

Chapter 1

Graphical Displays of Univariate Data

Topic 2 covers sorting data and constructing Stemplots and Dotplots, Topic 3 Histograms, and Topic 4 Frequency Plots. (Note: Boxplots are a graphical display but will be covered in Chapter 2, Topic 7.)

Topic 2—Stemplots, Dotplots and Sorting Data

Example: Tall building heights in Philadelphia, PA.

Save the following data, in order, in a list called **yrphil** in folder **BLDTALL**. Arrange the Stats/List Editor in folder **BLDTALL** as shown in screen 4 on the next page (**phily**, **yrphil**, **list1**, **list2**).

Year the 24 Tallest Buildings in Philadelphia, PA were Completed

1901	1927	1929	1930	1930	1930	1932	1969	1970	1973	1973	1973
1974	1982	1983	1987	1988	1989	1990	1990	1990	1991	1992	XXXX

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In the table, XXXX represents a missing value.

The TI-89 does not have stemplots or dotplots built in, but these are easy to construct by hand if the data is in order.

Forming a New List

- Highlight **list1**, press **2nd** **[INS]**, and type **yrphil**. Press **ENTER** (screen 1).

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints	
yrphil	list1	list2	list3				
yrphil[1]=							
BLDTALL		RAD APPROX		FUNC		1/4	

(1)

- Type the 24 years by rows (given in the table) into the **yrphil** list (screen 2).

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints	
yrphil	list1	list2	list3				
1901							
1927							
1929							
1930							
1930							
1930							
yrphil[1]=1901							
BLDTALL		RAD AUTO		FUNC		1/4	

(2)

- Highlight **yrphil**, press **2nd** **[INS]**, and type or paste **phily** in the input line. Press **ENTER** (screen 3).

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints	
phily	yrphil	list1	list2				
585	1901						
405	1927						
400	1929						
475	1930						
450	1930						
412	1930						
phily[1]=585							
BLDTALL		RAD AUTO		FUNC		1/5	

(3)

Putting Data in Order

To compare the data entered in list **phily**, you can sort the list in ascending order. To retain the relationship between **phily** and **yrphil**, however, you should make a copy of the list before you sort. You realize the building built in 1901 was 585 feet and not 400 feet, as shown in the first row of **list1** (screen 7).

- Make a copy of list **phily** in **list1**:
 - Highlight the name **list1** (screen 4).
 - Paste or type **phily** in the input line.

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints	
phily	yrphil	list1	list2				
585	1901						
405	1927						
400	1929						
475	1930						
450	1930						
412	1930						
list1=phily							
BLDTALL		RAD AUTO		FUNC		3/8	

(4)

- c. Press **ENTER** (screen 5).

(5)

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints
phily	yrphil	list1	list2			
585	1901	585	-----			
405	1927	405				
400	1929	400				
475	1930	475				
450	1930	450				
412	1930	412				
list1[1]=585						
BLDTALL RAD AUTO FUNC 3/5						

2. Sort **list1** in ascending order (smallest to largest):

- a. Press **F3 List**.
b. Select **2:Ops** and then **1:Sort List** (screen 6).

(6)

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints
phily	yrphil	list1	list2			
Sort List...						
585	List: list1					
405	Sort Order: Ascending					
400	Enter=OK ESC=CANCEL					
475						
450	1930	450				
412	1930	412				
list1[1]=585						
BLDTALL RAD AUTO FUNC 3/8						

3. If **list1** or any element of **list1** was highlighted before step 2, then **list1** is in the List: field of the Sort List dialog box. If not, paste or type it.
4. Press **ENTER** to execute the sort (screen 7). Notice that the smallest building in list **phily** is 400 feet.

(7)

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints
phily	yrphil	list1	list2			
585	1901	400	-----			
405	1927	400				
400	1929	405				
475	1930	412				
450	1930	416				
412	1930	417				
list1[1]=400						
BLDTALL RAD AUTO FUNC 3/8						

Keeping the Relationship Between Two Lists When Sorting

Make a copy of list **phily** in **list2** and list **yrphil** in **list3**. (See step 1 above.) If **list2** is a copy of **phily** and **list3** is a copy of **yrphil**, you could sort on List: **list2**, **list3** (screen 8).

1. Press **F3 List**.
2. Select **2:Ops** and then **1:Sort List**.
3. In the entry line, type **list2**, **list3** (screen 8).
4. Press **ENTER ENTER**.

(8)

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints
yrphil	list1	list2	list3			
Sort List...						
190	List: list2,list3					
191	Sort Order: Ascending					
192	Enter=OK ESC=CANCEL					
193	416	450	1930			
1930	435	412	1930			
list3[1]=1901						
BLDTALL RAD AUTO FUNC 5/5						

The first two outputs of **list2** after sorting are 400 feet, but the correct values of years built is also in **list3** (1929 and 1982). (See screen 9.)

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Dist	F6→ Tests	F7→ Ints	
yrphil	list1	list2	list3				
1901	400	400	1929				
1927	400	400	1982				
1929	405	405	1927				
1930	412	412	1930				
1930	416	416	1973				
1930	417	417	xxxx				
list3={1929,1982,1927,193...							
BLDTALL		RAD AUTO		FUNC		5/8	

(9)

Creating a Stemplot (Stem-and-Leaf Plots)

Make a sorted list for **phily** data as in **list1** above.

The first six values of **list1** measured in ten-foot units and rounded to the nearest ten feet are 40, 40, 41, 41, 42, and 42, with a stem of 4 and leaves 0, 0, 1, 1, 2, and 2 for 4:001122.

Press **2nd** **⊖** for the next six values and continue to get data for the complete stemplot.

4:001122445889999

5:0779 (City Hall)

6:

7:049

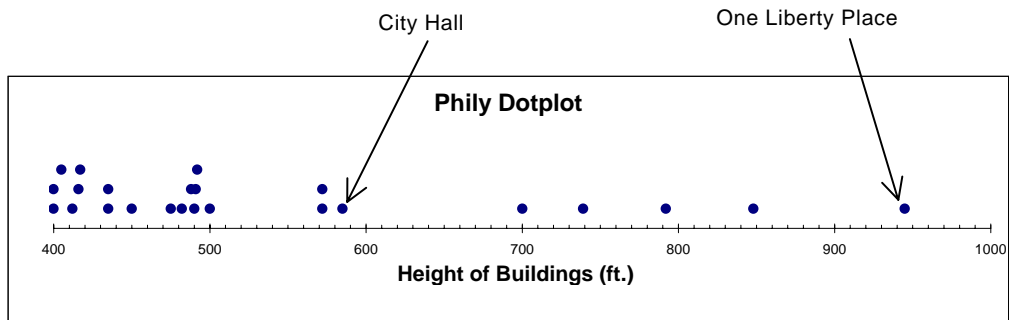
8:5

9:5 (One Liberty Place)

Stemplot of Tall Buildings in Philadelphia

Creating a Dotplot

For each value in **list2**, place one dot above its height on the number line as shown (screen 4). If there are repeated values (or values close together) stack them. A method of creating a dotplot on the TI-89 will be explained in Topic 9, screens 13 and 14.



While all of the buildings are tall (400 feet or taller), two are more than twice as tall as the smallest of 400 feet with the tallest at 945 feet, a 545-foot difference or spread.

The distribution is skewed to the higher values with 67% (16 of 24) of the heights from 400 to 500 feet and only five values (21%) are 700 feet or taller.

City Hall stands in a little cluster of three buildings that stand out more in the dotplot than in the stemplot. One Liberty Place is the tallest building and is a bit of an *outlier*, with the nearest building being almost 100 feet shorter. There is another cluster of buildings about 490 feet tall, with a small gap between them and the smaller buildings. There is a larger gap between them and the taller “City Hall three.” Finally, there is a 115-foot gap between City Hall and the 700-foot building which could be considered part of a widely spread cluster of four buildings.

Note: One Liberty Place (945 feet) was completed in 1987. Until that time, by agreement, no building was higher than the hat on the William Penn statue atop City Hall (585 feet).

Outliers are values that are far away from the rest of the data and that may have a special story.

Topic 3—Histograms

Constructing Histograms and Frequency Tables from a Data List

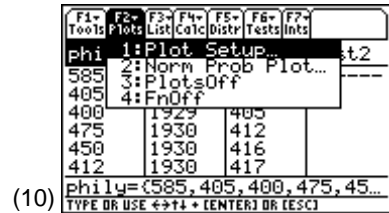
Example: Use the **phily** list of building heights from Topic 1 with $n = 24$, $\text{min}X = 400$ feet, and $\text{max}X = 945$ feet (Topic 1, screens 37 and 38).

The following approximation can be used to determine the number of cells to use for a given list size.

n (number of elements)	<25	25	50	100	200	400	800	1600	...	Double previous value
c (number of cells)	5	6	7	8	9	10	11	12	...	1 + previous value

In this example, use $c = 5$ because $n = 24$ is less than 25.

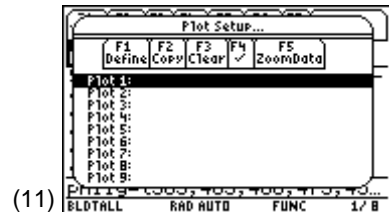
1. Define the plot.
 - a. From the Stats/List Editor, press **[F2]** **Plots** (screen 10).



(10)

Note: From screen 10 you can select **4:FnoFF** if you have been using function graphing. You could also turn off **StatPlots** by selecting **3:PlotsOff**.

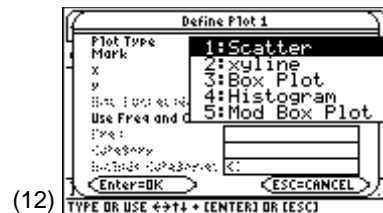
- b. Select **1:Plot Setup** (screen 11).



(11)

Note: If you have plot information displayed that you no longer need, you can highlight it and deselect it by pressing **[F4]** **✓**, or clear the line of information by pressing **[F3]** **[CLEAR]**.

- c. With **Plot 1** highlighted, press **[F1] Define**, and then press **[D]** for Plot Types (screen 12).



(12)

- d. Select **4:Histogram**, paste **phily** in the x field, with Hist. Bucket Width: **100**, and Use Freq and Categories?: **NO** (screen 13). (Bucket width is calculated using $b \approx (\max X - \min X) \div c = (945 - 400) \div 5 = 109 \approx 100$.)



(13)

- e. Press **[ENTER]** to confirm the entry.

- f. Press **[ENTER]** to display the Plot Setup screen with **Plot 1** now defined and selected with a check (**✓**) in the left margin (screen 14).



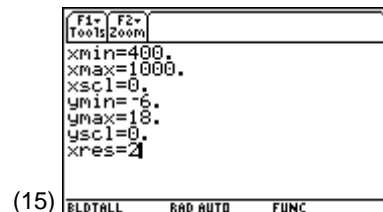
(14)

Note: For all other plot types, press **[F5] ZoomData**. Set up the window for histograms.

2. Set up the window using **[WINDOW]** with the following entries:

- **xmin = 400** (because it is a nice number).
- **xmax = 1000** (approximately $\max X = 945$) (because it works well with a bucket width of 100).
- **xscl = 0** (ensures that no tick marks will show).
- **ymin = -6** ($-1/4 * n = -1/4 * 24 = -6$) (to leave space below the plot for output from trace or cursor coordinates).
- **ymax = 18** ($3 * \text{lymin} = 3 * 6 = 18$) (as a first estimate of maximum cell height in the histogram).
- **yscl = 0**
- **xres = 2**

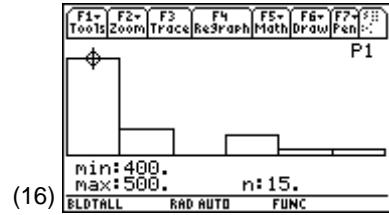
(See screen 15.)



(15)

3. Graph the histogram. Press \blacklozenge [GRAPH], and then press $\boxed{F3}$ Trace (screen 16).

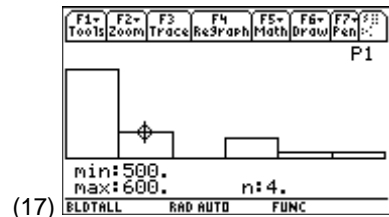
The plot fits well on the screen. If the first cell (or any other cell) had 20 values instead of 15, **ymin** and **ymax** would have to be adjusted to leave approximately the bottom quarter of the screen for output from the trace.



(16)

The histogram is best used with large data sets, however screen 16 shows information similar to the stemplot and dotplot of Topic 2 (data skewed to the right with an obvious gap). The fact that you end up with six cells (including the gap cell with frequency zero) while **c = 5**, is of no concern since **5** was a starting approximation and **24** is very close to **25**.

4. Construct a frequency table.
- From screen 16, notice that the first cell includes 15 values from **400 to 500**. (The building that is 500 feet tall goes in the second cell, not the first.)
 - Press \blacktriangleright for the second cell. There are four values from **500 to 600** (screen 17).
 - Continue for the frequency table of Philadelphia Tall Building Heights (in feet).



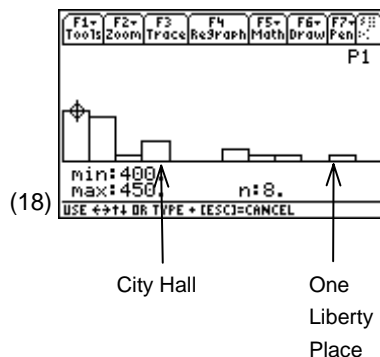
(17)

Philadelphia Tall Building Heights (in feet)

Cell limits	Cell midpoint	Frequency
400 to 500	450	15
500 to 600	550	4
600 to 700	650	0
700 to 800	750	3
800 to 900	850	1
900 to 1000	950	1

5. Change the bucket (or cell) width.
 - a. Return to the Stats/List Editor using \blacklozenge [APPS].
 - b. Select Stats/List Editor and press [ENTER].
 - c. Press [F2] **Plots** and select **1:Plot Setup** (screen 14).
 - d. Press [F1] **Define** (screen 13).
 - e. Press \odot twice and enter Hist. Bucket Width: **50**. Press [ENTER] to complete the entry.
 - f. Press [ENTER] for an updated plot setup with the last value now **50**.
 - g. Press [ESC] to return to the Stats/List Editor.
 - h. Press \blacklozenge [GRAPH] for the graph screen, and then press [F3] **Trace** (screen 18).

In screen 9, you see three clusters and two gaps with a possible outlier. The plot does not make the best use of the screen space, and window values could be adjusted.



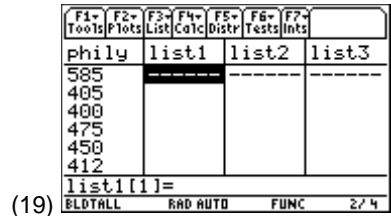
Note: To return to the Stats/List Editor from graph screen 18, press [2nd] [☐]. This command toggles between the current and previous screens. Press \blacklozenge [APPS] [ENTER] to return to the Stats/List Editor.

Creating a Histogram from a Frequency Table

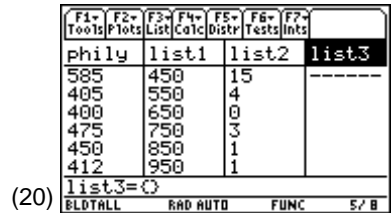
Example: Use the Philadelphia tall building height data from the previous frequency table.

1. Return to the Stats/List Editor using \blacklozenge [APPS]. Select Stats/List Editor and press [ENTER].
2. Set up the Stats/List Editor with **phily**, **list1**, **list2**, and **list3**.
 - a. Highlight **list1** and press [CLEAR] [ENTER].
 - b. Highlight **list2** and press [CLEAR] [ENTER].

- c. Highlight **list3** and press **[CLEAR]** **[ENTER]** (screen 19).
- d. Type the cell midpoints from the table of building heights on page 28 in **list1**.



- e. Type the frequencies from the table on page 28 in **list2** (screen 20).

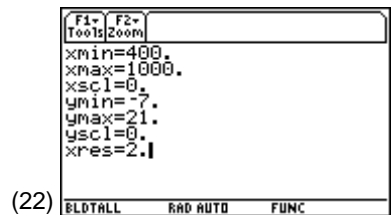


- 3. Set up the plot.
 - a. Press **[F2]** **Plots**. Select **1:Plot Setup** to display the Plot Setup screen.
 - b. Press **[F1]** **Define** to display the Define Plot 1 screen.
 - c. Select Plot Type: **Histogram**, paste **list1** in the x field from the VAR-LINK screen, with Hist. Bucket Width: **100**, Use Freq and Categories?: **YES**, and Freq: **list2** (screen 21).
 - d. Press **[ENTER]** to confirm the entry.
 - e. Press **[ENTER]** to return to the Plot Setup screen and **[ESC]** to return to the Stats/List Editor.



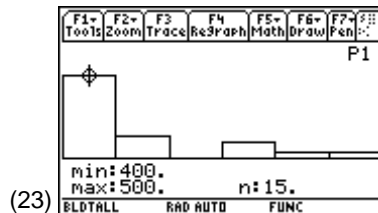
- 4. Set up the window using **[WINDOW]** with the following entries:

- **xmin = 400** (smallest cell limit from table)
- **xmax = 1000** (largest cell limit from table)
- **xscl = 0**
- **ymin ≈ -7** ($-1/2 * \text{largest freq} = -1/2 * 15 \approx -7$)
- **ymax ≈ 21** ($3 * \text{lymin} = 3 * 7 = 21$)
- **yscl = 0**
- **xres = 2**



(See screen 22.)

5. Graph the histogram. Press \blacklozenge [GRAPH], and then press $\boxed{\text{F3}}$ **Trace** (screen 23). This screen is similar to the histogram from the raw data in screen 16. (The windows differ a bit.)



Creating the Relative Frequency Histogram

The relative frequency histogram uses the previous example.

1. Calculate the relative frequencies.
 - a. Return to the Stats/List Editor using \blacklozenge [APPS].
 - b. Select Stats/List Editor and press $\boxed{\text{ENTER}}$.
 - c. Highlight **list3**.
 - d. Paste **list2** (press $\boxed{2\text{nd}}$ [VAR-LINK] and select **list2**) and divide by **24.0** (not 24), the sum of the frequencies to get decimal results instead of fractions (screen 24).

(24)

F1	F2	F3	F4	F5	F6	F7	F8
Tools	Plots	List	Calc	Distr	Tests	Ints	
phily	list1	list2	list3				
400	450	15	-----				
405	550	4	-----				
412	650	0	-----				
416	750	3	-----				
417	850	1	-----				
	950	1	-----				
list3=list2/24.0							
EBDTALL		RAD AUTO		FUNC		4/4	

- e. Press $\boxed{\text{ENTER}}$ (screen 25).

Observe that 62.5% of the buildings are 400 to 500 feet tall and 16.7% are 500 to 600 feet tall.

If divided by 24 instead of 24.0, pressing \blacklozenge $\boxed{=}$ (in screen 25) also gives decimal results.

If proper fractions were obtained, you could (1) highlight the list name, (2) press $\boxed{\text{ENTER}}$ to highlight the list in the input line, (3) press \blacktriangledown to go to the end of the set and multiply by a decimal * 1.0, and (4) press $\boxed{\text{ENTER}}$ to execute the operation. The resulting list will contain decimals.

If you use the Mode screen and select **Approximate**, all calculations would be decimal. Notice the AUTO or APPROX designations in the middle of the bottom status line.

(25)

F1	F2	F3	F4	F5	F6	F7	F8
Tools	Plots	List	Calc	Distr	Tests	Ints	
phily	list1	list2	list3				
585	450	15	.625				
405	550	4	.16667				
400	650	0	0.				
475	750	3	.125				
450	850	1	.04167				
412	950	1	.04167				
list3[1]=.625							
EBDTALL		RAD AUTO		FUNC		5/8	

Graphing the Relative Frequency Histogram

To set up the relative frequency histogram, you need to return to the Define Plot 1 screen and change the Freq: field to **list3**, the relative frequencies.

1. Press **[F2] Plots, 1:Plot Setup**, and then press **[F1] Define**.
2. Replace Freq: **list2** with **list3** (screen 26).
3. Change the window so that **y_{max}** and **y_{min}** are based on the greatest value, **.625**.



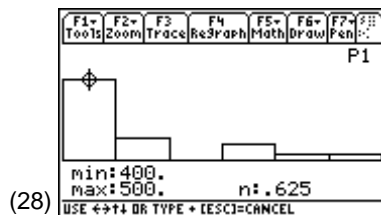
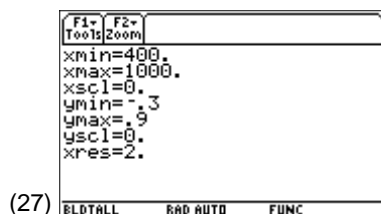
4. Set up the window using **[WINDOW]** with the following entries:

- **x_{min} = 400**
- **x_{max} = 1000**
- **x_{scl} = 0**
- **y_{min} ≈ -0.3** ($-1/2 * \text{largest value in y list} = -1/2 * 0.625 \approx -0.3$)
- **y_{max} ≈ 0.9** ($3 * |y_{\text{min}}| = 3 * 0.3 = 0.9$)
- **y_{scl} = 0**
- **x_{res} = 2**

(See screen 27.)

5. Press **[GRAPH]**, and then press **[F3] Trace** (screen 28).

This histogram is similar in shape to screen 23, but now **n = 0.625 = 62.5%** instead of 15. This *n*-value represents a relative frequency (**15/24**) instead of the frequency (**15**).



Topic 4—Frequency Plots

Cumulative Frequency Plots

Example: Use the building heights data in list **phily**.

To develop a cumulative frequency plot, you need the frequency list of the Define Plot 1 screen to be the list of cumulative frequencies.

1. Calculate the cumulative frequencies.
 - a. Return to the Stats/List Editor using \blacklozenge [APPS].
 - b. Select Stats/List Editor and press [ENTER].
 - c. Highlight **list1** and press [CLEAR] [ENTER]. Do the same for **list2** and **list3**.
 - d. Enter the lower cell limits from the frequency table in Topic 3 in **list1**. Enter the last value of 1000, the upper limit of the last cell.
 - e. Enter the frequencies from the table in Topic 3 in **list2**. Insert a **0** as the first value, indicating zero values below 400 feet, then **15** to indicate the frequency of the class with the upper limit of 500 feet, and so forth (screen 29).
2. Create the list of cumulative frequencies.
 - a. Highlight **list3**.
 - b. Press [F3] List.
 - c. Select **2:Ops** and then **6:cumSum**.
 - d. To complete the command, paste or type **list2** and close the parenthesis in the entry line (screen 30).

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints	
phily	list1	list2	list3				
585	400	0					
405	500	15					
400	600	4					
475	700	0					
450	800	3					
412	900	1					
list3[1]=							
BLDTALL		RAD AUTO		FUNC		4/4	

(29)

F1→ Tools	F2→ Plots	F3→ List	F4→ Calc	F5→ Distr	F6→ Tests	F7→ Ints	
phily	list1	list2	list3				
585	400	0					
405	500	15					
400	600	4					
475	700	0					
450	800	3					
412	900	1					
list3=cumSum(list2)							
BLDTALL		RAD AUTO		FUNC		4/4	

(30)

- e. Press **ENTER** to display the values in **list3** (screen 31).
3. Set up the plot and graph the cumulative frequency plot.
- a. Press **F2** **Plots**. Select **1:Plot Setup** to display the Plot Setup screen.
- b. Press **F1** **Define** to display the Define Plot 1 screen.
- c. Select Plot Type: **xyline**, Mark: **Box**, x: **list1**, y: **list3**, and Use Freq and Categories?: **NO** (screen 32).
- d. Press **ENTER** to return to the Plot Setup screen.

(31)

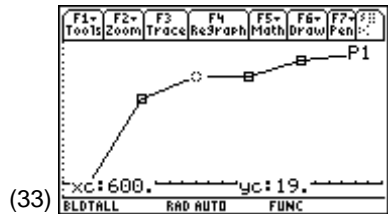
F4- Tools	F2- Plots	F3- List	F4- Calc	F5- Dist	F6- Tests	F7- Ints
list1	list2	list3	list4			
400	0	0				
500	15	15				
600	4	19				
700	0	19				
800	3	22				
900	1	23				
list4=list3/24.0						
BLDTALL RAD AUTO FUNC 5/5						

Note: The third value in **list3** is the sum of the first 3 rows of **list2** or $0 + 15 + 4 = 19$, indicating 19 values less than 600 feet tall. The last value is the sum of all the frequencies of **list2** or $n = 24$ (not shown).

(32)

Define Plot 1	
Plot Type	xyline
Mark	Box
x	list1
y	list3
Use Freq and Categories?	NO
Enter=DK ESC=CANCEL	
BLDTALL RAD AUTO FUNC 6/8	

- e. Press **F5** **ZoomData**, and then press **F3** **Trace** and **⏏** (screen 33).
- The value traced in screen 33 shows that 19 buildings (**yc = 19**) have heights below 600 feet (**xc = 600**).



Interpretation of the plot: The plot starts with a steep slope, indicating many of the buildings are at the smaller height.

Cumulative Relative Frequency Plot

This plot requires a list of cumulative relative frequencies.

- Calculate the cumulative relative frequencies.
 - Return to the Stats/List Editor using **♦** **APPS**.
 - Select Stats/List Editor and press **ENTER**.
 - Highlight **list4** (screen 31).
 - Paste **list3**, and then divide by **24.0** (do not forget the decimal point). (See screen 31.)

e. Press **ENTER** (screen 34).

Observe that **0.79167** in the third row indicates that 79.2% of the buildings (19/24) are less than 600 feet tall. The last value in the list of **1.0** (not shown) indicates that all of the buildings (100%) are less than 1000 feet tall.

2. Set up the plot and graph the relative cumulative frequency.
 - a. Press **F2 Plots**. Select **1:Plot Setup** to display the Plot Setup screen.
 - b. Press **F1 Define** to display the Define Plot 1 screen.
 - c. Select Plot Type: **xyline**, Mark: **Box**, x: **list1**, y: **list4**, and Use Freq and Categories?: **NO** (screen 35).

- d. From the Plot Setup screen, press **F5 ZoomData**, and then press **F3 Trace** and **⏏** (screen 36). This plot is the same shape as screen 33, but now it has cumulative relative frequencies.

(34)

F4- Tools	F2- Plots	F3- List	F4- Calc	F5- Distr	F6- Tests	F7- Ints
list1	list2	list3	list4			
400	0	0	0.			
500	15	15	.625			
600	4	19	.79167			
700	0	19	.79167			
800	3	22	.91667			
900	1	23	.95833			
list4[3]=.791666666666667						
BLDTALL RAD AUTO FUNC E/E						

Note: The order of operations in screens 29 and 30 could be reversed. The relative frequencies could have been found (as in Topic 3, screen 25, **list3**), and then the cumulative sum found for **list4** (screen 34).

(35)

Define Plot 1	
Plot Type	xyline →
Mark	Box →
x	list1
y	list4
Use Freq and Categories?	NO →
Enter=OK	ESC=CANCEL
BLDTALL RAD AUTO FUNC	

