A Course in Business Statistics

4th Edition

Chapter 2

Graphs, Charts, and Tables – Describing Your Data

Chapter Goals

After completing this chapter, you should be able to:

- Construct a frequency distribution both manually and with a computer
- Construct and interpret a histogram
- Create and interpret bar charts, pie charts, and stem-and-leaf diagrams
- Present and interpret data in line charts and scatter diagrams

Frequency Distributions

What is a Frequency Distribution?

- A frequency distribution is a list or a table …
- containing the values of a variable (or a set of ranges within which the data falls) ...
- and the corresponding frequencies with which each value occurs (or frequencies with which data falls within each range)

Why Use Frequency Distributions?

- A frequency distribution is a way to summarize data
- The distribution condenses the raw data into a more useful form...
- and allows for a quick visual interpretation of the data

Frequency Distribution: Discrete Data

- Discrete data: possible values are countable

Example: An advertiser asks 200 customers how many days per week they read the daily newspaper.

Number of days read	Frequency
0	44
1	24
2	18
3	16
4	20
5	22
6	26
7	30
Total	**200**

Relative Frequency

Relative Frequency: What proportion is in each category?

Number of days read	Frequency	Relative Frequency
0	44	.22
1	24	.12
2	18	.09
3	16	.08
4	20	.10
5	22	.11
6	26	.13
7	30	.15
Total	**200**	**1.00**

$$\frac{44}{200} = .22$$

22% of the people in the sample report that they read the newspaper 0 days per week

Frequency Distribution: Continuous Data

- Continuous Data: may take on any value in some interval

Example: A manufacturer of insulation randomly selects 20 winter days and records the daily high temperature

24, 35, 17, 21, 24, 37, 26, 46, 58, 30,
32, 13, 12, 38, 41, 43, 44, 27, 53, 27

(Temperature is a continuous variable because it could be measured to any degree of precision desired)

Grouping Data by Classes

Sort raw data in ascending order:

12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58

- Find range: 58 - 12 = 46
- Select number of classes: 5 (usually between 5 and 20)
- Compute class width: 10 (46/5 then round off)
- Determine class boundaries:10, 20, 30, 40, 50
- Compute class midpoints: 15, 25, 35, 45, 55
- Count observations & assign to classes

Frequency Distribution Example

Data in ordered array:

12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58

Frequency Distribution

Class	Frequency	Relative Frequency
10 but under 20	3	.15
20 but under 30	6	.30
30 but under 40	5	.25
40 but under 50	4	.20
50 but under 60	2	.10
Total	20	1.00

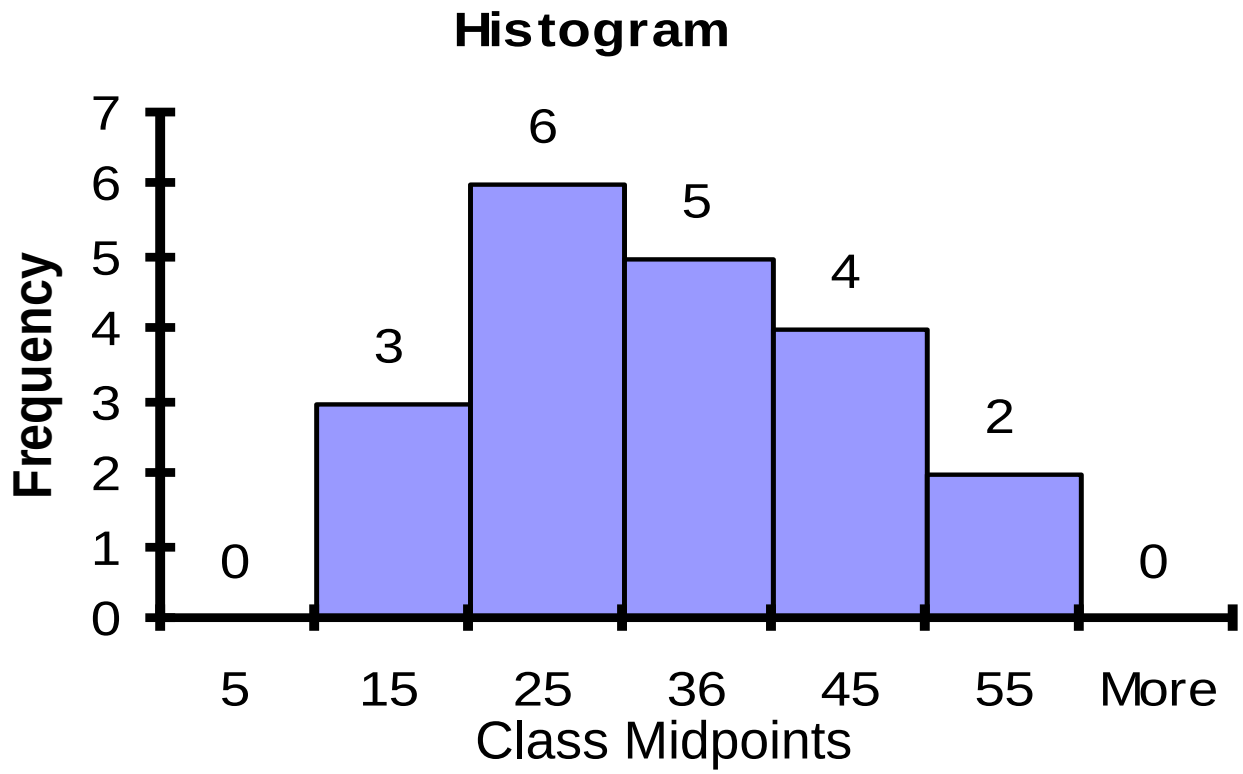
Histograms

- The **classes** or **intervals** are shown on the horizontal axis
- **frequency** is measured on the vertical axis
- Bars of the appropriate heights can be used to represent the number of observations within each class
- Such a graph is called a **histogram**

Histogram Example

Data in ordered array:

12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58



No gaps between bars, since continuous data

Questions for Grouping Data into Classes

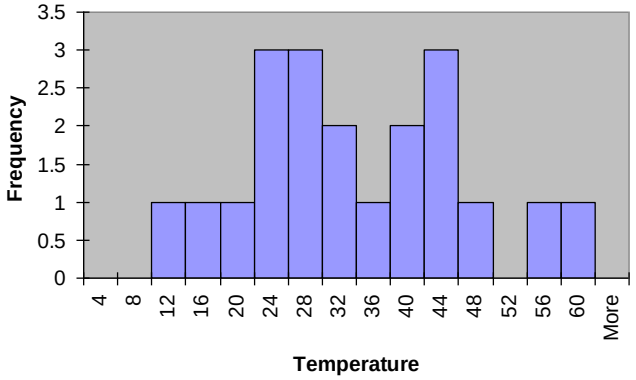
- 1. How wide should each interval be?

  (How many classes should be used?)

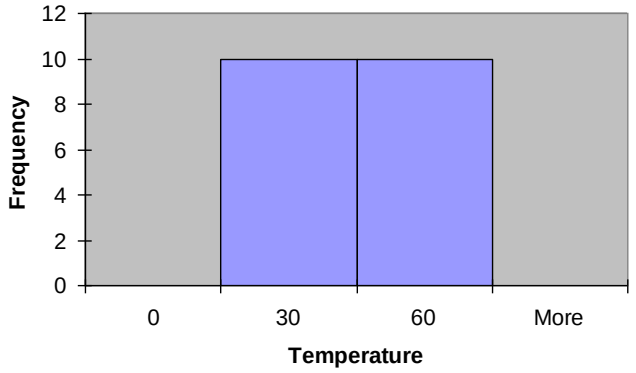
- 2. How should the endpoints of the intervals be determined?
  - Often answered by trial and error, subject to user judgment
  - The goal is to create a distribution that is neither too "**jagged**" nor too "**blocky**"
  - Goal is to appropriately show the pattern of variation in the data

How Many Class Intervals?

- **Many (Narrow class intervals)**
  - may yield a very jagged distribution with gaps from empty classes
  - Can give a poor indication of how frequency varies across classes



- **Few (Wide class intervals)**
  - may compress variation too much and yield a blocky distribution
  - can obscure important patterns of variation.



(X axis labels are upper class endpoints)

General Guidelines

Number of Data Points	*Number of Classes*
under 50	5 - 7
50 – 100	6 - 10
100 – 250	7 - 12
over 250	10 - 20

- Class widths can typically be reduced as the number of observations increases
- Distributions with numerous observations are more likely to be smooth and have gaps filled since data are plentiful

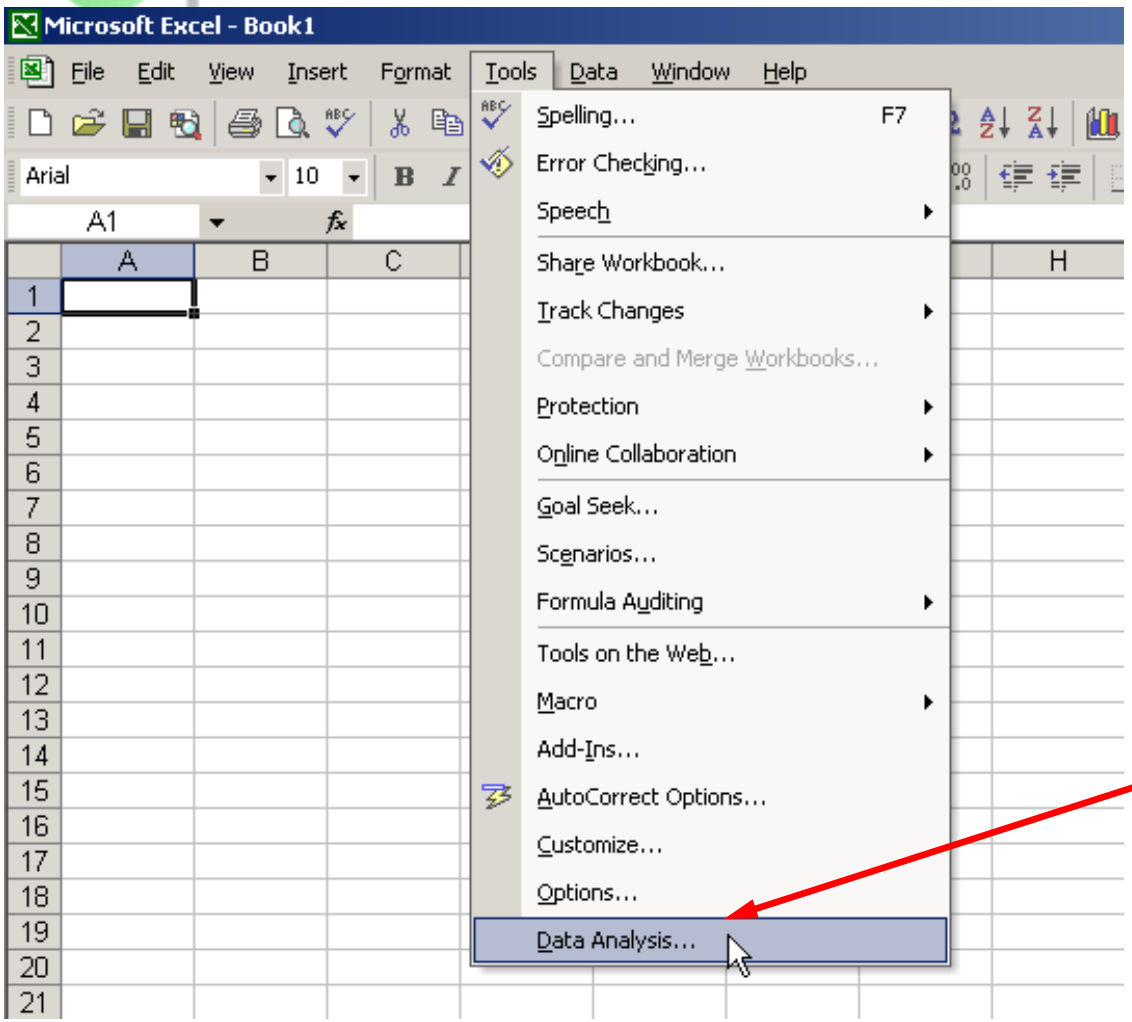
Class Width

- The class width is the distance between the lowest possible value and the highest possible value for a frequency class

- The minimum class width is

$$W = \frac{\text{Largest Value - Smallest Value}}{\text{Number of Classes}}$$

Histograms in Excel



1

Select

Tools/Data Analysis

Histograms in Excel

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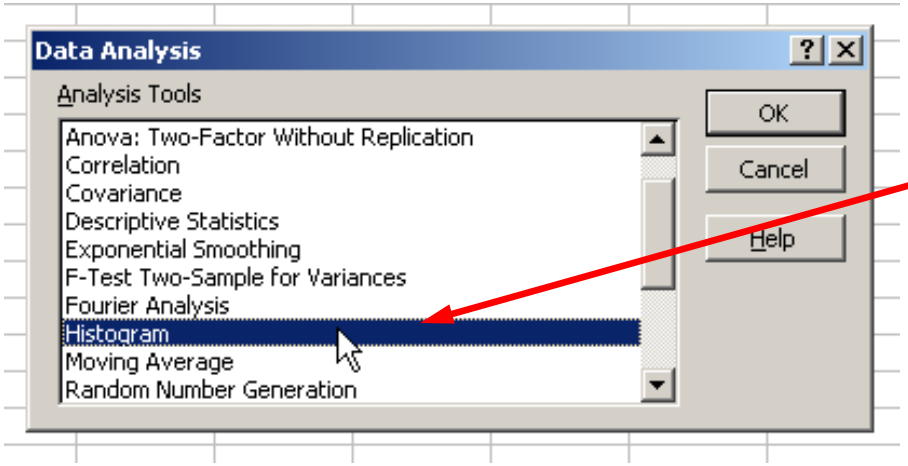

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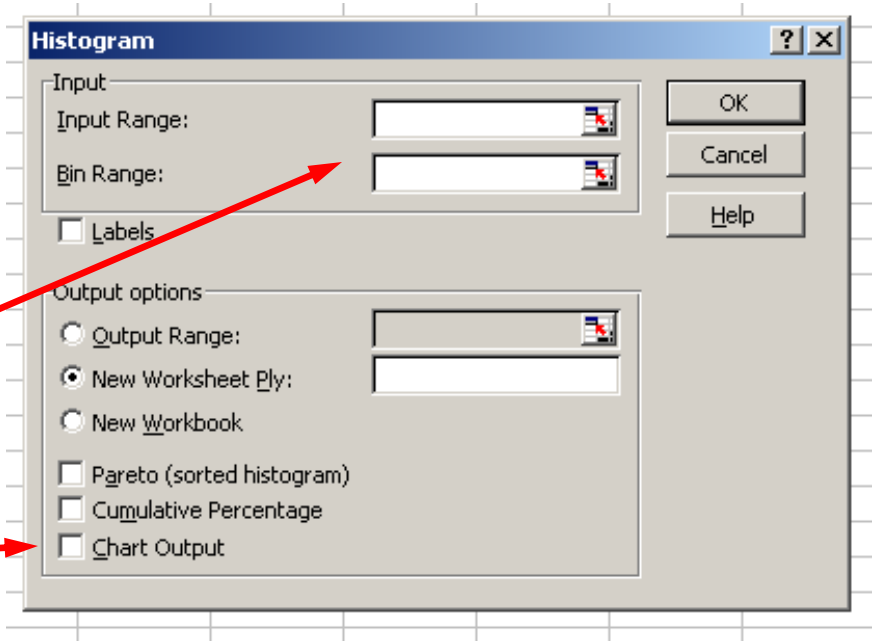
Choose Histogram



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Input data and bin ranges

Select Chart Output

Stem and Leaf Diagram

- A simple way to see distribution details in a data set

METHOD: Separate the sorted data series into leading digits (the **stem**) and the trailing digits (the **leaves**)

Example:

Data in ordered array:

12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58

- Here, use the 10's digit for the stem unit:
  - 12 is shown as
  - 35 is shown as

Stem	Leaf
1	2
3	5

Example:

Data in ordered array:

12, 13, 17, 21, 24, 24, 26, 27, 27, 30, 32, 35, 37, 38, 41, 43, 44, 46, 53, 58

- Completed Stem-and-leaf diagram:

Stem	Leaves
1	2 3 7
2	1 4 4 6 7 8
3	0 2 5 7 8
4	1 3 4 6
5	3 8

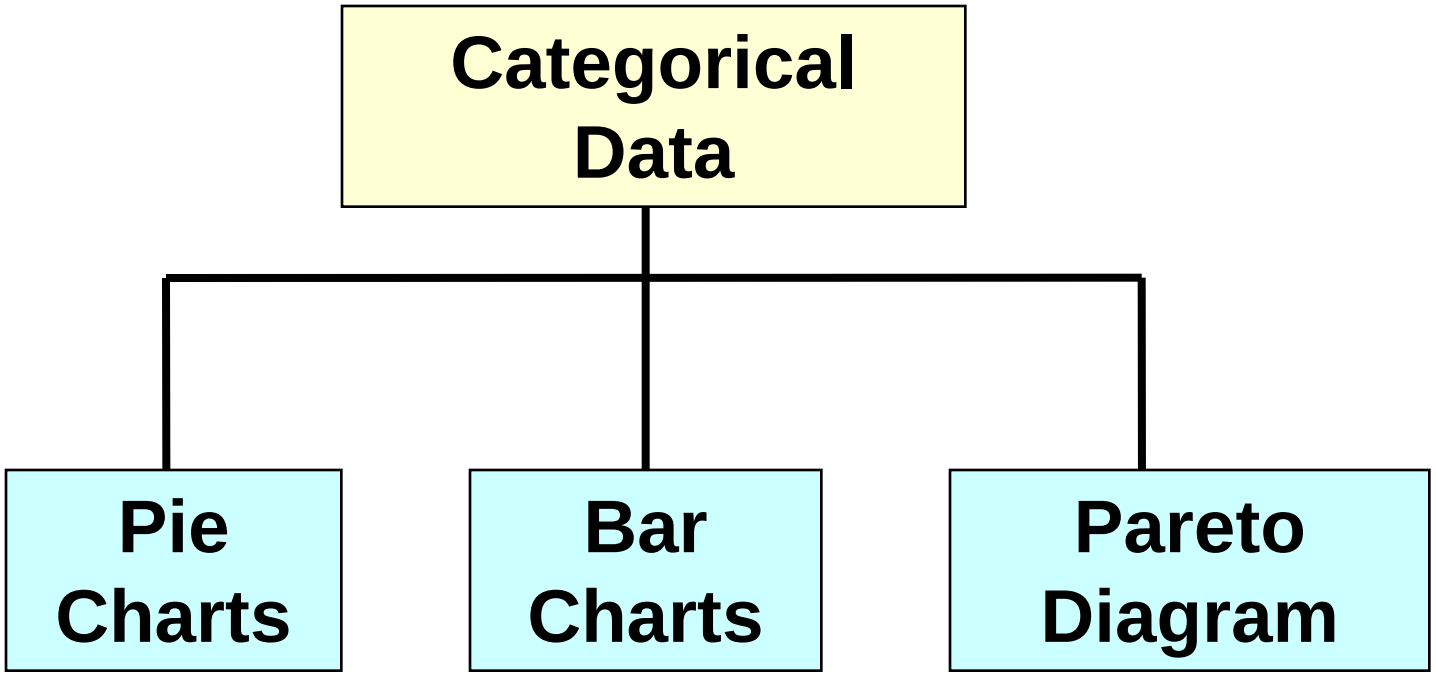
Using other stem units

- Using the 100's digit as the stem:
  - Round off the 10's digit to form the leaves

- 613 would become
- 776 would become
- . . .
- 1224 becomes

Stem	Leaf
6	1
7	8
12	2

Graphing Categorical Data



Bar and Pie Charts

- Bar charts and Pie charts are often used for qualitative (category) data

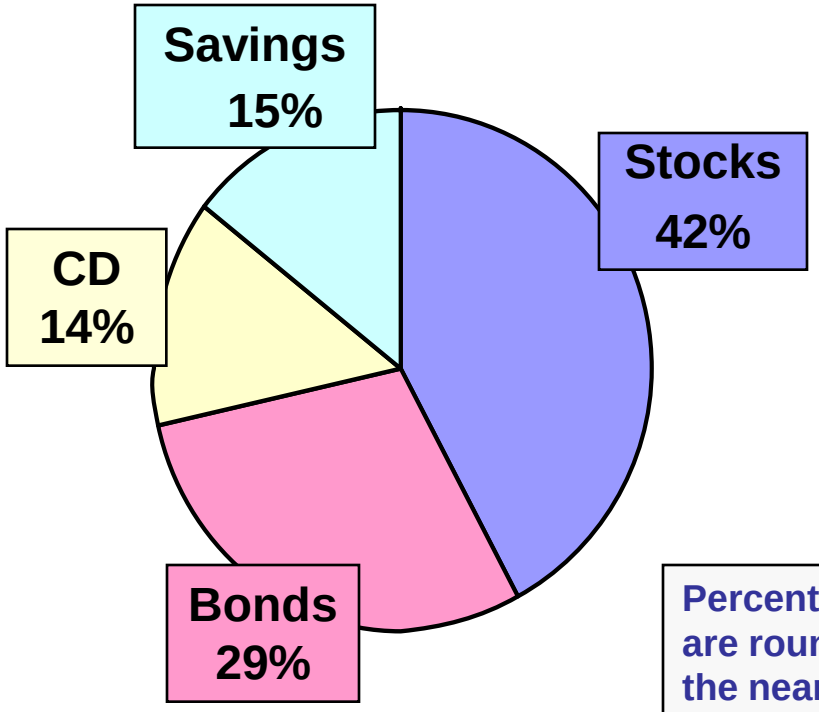
- Height of bar or size of pie slice shows the frequency or percentage for each category

Pie Chart Example

Current Investment Portfolio

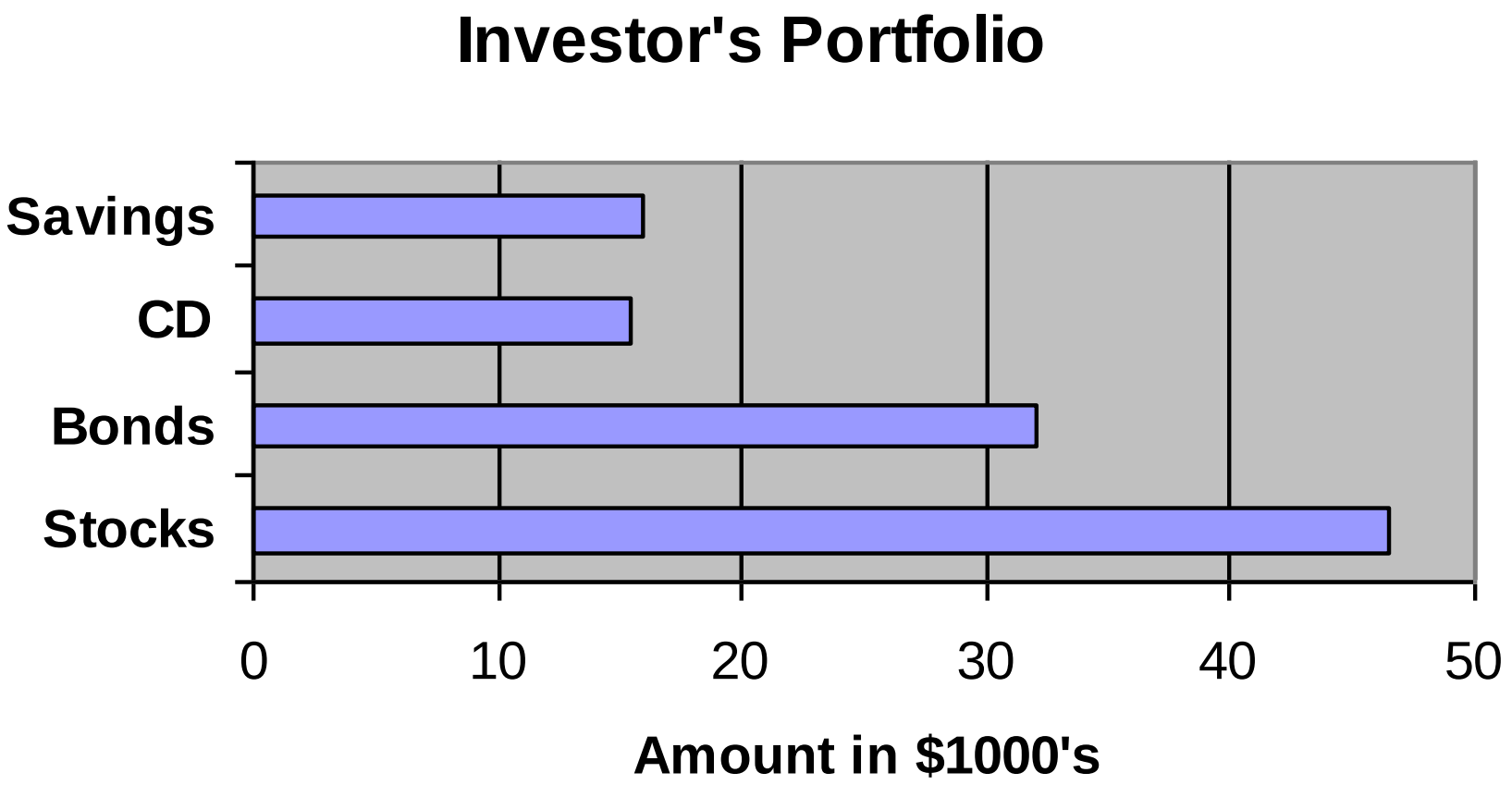
Investment Type	Amount (in thousands $)	Percentage
Stocks	46.5	42.27
Bonds	32.0	29.09
CD	15.5	14.09
Savings	16.0	14.55
Total	**110**	**100**

(Variables are Qualitative)

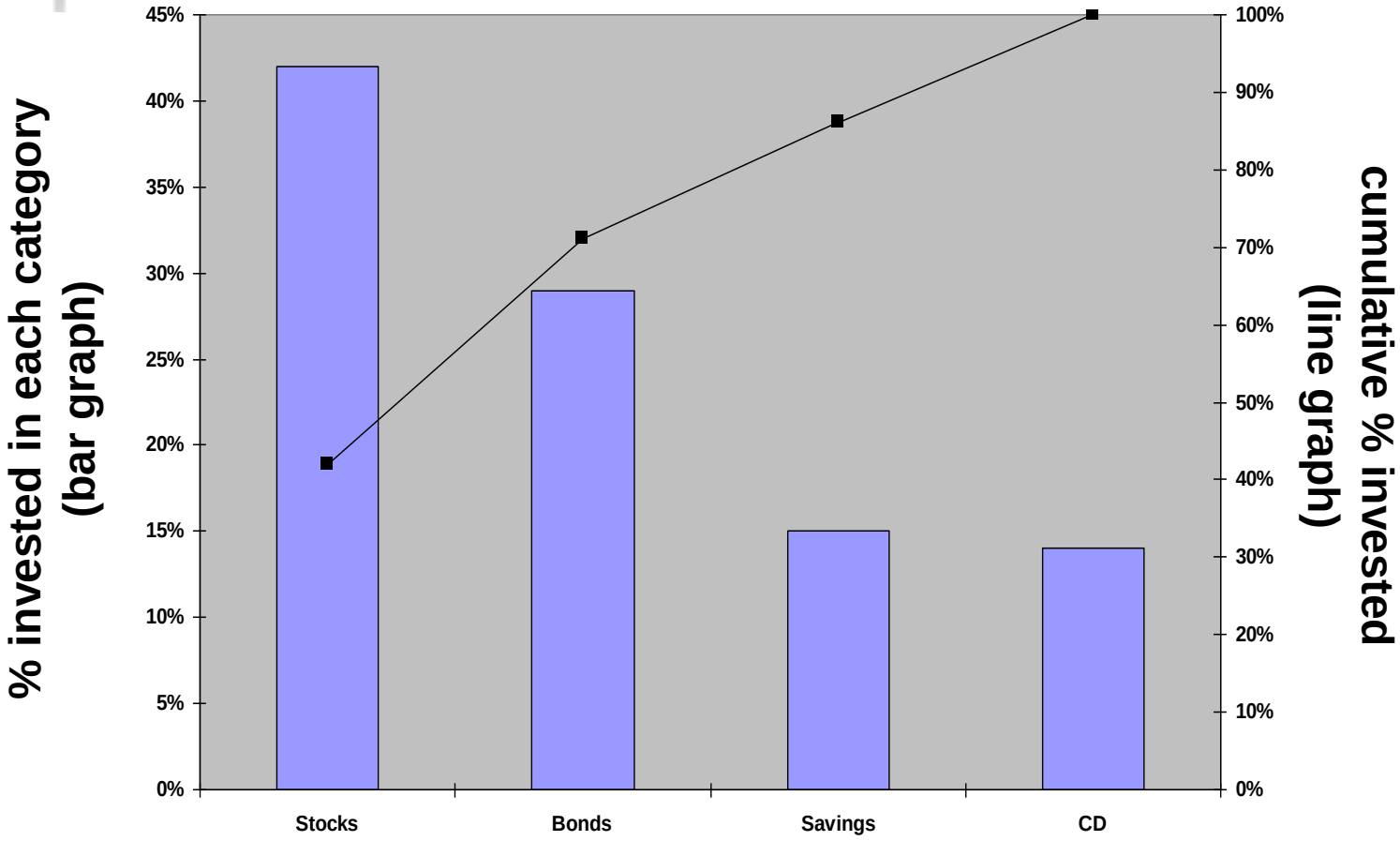


Percentages are rounded to the nearest percent

Bar Chart Example

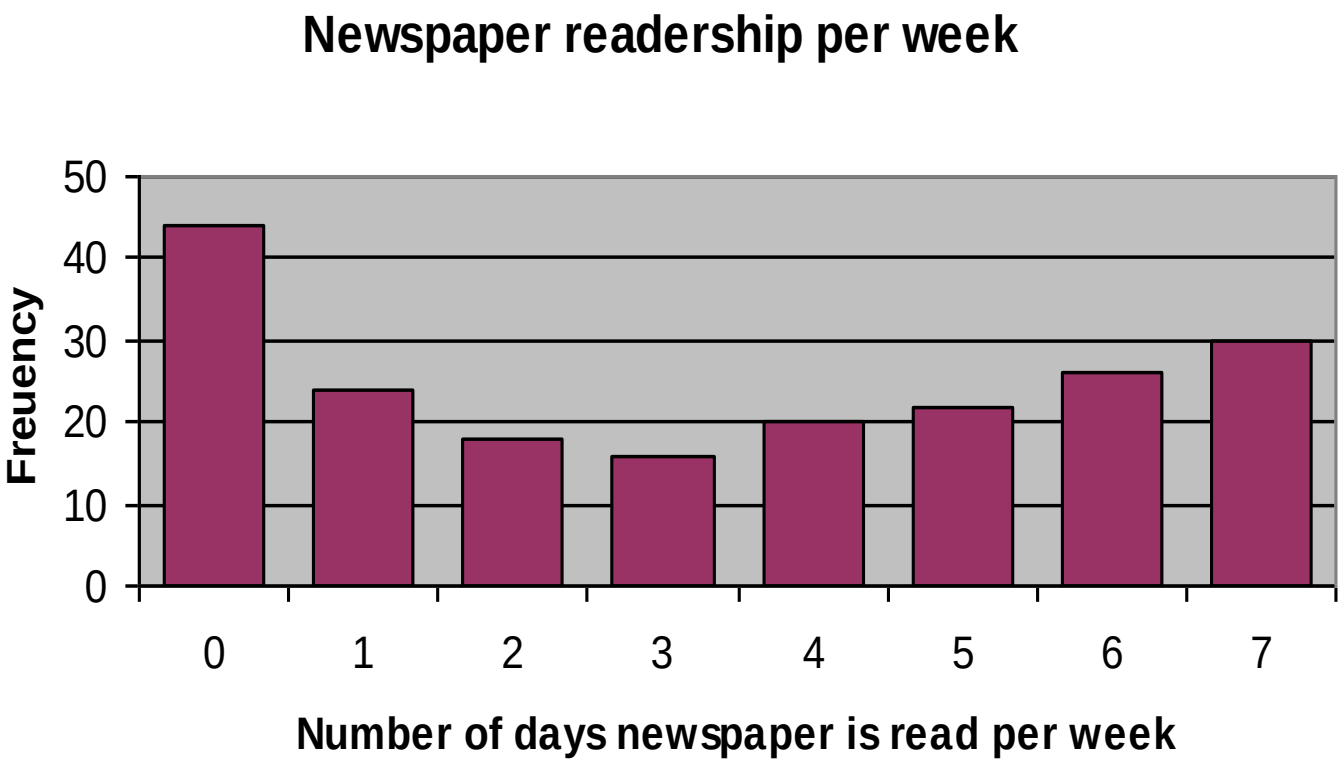


Pareto Diagram Example



Bar Chart Example

Number of days read	Frequency
0	44
1	24
2	18
3	16
4	20
5	22
6	26
7	30
Total	**200**



Tabulating and Graphing Multivariate Categorical Data

- Investment in thousands of dollars

Investment Category	Investor A	Investor B	Investor C	Total
Stocks	46.5	55	27.5	**129**
Bonds	32.0	44	19.0	**95**
CD	15.5	20	13.5	**49**
Savings	16.0	28	7.0	**51**
Total	**110.0**	**147**	**67.0**	**324**

Tabulating and Graphing Multivariate Categorical Data

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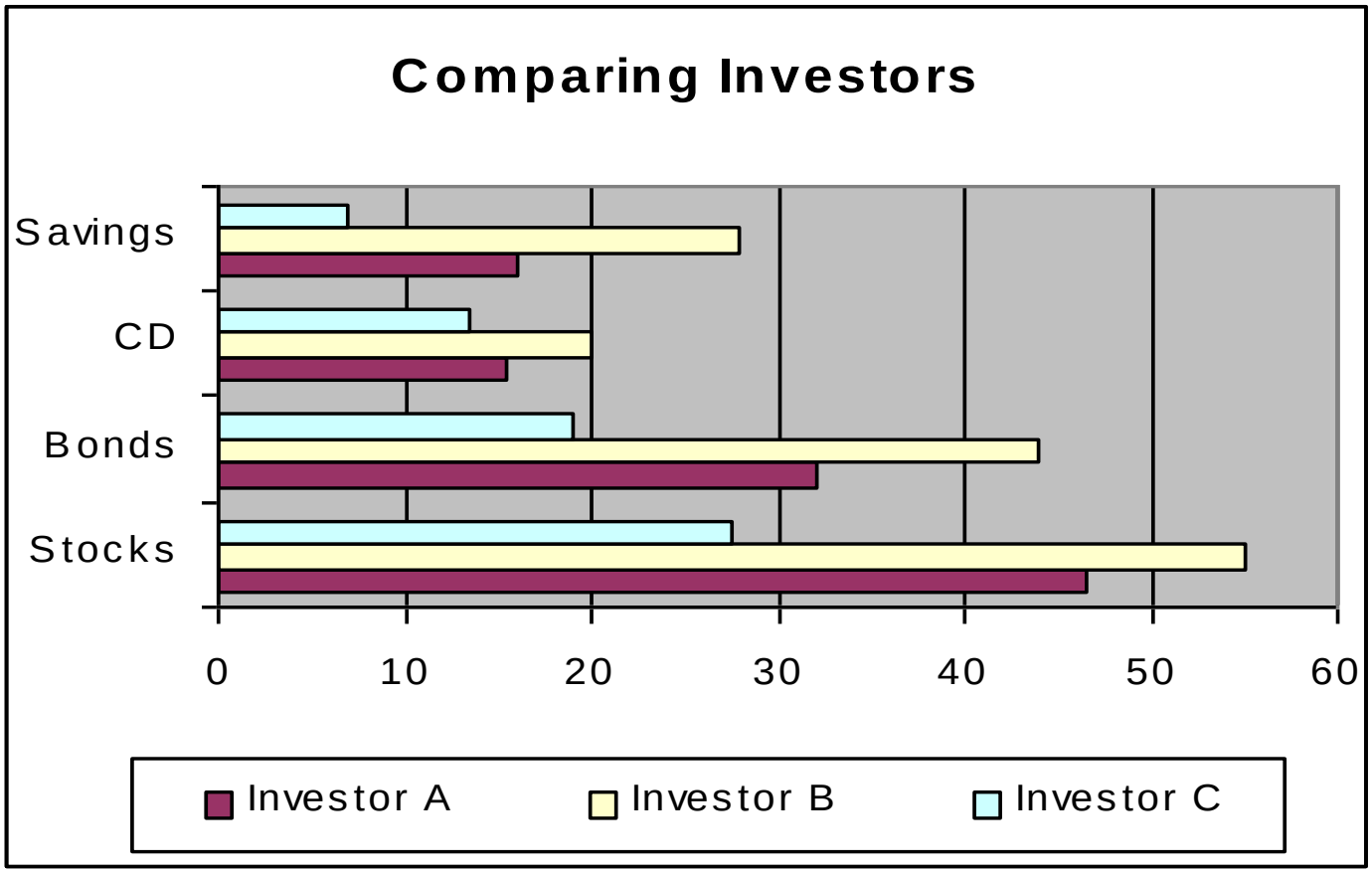
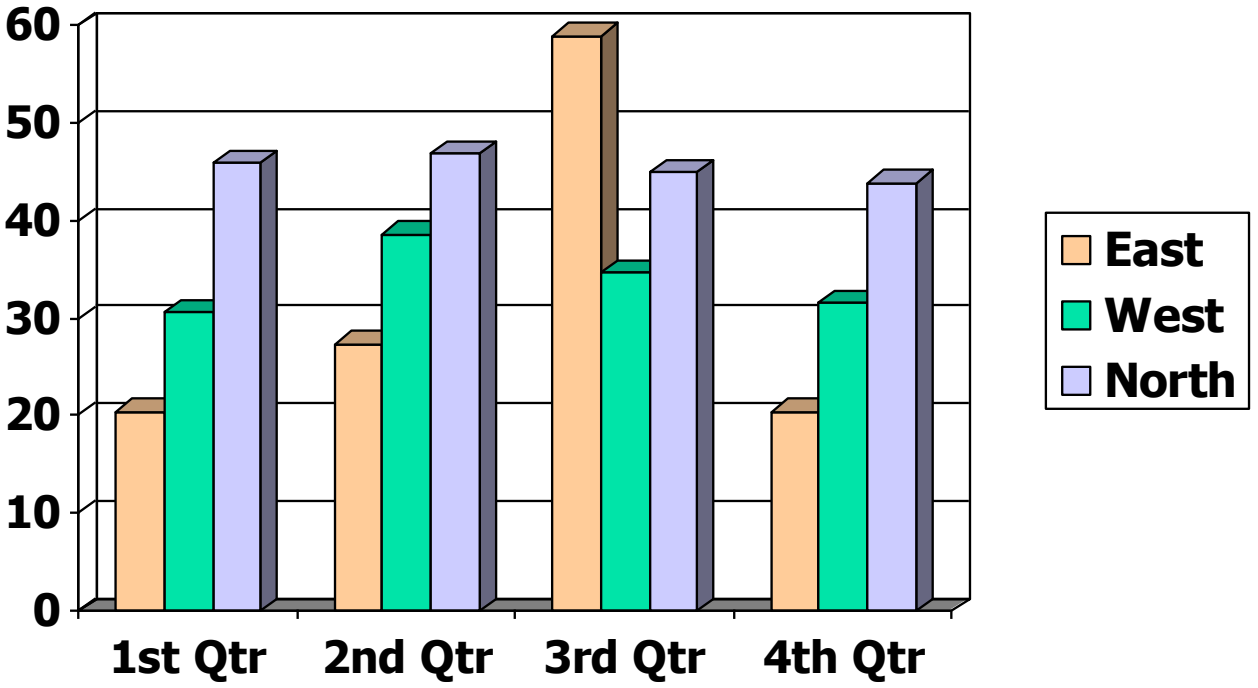
- Side by side charts



Side-by-Side Chart Example

- Sales by quarter for three sales territories:

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
East	20.4	27.4	59	20.4
West	30.6	38.6	34.6	31.6
North	45.9	46.9	45	43.9



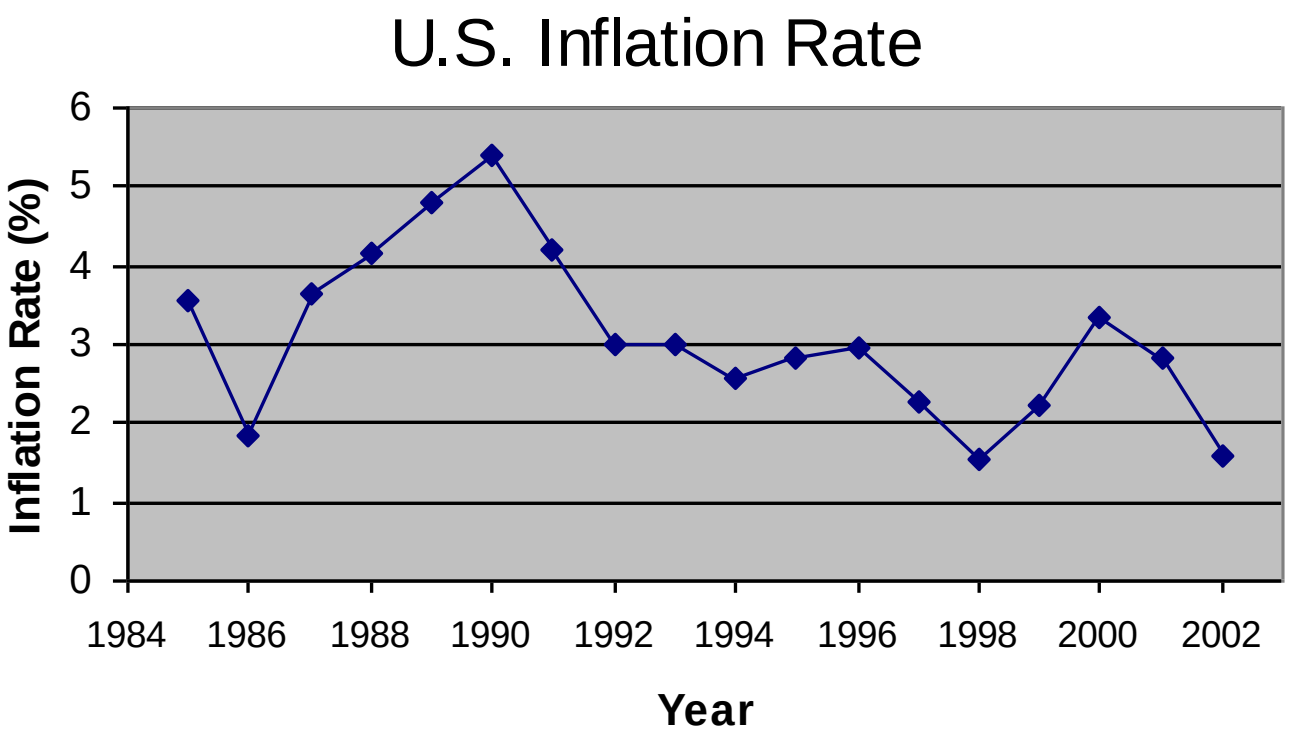
Line Charts and Scatter Diagrams

- Line charts show values of one variable vs. time
  - Time is traditionally shown on the horizontal axis

- Scatter Diagrams show points for bivariate data
  - one variable is measured on the vertical axis and the other variable is measured on the horizontal axis

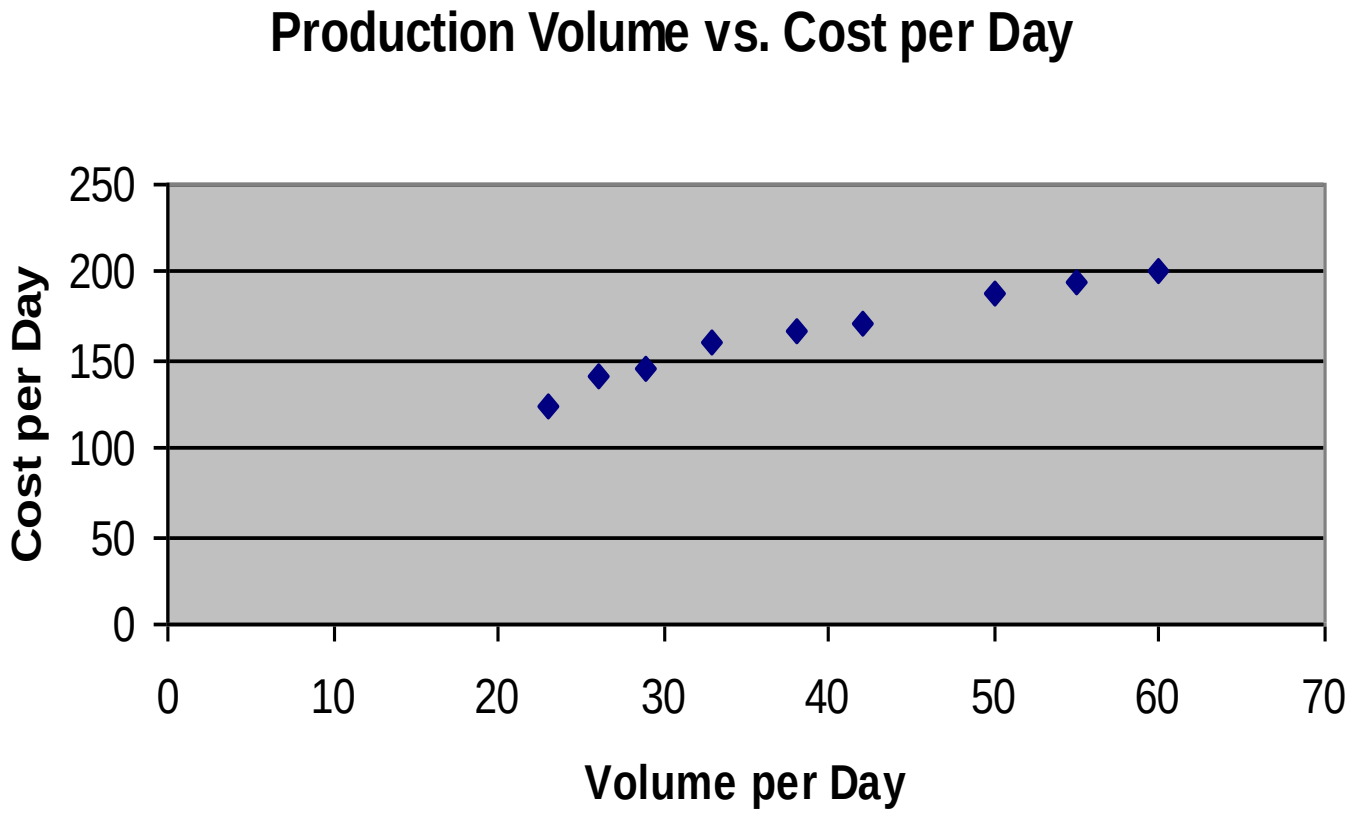
Line Chart Example

Year	Inflation Rate
1985	3.56
1986	1.86
1987	3.65
1988	4.14
1989	4.82
1990	5.40
1991	4.21
1992	3.01
1993	2.99
1994	2.56
1995	2.83
1996	2.95
1997	2.29
1998	1.56
1999	2.21
2000	3.36
2001	2.85
2002	1.58



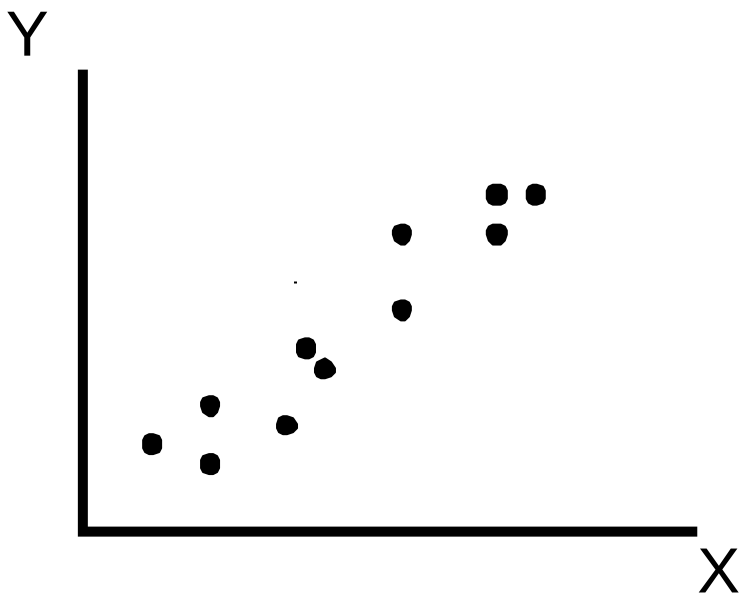
Scatter Diagram Example

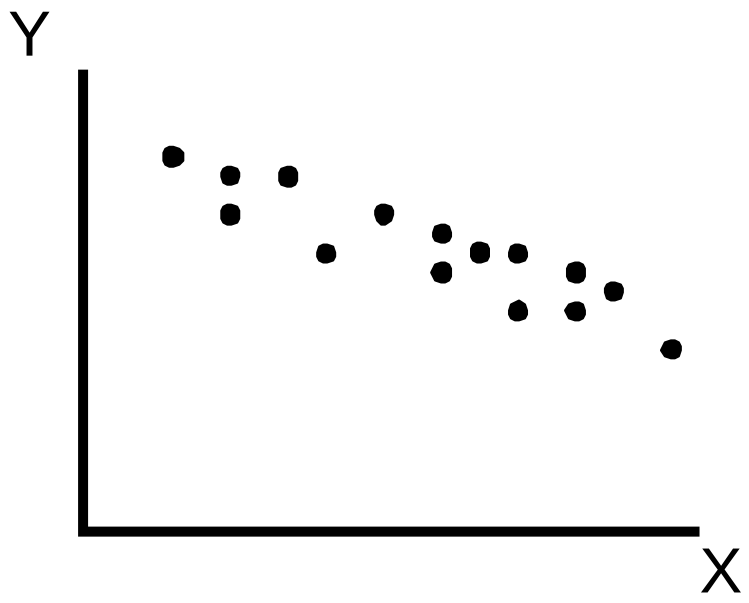
Volume per day	Cost per day
23	125
26	140
29	146
33	160
38	167
42	170
50	188
55	195
60	200



Types of Relationships

- Linear Relationships





Types of Relationships

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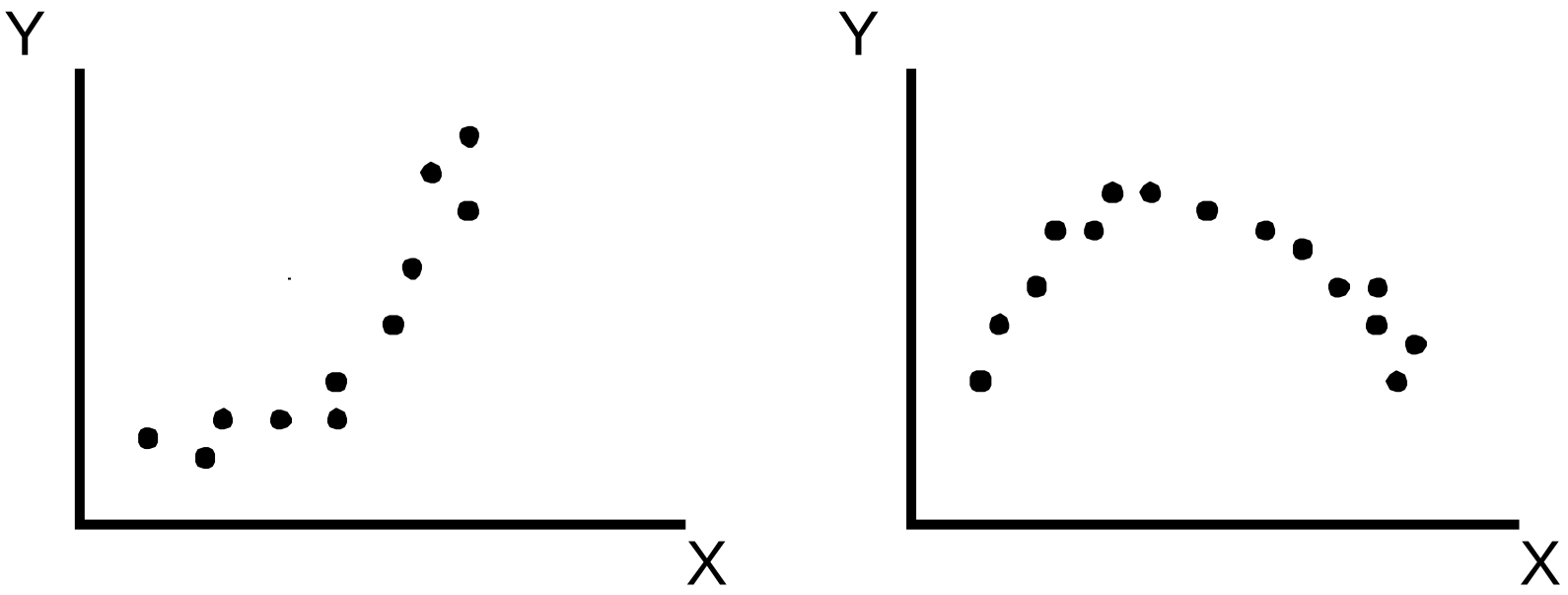
- Curvilinear Relationships



Types of Relationships

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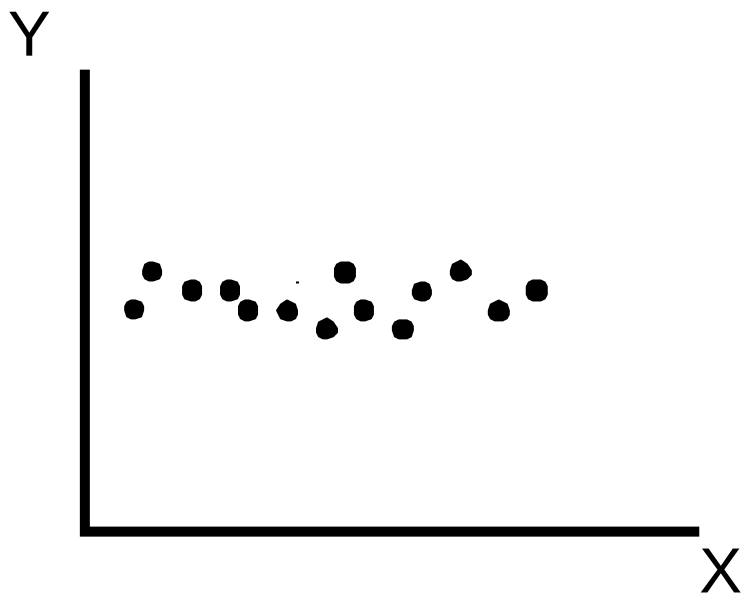
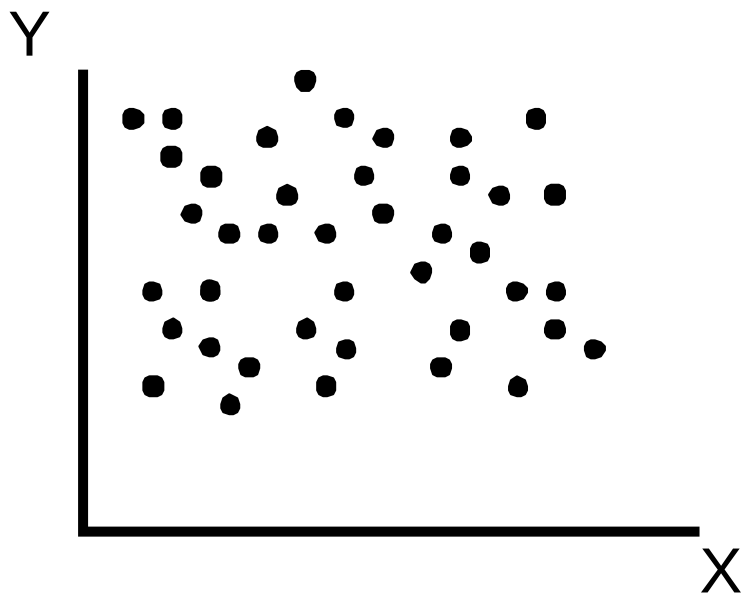
- No Relationship





Chapter Summary

- Data in raw form are usually not easy to use for decision making -- Some type of organization is needed:
  - Table
  - Graph
- Techniques reviewed in this chapter:
  - Frequency Distributions and Histograms
  - Bar Charts and Pie Charts
  - Stem and Leaf Diagrams
  - Line Charts and Scatter Diagrams