the data; the data range can be one column or multiple columns.

=average(data range) *example: =average(f3.f64)*
data in column "f" from cell 3 to cell 64 will be averaged

=median(data range)

=mode(data range)

=min(data range) *example: =min(f3.h64)*
the minimum value in columns "f, g, h" from cell 3 to cell 64 will be located

=max(data range)

=stdev(data range)

Range is calculated by subtracting the minimum value from the maximum value

2. Review the results, do they make sense?
 - Is the minimum or maximum value within the specification range?
 - Is the calculated range larger than the specification range?

At this point, mixed data and typographical errors can be located.

Example: specification is 0.370 – 0.390

Minimum value = 0.037 -- looks like a typo; locate this point in the dataset and review original record to establish actual value

Maximum value = 9.87 -- could this be mm instead of inches; locate this point in the dataset and review original record to establish actual value and/or units

D. Graphical Representations

When creating histograms in Excel, there are two options for creating the "bins" or categories that the data will be counted in. Refer to Lab #6 for a discussion on histograms.

First, Excel will divide the data into equal bins

Second, based on the range (min and max values) calculated above you (the analyst) can create the bins.

Both methods for creating the graph will be discussed here. Screen shots are located at the end of the lab.

Reminder - A histogram is a bar graph that depicts the frequency of data that has been recorded within a range of values. Each bin is a small division of the overall range. Refer back to Lab #6 for a more detailed explanation.

1. **Create histograms for the dimension and tool combinations for the washer and bracket as follows, a total of 4 graphs will be generated:**
 - **Washer: Thickness measured with micrometer and Outer Diameter measured with caliper**
 - **Bracket: Thickness measured with micrometer and thickness measured with caliper.**
 - a. Using both the calculated range and specification range will be helpful for determine bin sizes.

- b. *Note: If the analysis toolpak has not been added, it should be now, as it will be needed.*
- c. *Note: The ID dimension on the bracket can be pooled to create one graph rather than four.*
- d. *This may take more than one try to get the bin spacing correct.*

2. Print out of the various graphs created shall be printed and submitted.

Method 1 - Creating a histogram, allowing Excel to create the bins (pages 12-13)

1. *Beginning on the "Data Tab", select data analysis.*
2. *Scroll down through list to locate "histogram" and select by clicking OK*
3. *Using the "grid icon" in the "input data" field, select the data set that will be charted*
4. *In "output options"*
 - a. *Select either output range or new worksheet (radial buttons)*
 - b. *Select "chart output" (check boxes)*
5. *Click OK*
6. *The histogram will either appear in a new worksheet or the location in the current worksheet that you selected.*

Method 2 - Creating a histogram, Analyst creates bins (pages 14-15)

1. *Using the specification range for the data and the minimum/maximum values create at least 5 bins that the data will be categorized into*
2. *Insert a blank column next to the data you wish to graph in the histogram*
3. *Enter the individual values for each bin to be created. The column shall have the title "bin"*
4. *Beginning on the "Data Tab", select data analysis.*
5. *Scroll down through list to locate "histogram" and select by clicking OK*
6. *Using the "grid icon" in the "input data" field, select the data set that will be charted*
7. *Using the "grid icon" in the "bin" field, select the data entered in the bin column (step #3)*
8. *In "output options"*
 - a. *Select either output range or new worksheet (radial buttons)*
 - b. *Select "chart output" (check boxes)*
9. *Click OK*
10. *The histogram will either appear in a new worksheet or the location in the current worksheet that you selected.*

*Example: specification range is 0.380 – 0.390,
minimum data value recorded was 0.372 and the maximum value was 0.407*

bins (to count frequency of occurrence) could be

*0.370 – 0.374
0.375 – 0.379
0.380 – 0.384
0.385 – 0.389
0.390 – 0.394
0.395 – 0.399
0.400 – 0.404
0.405 – 0.409
≥ 0.410*

The resulting graph will then depict how many times an individual data point was recorded for the range in that bin.

E. EXERCISE

Using the worksheet “class combined data” for the washer, generate the stastical summary described in Section C.

Using the worksheet “Class combined” data for the washer, Bottom ID – caliper and OD – caliper dimensions create a histogram, as described in Section D.

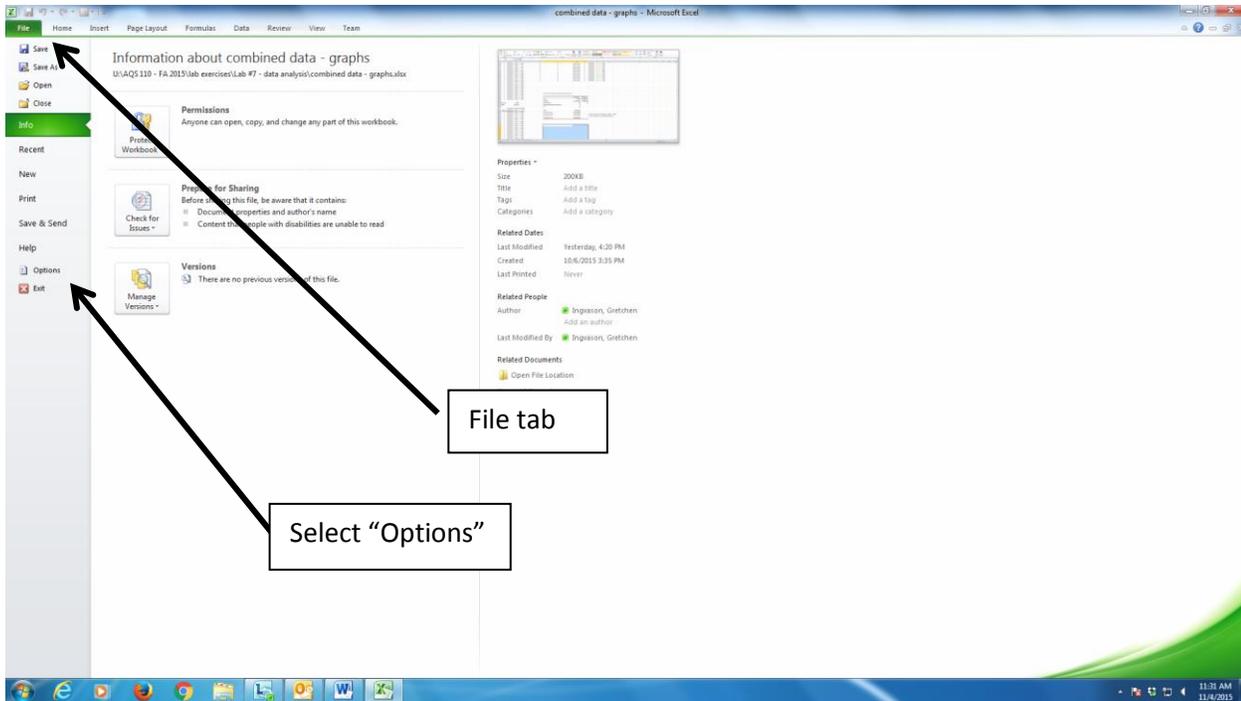
F. Post Lab Questions

- Were there any unusual observations in the data?
 - a. During initial review? Describe.

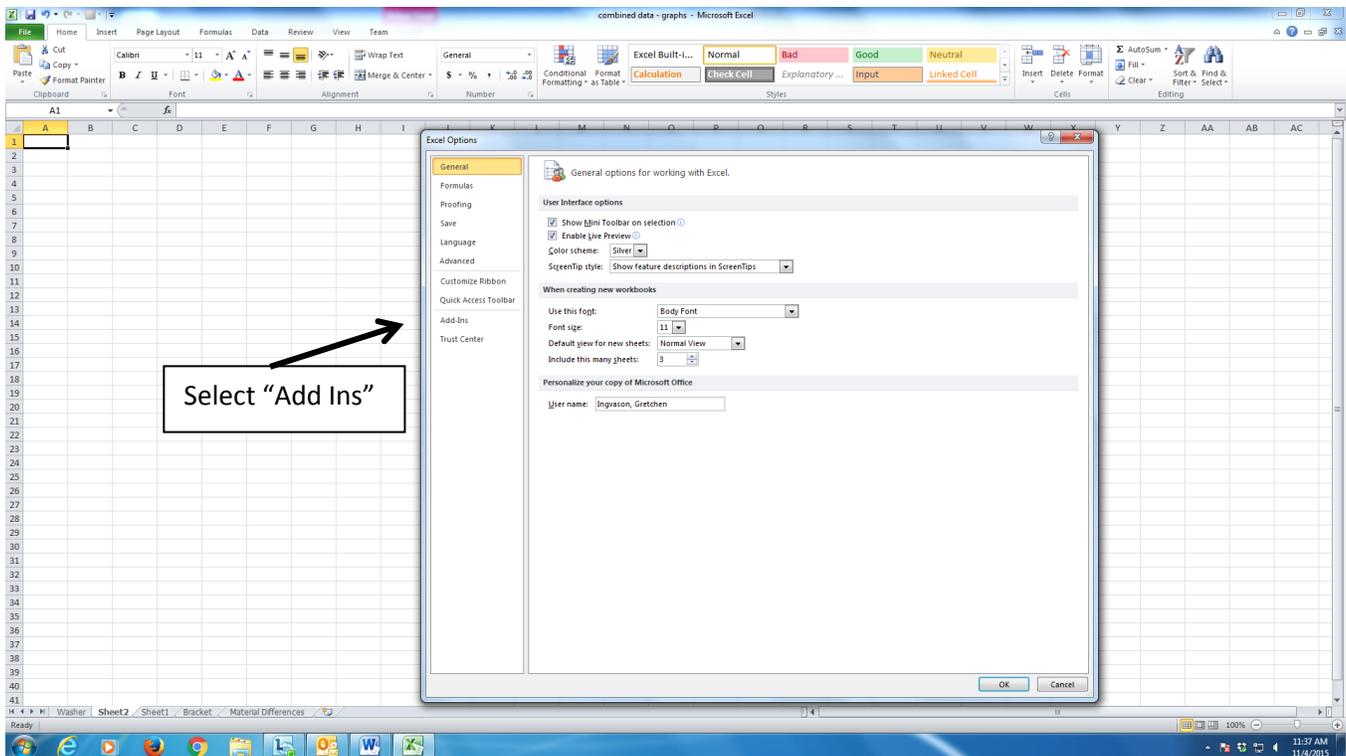
 - b. After calculations for statistical summary? Describe.

- For each component, the dimensions measured were obtained using at least 2 different tools. Referencing the statistical summary data (mean, median, mode, range, standard deviation) describe the differences observed between the tools.
 - A. Machined washer:

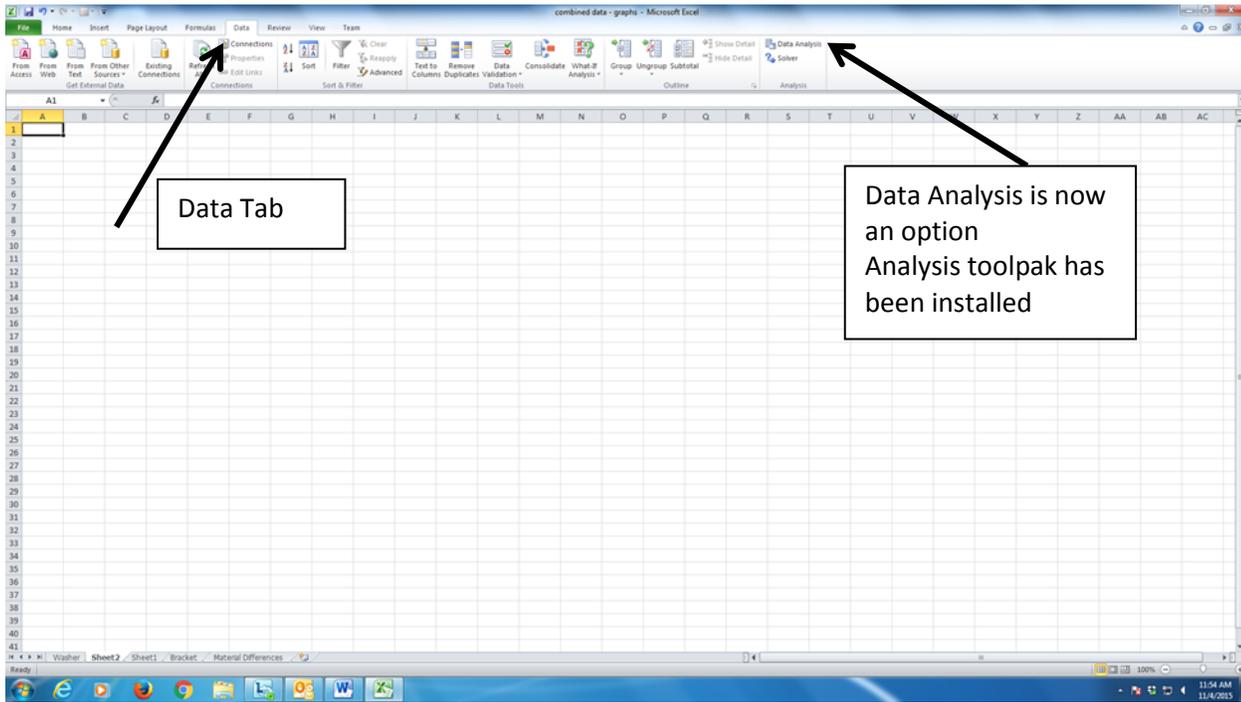
Adding the "Analysis ToolPak"



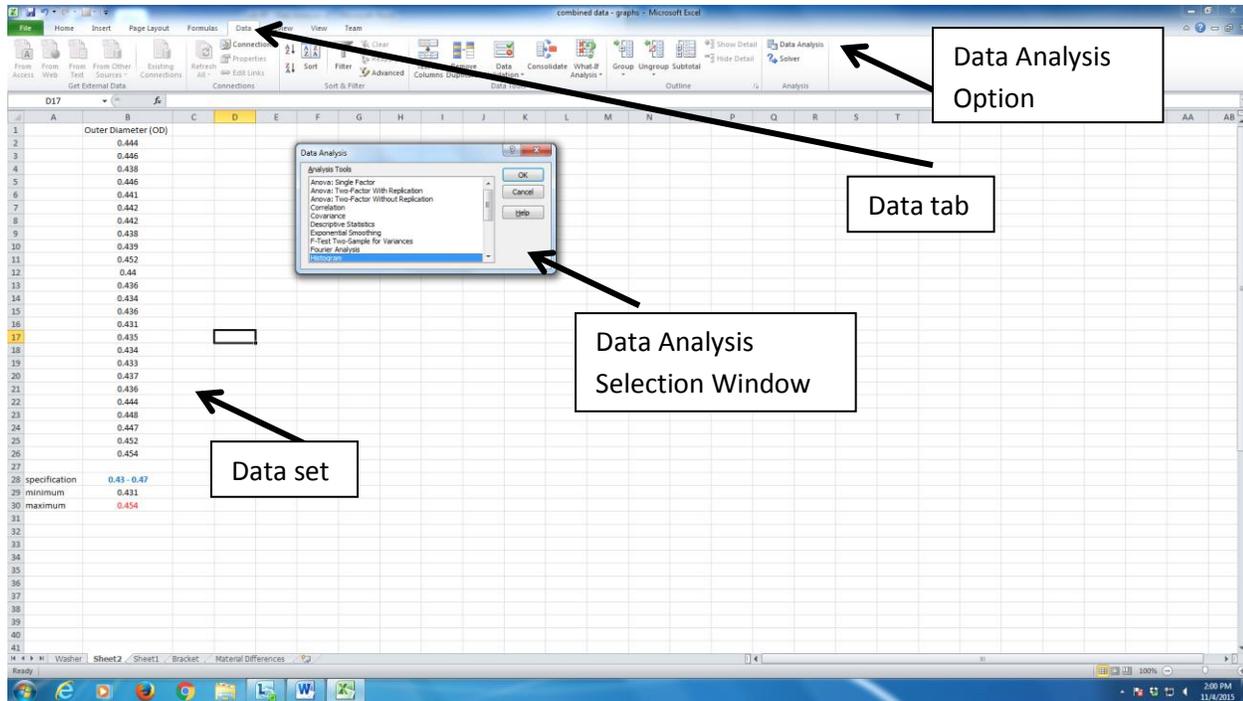
Options window will appear



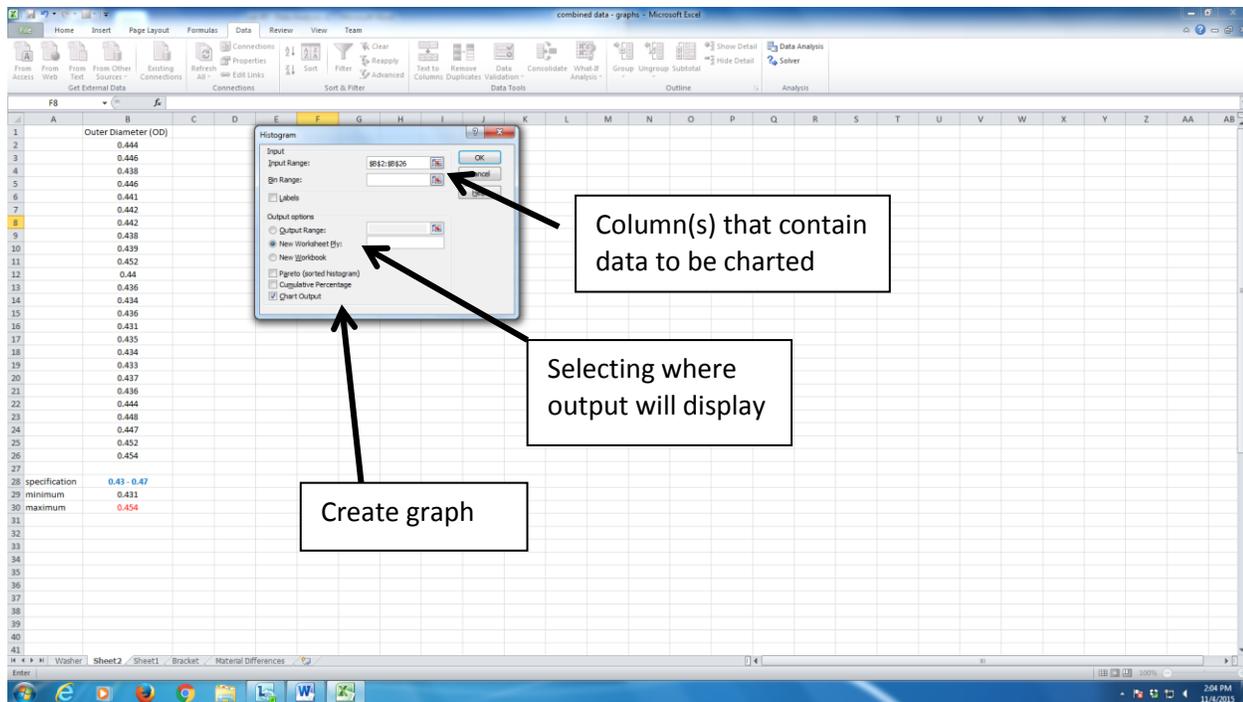
“data analysis” now appears on Data tab



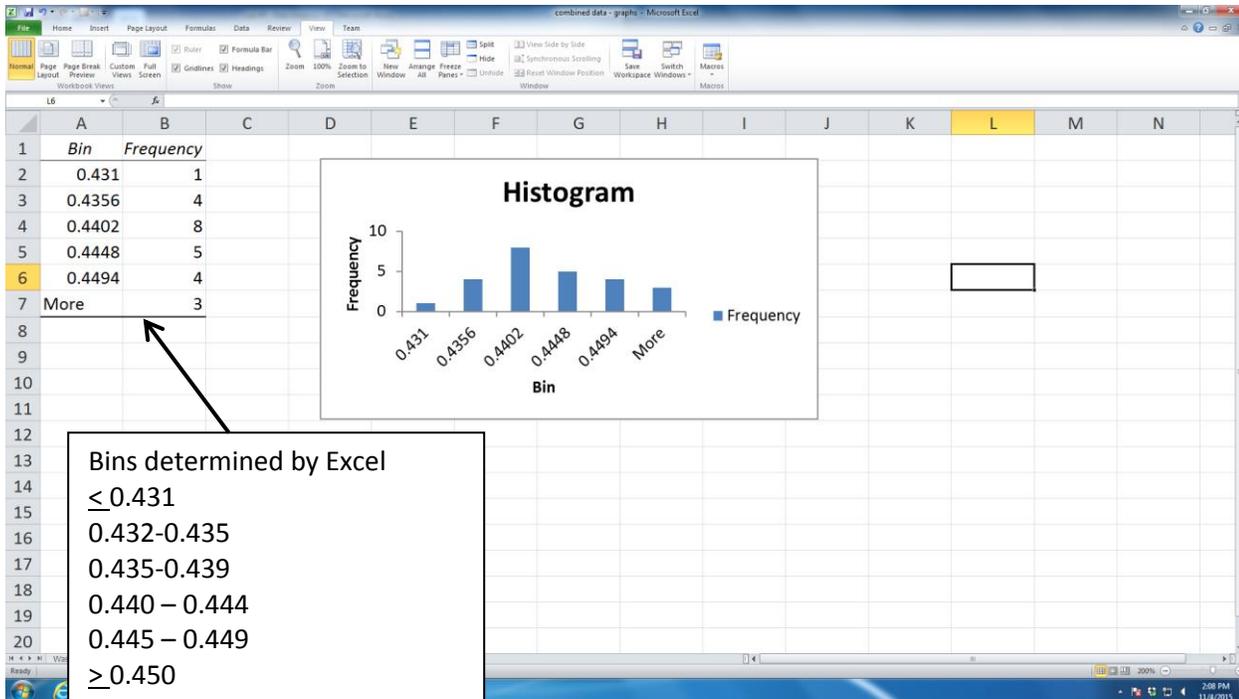
METHOD 1 – Excel Creates bins for Histogram



Selecting data to chart



Histogram Results



METHOD 2 – Excel Creates bins for Histogram

Values entered to create bins where data frequency can be counted

Column added manually prior to creating the histogram

Data used to create bins
Want to incorporate both the minimum and maximum values recorded AND the specification range

Inner Diameter (ID)	bin
0.386	0.370
0.386	0.375
0.407	0.380
0.386	0.385
0.386	0.390
0.386	0.395
0.386	0.400
0.386	0.405
0.386	0.410

specification 0.380 - 0.390
 minimum 0.372
 maximum 0.407

Select data analysis option - histogram

Data Analysis option

Data Analysis Selection Window

Data Tab

Select column(s) to chart AND where bins are located

Column(s) that contain data to chart

Column that contain assigned bin values (how to count frequency of occurrence)

Selecting where output will display

Inner Diameter (ID)	bin
0.372	0.370
0.400	0.375
0.401	0.380
0.400	0.385
0.401	0.390
0.384	0.395
0.382	0.400
0.387	0.405
0.383	0.410
0.384	
0.385	
0.385	
0.385	
0.385	
0.385	
0.386	
0.386	
0.386	
0.374	
0.373	
0.375	
0.376	
0.374	
0.376	
0.384	

Histogram Results

Bin Frequency

Bin	Frequency
0.370	0
0.375	5
0.380	2
0.385	30
0.390	17
0.395	1
0.400	2
0.405	2
0.410	1
More	0

Histogram

Frequency

Bin