

Chapter 1.2 Lecture Notes & Examples Part B

Quantitative variables often take many values. A graph of the distribution is clearer if nearby values are grouped together. The most common graph of the distribution of one quantitative variable is a **histogram**.

Example – Foreign-Born Residents

Making a histogram

What percent of your home state's residents were born outside the United States? The country as a whole has 12.5% foreign-born residents, but the states vary from 1.2% in West Virginia to 27.2% in California. The table below presents the data for all 50 states. The individuals in this data set are the states. The variable is the percent of a state's residents who are foreign-born. It's much easier to see from a graph than from the table how your state compares with other states.

State	Percent	State	Percent	State	Percent
Alabama	2.8	Louisiana	2.9	Ohio	3.6
Alaska	7.0	Maine	3.2	Oklahoma	4.9
Arizona	15.1	Maryland	12.2	Oregon	9.7
Arkansas	3.8	Massachusetts	14.1	Pennsylvania	5.1
California	27.2	Michigan	5.9	Rhode Island	12.6
Colorado	10.3	Minnesota	6.6	South Carolina	4.1
Connecticut	12.9	Mississippi	1.8	South Dakota	2.2
Delaware	8.1	Missouri	3.3	Tennessee	3.9
Florida	18.9	Montana	1.9	Texas	15.9
Georgia	9.2	Nebraska	5.6	Utah	8.3
Hawaii	16.3	Nevada	19.1	Vermont	3.9
Idaho	5.6	New Hampshire	5.4	Virginia	10.1
Illinois	13.8	New Jersey	20.1	Washington	12.4
Indiana	4.2	New Mexico	10.1	West Virginia	1.2
Iowa	3.8	New York	21.6	Wisconsin	4.4
Kansas	6.3	North Carolina	6.9	Wyoming	2.7
Kentucky	2.7	North Dakota	2.1		

Steps to make a histogram:

1. **Divide the range of the data into classes of equal width.** The data in the table vary from 1.2 to 27.2, so we might choose to use classes of width 5, beginning at 0:

0–5 5–10 10–15 15–20 20–25 25–30

But we need to specify the classes so that each individual falls into exactly one class. For instance, what if a state had exactly 5.0% of its residents born outside the United States? Since a value of 0.0% would go in the 0–5 class, we'll agree to place a value of 5.0% in the 5–10 class, a value of 10.0% in the 10–15 class, and so on. In reality, then, our classes for the percent of foreign-born residents in the states are

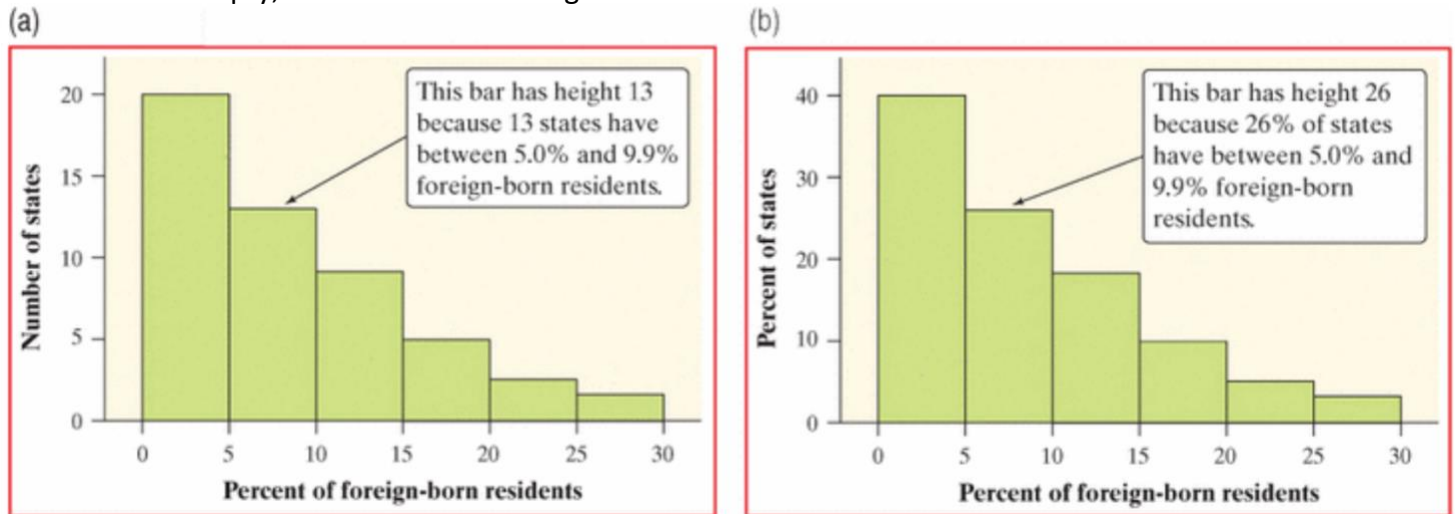
0 to < 5 5 to < 10 10 to < 15 15 to < 20 20 to < 25 25 to < 30

2. **Find the count (frequency) or percent (relative frequency) of individuals in each class.** Here is a frequency table and a relative frequency table for these data:

Frequency table	
Class	Count
0 to < 5	20
5 to < 10	13
10 to < 15	9
15 to < 20	5
20 to < 25	2
25 to < 30	1
Total	50

Relative frequency table	
Class	Percent
0 to < 5	40
5 to < 10	26
10 to < 15	18
15 to < 20	10
20 to < 25	4
25 to < 30	2
Total	100

3. Label and scale your axes and draw the histogram. Label the horizontal axis with the variable whose distribution you are displaying. That's the percent of a state's residents who are foreign-born. The scale on the horizontal axis runs from 0 to 30 because that is the span of the classes we chose. The vertical axis contains the scale of counts or percents. Each bar represents a class. The base of the bar covers the class, and the bar height is the class frequency or relative frequency. Draw the bars with no horizontal space between them unless a class is empty, so that its bar has height zero.



Histogram **(a)** is a frequency histogram. Histogram **(b)** is relative frequency histogram.

Discuss frequency histogram versus relative frequency histogram. Relative frequency histograms are typically more useful because they make it easier to compare two distributions especially when the number of individuals is very different.

What do the histograms in the Figure above tell us about the percent of foreign-born residents in the states? To find out, we follow our familiar routine: describe the pattern and look for any departures from the pattern.

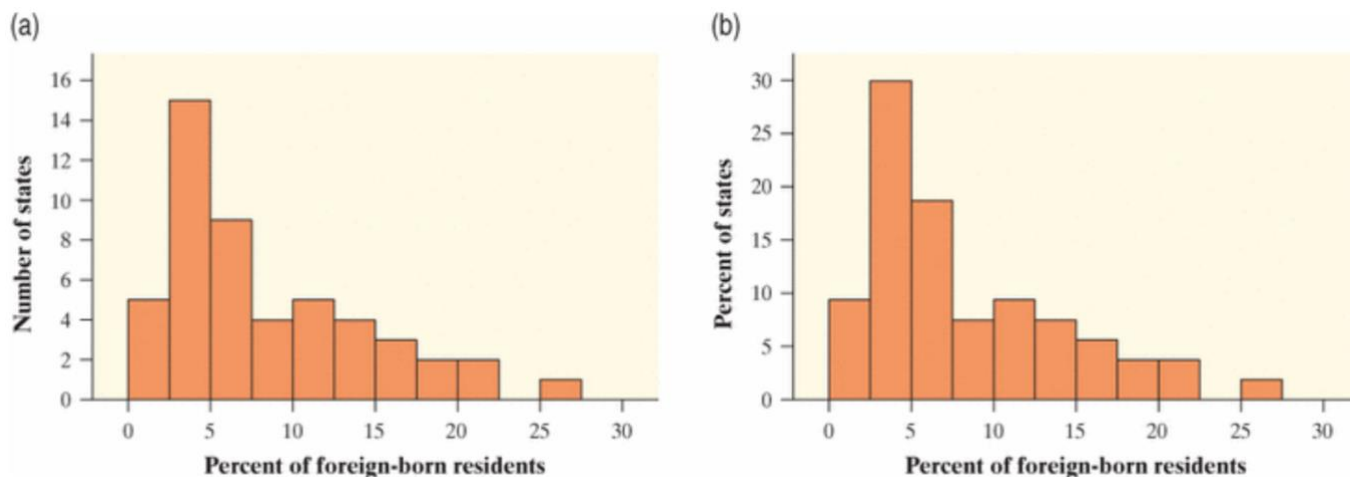
Shape: The distribution is skewed to the right. A majority of states have fewer than 10% foreign-born residents, but several states have much higher percents, so that the graph extends quite far to the right of its peak. The distribution has a single peak at the left, which represents states in which between 0% and 4.9% of residents are foreign-born.

Center: From the graph, we see that the midpoint (median) would fall somewhere in the 5.0% to 9.9% class. Remember that we're looking for the value having 25 states with smaller percents foreign-born and 25 with larger. (Arranging the observations from the table in order of size shows that the median is 6.1%.)

Spread: The histogram shows that the percent of foreign-born residents in the states varies from less than 5% to over 25%. (Using the data in the table, we see that the range is $27.2\% - 1.2\% = 26.0\%$.)

Outliers: We don't see any observations outside the overall single-peaked, right-skewed pattern of the distribution. The histograms below shows (a) a frequency histogram and (b) a relat

The histograms below show (a) a frequency histogram and (b) a relative frequency histogram of the same distribution, with classes half as wide. The new classes are 0–2.4, 2.5–4.9, etc. Now California, at 27.2%, stands out as a potential outlier in the right tail. The choice of classes in a histogram can influence the appearance of a distribution. Histograms with more classes show more detail but may have a less clear pattern.



Histogram on the calculator

TECHNOLOGY CORNER Histograms on the calculator

TI-83/84

TI-89

1. Enter the data for the percent of state residents born outside the United States in your Statistics/List Editor.

- Press **[STAT]** and choose 1:Edit...
- Press **[APPS]** and select Stats/List Editor.
- Type the values into list L1.
- Type the values into list1.

L1	L2	L3	1
2.8			
7			
15.1			
3.8			
27.2			
10.3			
12.9			
L1C0=2.8			

list1	list2	list3	list4
2.8			
7			
15.1			
3.8			
27.2			
10.3			
list1[1]=2.8			

2. Set up a histogram in the Statistics Plots menu.

- Press **[2nd]** **[Y=]** (STAT PLOT).
- Press **[F2]** and choose 1:Plot Setup...
- Press **[ENTER]** or **[1]** to go into Plot1.
- With Plot1 highlighted, press **[F1]** to define.

Plot1	Plot2	Plot3
On	Off	Off
Type: []	Type: []	Type: []
Xlist: L1	Xlist: []	Xlist: []
Freq: 1	Freq: []	Freq: []

Plot Type	Plot Name
Histogram	list1
Box Plot	list1
Box Plot with Normal Curve	list1
Box Plot with Q-Q Plot	list1
Box Plot with Residuals	list1
Box Plot with Histogram	list1
Box Plot with Histogram and Normal Curve	list1
Box Plot with Histogram and Q-Q Plot	list1
Box Plot with Histogram and Residuals	list1
Box Plot with Histogram and Histogram	list1

Set Hist. Bucket Width to 5.

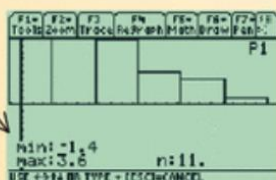
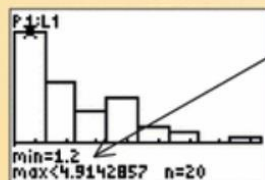
What percent of your home state's residents were born outside the United States? The percentage for each state is listed below:

2.8, 7.0, 15.1, 3.8, 27.2, 10.3, 12.9, 8.1, 18.9, 9.2, 16.3, 5.6, 13.8, 4.2, 3.8, 6.3, 2.7, 2.9, 3.2, 12.2, 14.1, 5.9, 6.6, 1.8, 3.3, 1.9, 5.6, 19.1, 5.4, 20.1, 10.1, 1.6, 6.9, 2.1, 3.6, 4.9, 9.7, 5.1, 12.6, 4.1, 2.2, 3.9, 15.9, 8.3, 3.9, 10.1, 12.4, 1.2, 4.4, 2.7

3. Use ZoomStat (ZoomData on the TI-89) to let the calculator choose classes and make a histogram.

- Press **ZOOM** and choose 9:ZoomStat.
- Press **TRACE** and **◀ ▶** to examine the classes.
- Press **F5** (ZoomData).
- Press **F3** (Trace) and **◀ ▶** to examine the classes.

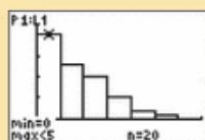
Note the calculator's unusual choice of classes.



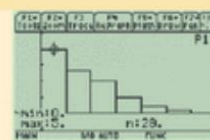
4. Adjust the classes to match those in **Figure 1.16**, and then graph the histogram.

- Press **WINDOW** and enter the values shown.
- Press **GRAPH**
- Press **TRACE** and **◀ ▶** to examine the classes.
- Press **◀ ▶ F2** (WINDOW) and enter the values shown.
- Press **◀ ▶ F3** (GRAPH)
- Press **F3** (trace and **◀ ▶** to examine the classes)

WINDOW
Xmin=-5
Xmax=35
Xscl=5
Ymin=-5
Ymax=25
Yscl=5
Xres=1

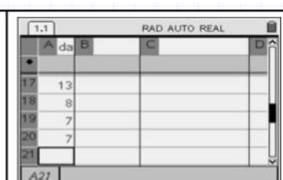


F1 F2 F3 F4 F5 F6 F7 F8
T1 T2 T3 T4 T5 T6 T7 T8
T9 T10 T11 T12 T13 T14 T15 T16
T17 T18 T19 T20 T21 T22 T23 T24
T25 T26 T27 T28 T29 T30 T31 T32
T33 T34 T35 T36 T37 T38 T39 T40
T41 T42 T43 T44 T45 T46 T47 T48
T49 T50 T51 T52 T53 T54 T55 T56
T57 T58 T59 T60 T61 T62 T63 T64
T65 T66 T67 T68 T69 T70 T71 T72
T73 T74 T75 T76 T77 T78 T79 T80
T81 T82 T83 T84 T85 T86 T87 T88
T89 T90 T91 T92 T93 T94 T95 T96
T97 T98 T99 T100

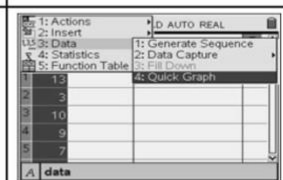


TI Inspire Directions

1. Enter the data into the *Lists & Spreadsheets* area.
(See *Lists and Spreadsheets* for entering data.)

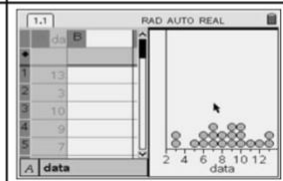


2. Arrow up to select the entire column.
Press **menu** and choose #3 Data, #4 Quick Graph.



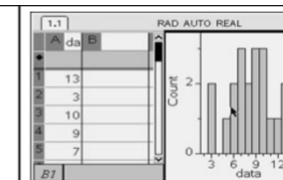
3. The window will be split and a dot plot will appear to the right.

Remember that **CTRL-TAB** will move between the split screens.

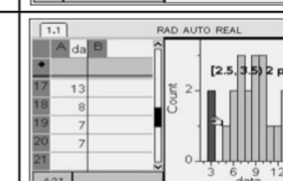


4. From the right window, press **MENU**.

Choose #1 Plot Type, #3 Histogram



5. To see the size of the bars and the number of values represented by each bar, click on the bar.



6. To adjust the histogram, press **MENU**.

Choose #2 Plot Properties, #2 Histogram Properties

#1 Histogram Scale

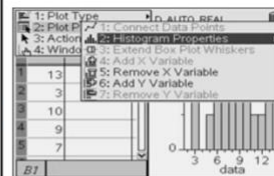
#1 Count = Displays the data based upon the number of values that occur within each bar (or bin) on the histogram. This is the default data representation when you create a histogram. The Count tool is not available because it is currently in use.

#2 Percent = Displays data in the histogram by each group's percent value of the whole data set.

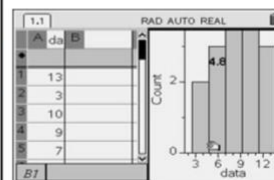
#3 Density = Displays data in the histogram based upon the density of each value within the data set.

#2 Bin Settings - Displays a dialog for setting the histogram values for bin (bar) width and alignment.

You can adjust the bins' width and number by dragging the side of one bin. A value that occurs on the edge of a bin is counted in the bin to the right. **Avoid problems by staying with the default bin widths.**



The number of bins displayed depends upon the number of data points and the distribution of these points.



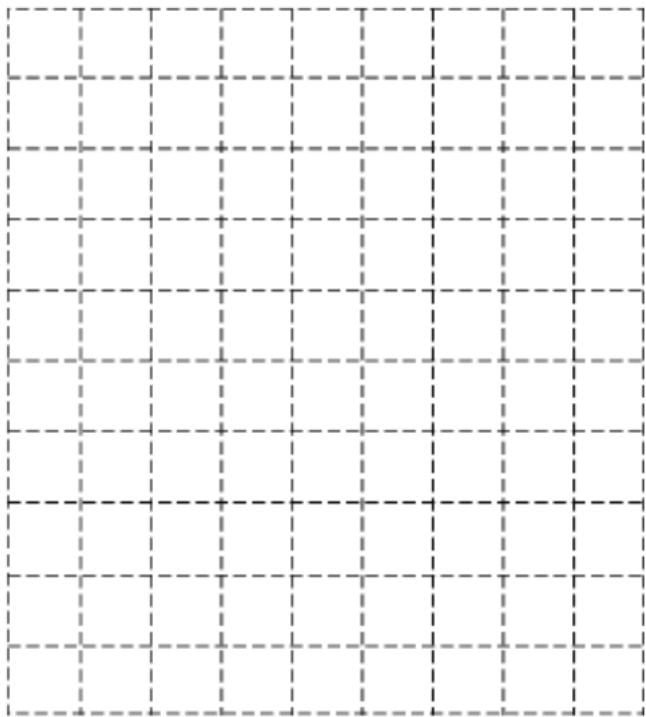
Each bin (bar) width can be adjusted by clicking and dragging the side of the bin.

Check Your Understanding

Many people believe that the distribution of IQ scores follows a “bell curve,” like the one shown in the margin. But is this really how such scores are distributed? The IQ scores of 60 fifth-grade students chosen at random from one school are shown below.

145	139	126	122	125	130	96	110	118	118
101	142	134	124	112	109	134	113	81	113
123	94	100	136	109	131	117	110	127	124
106	124	115	133	116	102	127	117	109	137
117	90	103	114	139	101	122	105	97	89
102	108	110	128	114	112	114	102	82	101

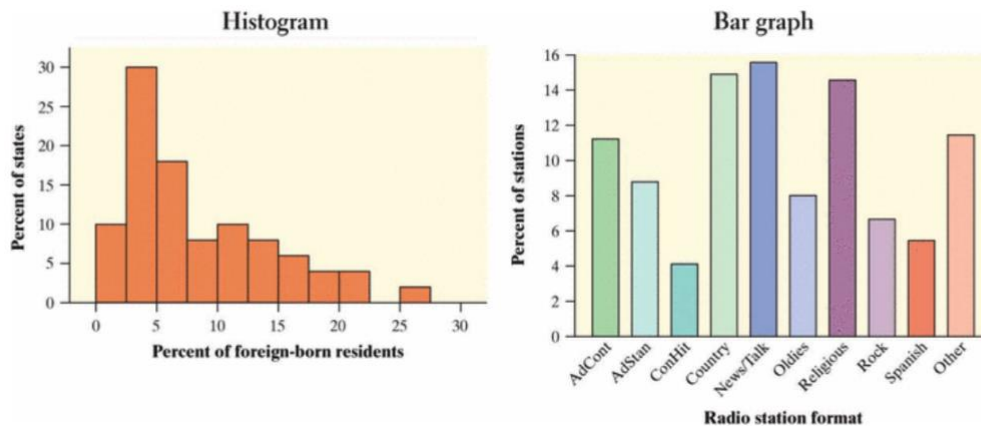
1. Construct a histogram that displays the distribution of IQ scores effectively



2. Describe what you see. Is the distribution bell-shaped?

Using Histograms Wisely

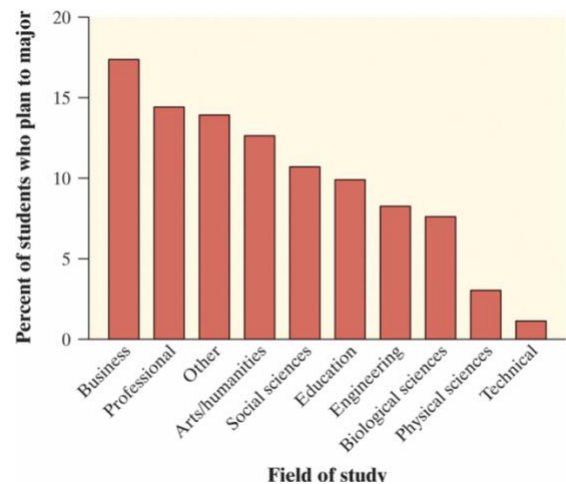
- Do not confuse histograms and bar graphs
 - Histograms are for quantitative variables
 - Bar graphs are for categorical variables
 - Histograms have no space between bars; bar graphs have a blank space between bars



- Do not use counts or percents as data on the horizontal axis.
- Use percents instead of counts when comparing distributions with different numbers of observations
- Just because a graph looks nice, it is not necessarily a meaningful display of data.

Check Your Understanding

Questions 1 and 2 relate to the following setting. About 1.6 million first-year students enroll in colleges and universities each year. What do they plan to study? The graph displays data on the percents of first-year students who plan to major in several discipline areas.



1. Is this a bar graph or a histogram? Explain.

2. Would it be correct to describe this distribution as right-skewed? Why or why not?