



Turning Data into Information

John Snodgrass

Educators are constantly asked to turn Data into Information. 


Consider the array of data that educators regularly confront:

- State Proficiency Tests
- National Achievement and Ability Tests
- SAT, ACT, PSAT...etc.
- NAEP
- Diagnostic Assessments
- High Stakes Graduation Tests

There are also: 

- Classroom assessments
- Discipline records
- Attendance records
- Graduation rates
- Demographic data like gender, ethnicity, ...etc.

Educators are inundated with data, but this does not necessarily mean that they have information.

Data are Merely Numbers 


To turn data into information, one must:

- Organize the data
- Describe the data
- Interpret the data


The workshop presentations and materials from the U.S. Department of Education Teacher-to-Teacher Summer Workshops were developed by various individuals and are being provided as illustrative examples of what might be useful to teachers. The Department is not requiring or encouraging the use of any particular methods or materials in the classroom, and the use of the methods and materials in these sessions does not constitute an endorsement by the U.S. Department of Education.

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Moreover 

For data analysis techniques to be valuable to educators, the techniques must enhance the chances that educators gain insight into student performance and that they translate this insight into improved educational experiences for children.

Graphical Data Analysis 

Graphical data analysis methods are ideal for these purposes. Graphical data analysis methods provide school-based educators with concrete, clear and powerful exploratory techniques around which they can organize large and small sets of test scores into meaningful representations of their building and classroom realities.



Once educators have developed a concrete understanding of the concepts underlying the visual displays of information, a few well placed numbers, such as a mean, a median, or an interquartile range, can add specificity and depth to educators' understanding of the data.

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Three good rules to follow when turning data into information:

1. When confronted with a set of scores, organize the scores numerically.
2. When comparing two or more sets of scores, place the scores on the same scale.
3. When graphing test scores, make sure the visual display is an honest and undistorted representation of the numerical test scores.

In creating good visual displays it is important to:

1. Make sure the labels, titles and values on the visual display are so complete and clear that the display is understandable, independent of the narrative of the report.
2. Date every display.
3. Include the author's name on each display.
4. Identify the specific source of the data presented on the display.
5. Whenever possible, provide your audience with a context for the data and points of comparison. For example, you might discuss how the average of a particular class on some given task compared with the average for the entire district or how the same group of students performed in previous years.

Data Should Not Be Viewed in a Vacuum!

Stem-and-leaf plots are a particularly useful and user-friendly data analysis technique.

Stem-and-leaf plots help educators graphically, rather than mathematically, explore data in ways that can assist them in making meaningful instructional decisions based on factual information.

(This technique was developed by John Tukey, statistician emeritus Bell Labs, and is promoted by the Quantitative Literacy Movement.)

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Landwehr and Watkins point out that exploratory data analysis techniques like stem-and-leaf plots are designed to help professionals reveal perhaps unexpected *"patterns and surprises"* within sets of data.

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Activity

Today we will use dot plots (which Landwehr and Watkins call line plots) and stem-and-leaf plots to explore a variety of data sets.

Let's locate our handout packet and begin to explore our topic, turning data into information.

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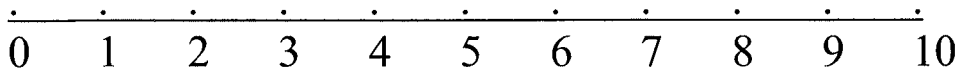
Data are merely numbers.
To turn data into information:

Organize the numbers
Describe the numbers
Interpret the numbers

Consider the set of numbers below. They are a set of test scores from a 10 point test. In this form they are merely data. They provide little information. To turn these numbers into information, first organize the numbers.

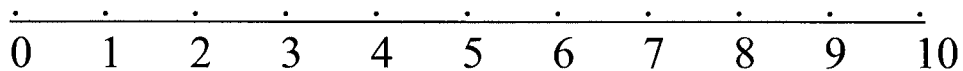
9	5	2	4	3
3	2	3	2	6
0	1	2	5	4
8	4	6	3	1
1				

The simplest way to organize numbers is to use a simple dot plot (also called a line graph). The graph below runs from 0 to 10. The range of numbers on the graph represents the number of points on the test.



Place a dot or an “X” on the line graph where each number belongs. There are 21 numbers, so there should be 21 dots or “Xs”.

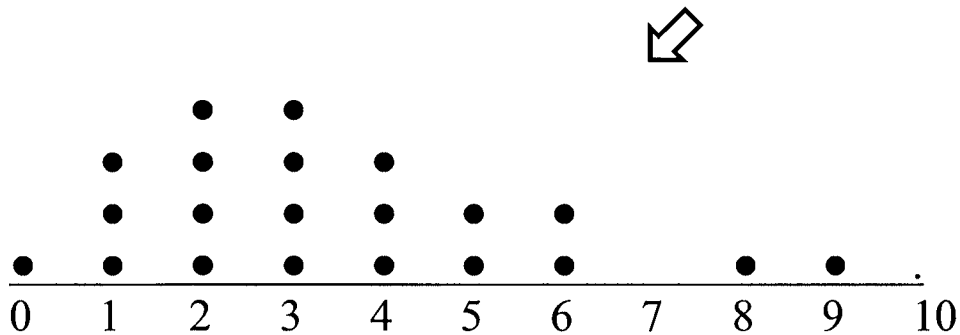
9	5	2	4	3
3	2	3	2	6
0	1	2	5	4
8	4	6	3	1
1				



Does your graph look like the one on the following page?

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Your graph should look like this graph.



Use the space below to describe the shape of the distribution of scores on the graph. Look for patterns in the distribution of scores like *gaps in the scores clusters of scores, the range of scores, etc.*

Look on the following page for some descriptions.

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There are 21 scores

The range of numbers is from 0 to 9.

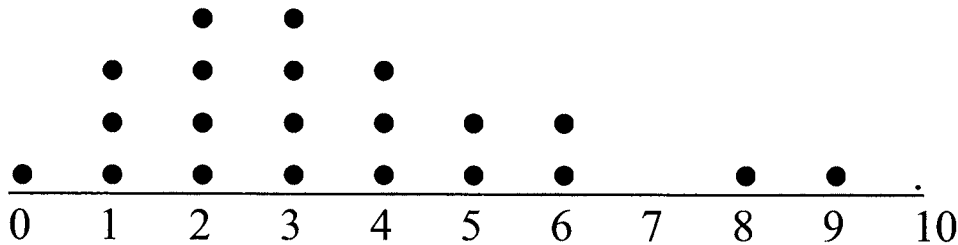
No one earned a perfect score.

Scores clustered at the lower end of the distribution, around 2 and 3.

The majority of the students (18/21) scored between 1 and 6

There is a gap between 6 and 8.

Now interpret the distribution of scores represented on the graph and use them to plan instruction.



Use the space on the next page to explain how you would interpret the distribution of scores differently if it represented a distribution of **pretest** scores rather than a distribution of **posttest** score.

Pretest interpretation:

Posttest interpretation:

This type of graph is an excellent choice for organizing numbers if the range of scores is small, for example, if a test has only 10 or 20 points on it. What if a test has 100 points on it? The graph would be ridiculously long. Also twenty-one students' scores might be lost on a line graph with 100 points.

There is a solution. Create a graph, which has intervals of scores on it. An excellent choice is a stem-and-leaf plot.

Consider the set of twenty-seven scores below, which represent a 50-point end of unit social studies test.

25	50	26
16	48	33
32	49	32
33	44	46
47	46	28
29	45	37
50	31	45
6	27	50
44	14	49

If one were to make a line graph it would have to have 50 points on it. Again, the graph would be long. Another way is to organize the data is to create a stem-and-leaf plot with 10 point intervals.

Stem-and-Leaf Plot Intervals of 10

Stem

↓

0

1

2

3

4

5

Stem

↓

Leaves

↓

0

6

1

6 4

2

5 9 7 6 8

3

2 3 1 3 2 7

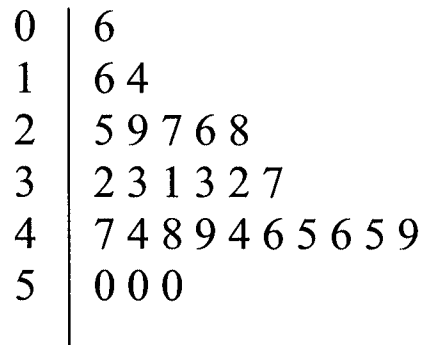
4

7 4 8 9 4 6 5 6 5 9

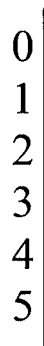
5

0 0 0

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The above stem-and-leaf plot can be more organized.
How would you do it? Use the graph paper on the
following page to show your solution.

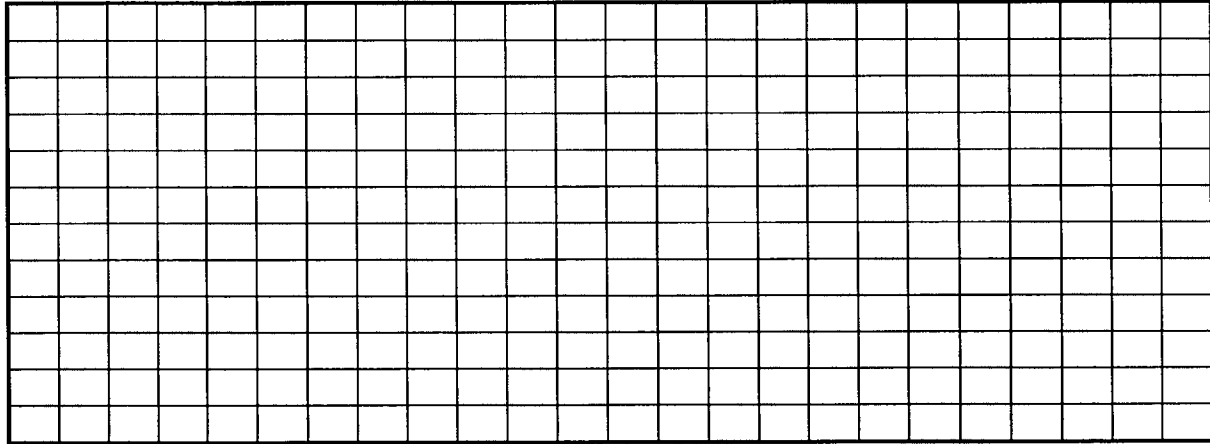


Graph Paper →

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Title:
Author:

Date:
Source:



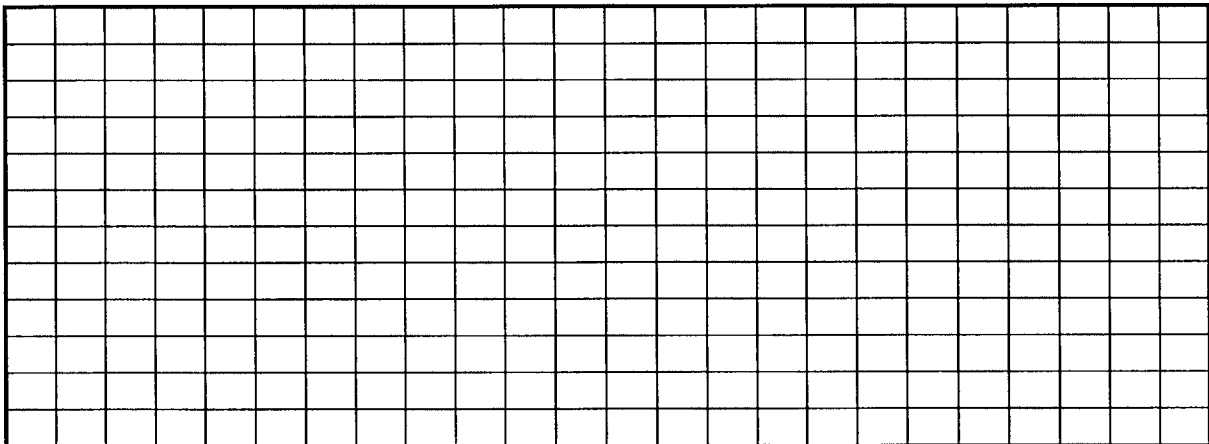
Check your graph with the one on the top of the next page. →

DISAGGREGATING DATA

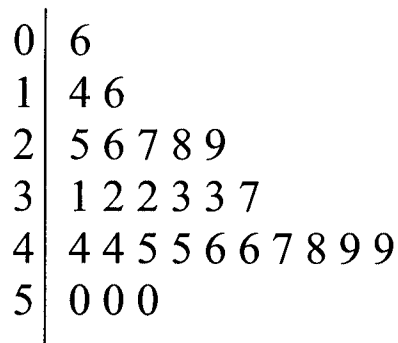
Consider the following data set which consists of a gender code (b = boy , g = girl) and a score on a 30 point quiz given at the end of an earth science unit on sources of energy.

b 24	g 28	b 25	b 30	g 16	g 29	g 28
b 15	b 9	b 23	g 21	g 28	b 27	g 23
g 24	b 26	g 29	b 25	b 24	b 29	g 30
g 23	b 28	g 26				

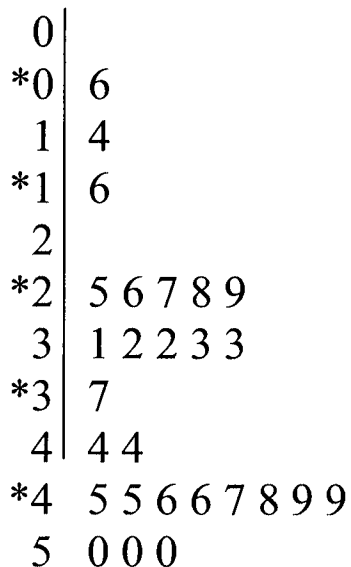
Create a stem-and-leaf plot using different colors for the two genders represented by b and g.



Your stem-and-leaf plot should look like the one below.



Stem-and-Leaf Plot Intervals of 5



KEY

<u>Stem</u>	<u>Leaves</u>
4	0-4 (40-44)
*4	5-9 (45-49)

Interpreting Various Stem-and-Leaf Plots

Symmetrical Distribution (some would call this **Bell Shaped or Normal)**

```

2 | 5
3 | 2 6
4 | 4 5 8 9
5 | 1 4 6 7 8
6 | 0 3 9 9
7 | 6 7
8 | 1
  
```

Bimodal Distribution or U-Shaped Distribution

```

1 | 3 5 6
2 | 0 3 4 7 8 9
3 | 2 4 5 6
4 | 0
5 | 1 5 7
6 | 0 1 3 8 9 9
7 | 2 4 7
8 | 6
  
```

Truncated or J-Shaped Distributions

```

1 | 0 0 1 2 3 3 4 6 7 7 8 8 9
2 | 1 2 2 3 4 7 8 9
3 | 4 6 7 8
4 | 0 4 5 5
5 | 1 6 7
6 | 2 8
7 | 3 7
8 | 8
  
```

```

1 | 9
2 | 3
3 | 4 6
4 | 3 5 8
5 | 0 2 7 8
6 | 2 4 6 7 7 8 8 9
7 | 0 0 1 3 4 4 5 6 7 8 9 9
8 | 1 1 2 2 2 2 3 3 3 6 6 8 8 9
  
```

Skewed Distributions

```

2 | 9
3 | 3 5
4 | 4 6 7
5 | 3 5 6 7 8
6 | 0 2 7 8 8 8 9 9
7 | 2 4 6 7 7 8 8
8 | 0 0 1 3 4 4
  
```

```

2 | 0 0 1 3 4 4
3 | 2 4 6 7 7 8 8
4 | 0 2 5 5 7 8 8 9 9
5 | 3 5 6 7 8
6 | 4 6 7
7 | 3 5
8 | 9
  
```

Now try doing a Stem-and-Leaf plot using the 50-point pretest social studies scores from the same class. Create a *mirror image* or *back-to-back* stem-and-leaf plot. Use the graph paper on the following page.

Social Studies Pretest Scores

1 2 3 3 4 5 5 6
8 9 9 10 11 12 13 13
14 15 15 16 17 18 19 20
22 27 42

Pretest scores



Posttest scores

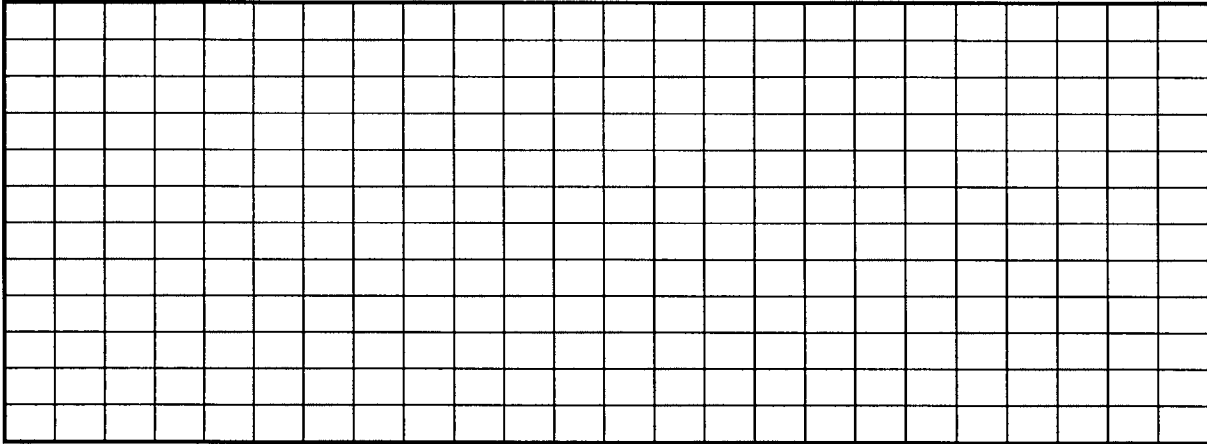


0	6
1	4 6
2	5 6 7 8 9
3	1 2 2 3 3 7
4	4 4 5 5 6 6 7 8 9 9
5	0 0 0

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Title:
Author:

Date:
Source:



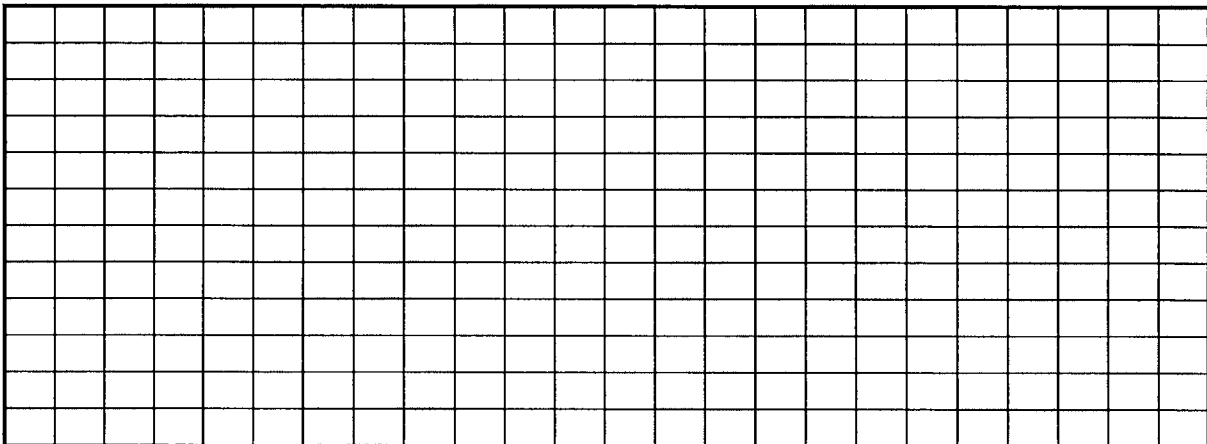
Check your graph with the one on the top of the next page. →

DISAGGREGATING DATA USING BACK-TO-BACK STEM-AND-LEAF PLOTS

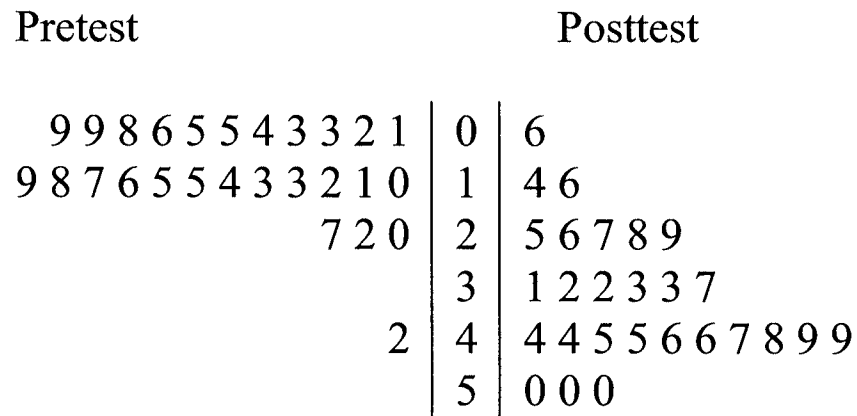
Consider the following data set which consists of a gender code (b = boy, g = girl) and a score on a 30 point quiz given at the end of an earth science unit on sources of energy.

b 24	g 28	b 25	b 30	g 16	g 29	g 28
b 15	b 9	b 23	g 21	g 28	b 27	g 23
g 24	b 26	g 29	b 25	b 24	b 29	g 30
g 23	b 28	g 26				

Create a back-to-back stem-and-leaf plot to compare the scores of girls with those of boys.



Your mirror image stem-and-leaf plot should look like the one below.



You have organized the students' pretest and posttest social studies scores into two back-to-back stem-and-leaf plots. On the following page, describe the differences between the two sets of scores.

**Describe the
Pretest distribution**

**Describe the
Posttest distribution**

How would you interpret the difference between the two sets of scores? What are the instructional implications of the two sets of score?

One of the rules of stem-and-leaf plots is that you can only have one number for each leaf. How would you make a stem-and-leaf plot with data like proficiency scores that are three digit numbers?

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4th Grade OPT Reading Scores – October 2002

Class 1

16	7
17	
18	3
19	1 5 7
20	0 0 0 2 2 4 6
21	2 2 5 5 7 7 7
22	0 7 7 7 7
23	1
24	
25	
26	

Class 2

16	
17	2 7
18	0 1 1
19	2 4 5 5 5
20	4 4 6 6 6 8
21	2 5 7
22	0 7 7
23	
24	
25	
26	

Class 3

16	
17	
18	0 1 5 8
19	2 2 5 9
20	0 2 4 4
21	0 0 2 5 5 5
22	0
23	1 1
24	3
25	
26	

Class 4

16	
17	
18	0 0
19	1 5 7
20	0 2 4 6 6 8
21	2 7 7
22	3 3
23	1 1 6 6
24	3 3 3
25	2
26	8

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Stem-and-Leaf plots allow you to compare 2 or more sets of data by looking at the distribution. But you can also compare 2 or more data sets by comparing some *DATA POINTS* of each distribution.

Statisticians have come up with *KEY POINTS* that adequately summarize any data set and allow you to compare them to another data set.

By finding the *KEY POINTS*, you can compare data sets with a level of exactness and specificity that you can not get by comparing the graphical distributions of a stem-and-leaf plot.

Three key points can be ‘read’ from the stem-and-leaf plot.

Examine the 4th Grade OPT Reading Scores – October 2002 on page 18.

Fill in the chart below.

<u>Class</u>	<u>high score</u>	<u>low score</u>	<u>middle score</u>
--------------	-------------------	------------------	---------------------

#1 _____

#2 _____

#3 _____

#4 _____

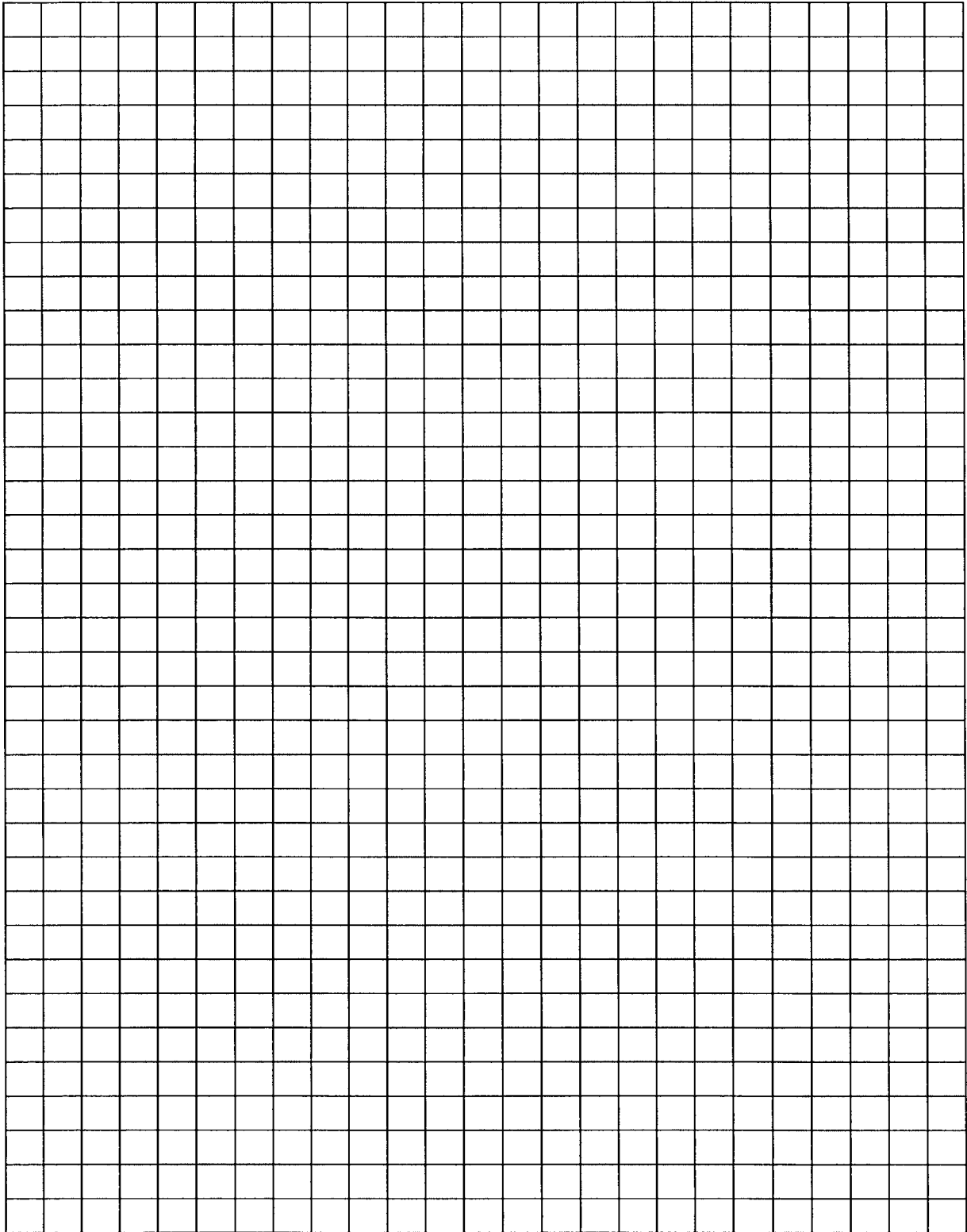
The relative simplicity of today's activities will, hopefully, inspire you to use the techniques that we worked with today to analyze the data that you frequently confronted with.

Here is the set of data that appeared in the PowerPoint presentation. At your convenience, please organize, describe and interpret the data to reinforce what we did today so that when you return to your professional duties, you will be able to use these techniques with ease.

■ Abby	24	
■ Barry	30	
■ Chloe	34	
■ Dawann	28	
■ Eric	28	
■ Fred	14	1
■ Gerry	36	1
■ Hannah	32	2
■ Iyauna	30	2
■ Jason	28	3
■ Kathy	34	3
■ Liron	30	4
■ Murray	30	
■ Nuran	26	
■ Otis	22	
■ Perry	24	
■ Qiana	38	
■ Riley	32	
■ Sam	26	
■ Tanya	40	
■ Ulrich	28	
■ Vanessa	32	
■ Whitney	22	
■ Yuri	26	
■ Zoltan	36	

There is a sheet of graph paper on the next page on which you might prefer to construct your stem-and-leaf plot.

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