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Chapter 2

This chapter moves on to the organizing and visualizing steps of the DCOVA framework. If you are going to collect sample data to use in Chapters 2 and 3, you can illustrate sampling by conducting a survey of students in your class. Ask each student to collect his or her own personal data concerning the time it takes to get ready to go to class in the morning or the time it takes to get to school or home from school. First, ask the students to write down a definition of how they plan to measure this time. Then, collect the various answers and read them to the class. Then, a single definition could be provided (such as the time to get ready is the time measured from when you get out of bed to when you leave your home, recorded to the nearest minute). In the next class, select a random sample of students and use the data collected (depending on the sample size) in class when Chapters 2 and 3 are discussed. Then, move on to the Organize step that involves setting up your data in an Excel, JMP, or Minitab. Show the summary worksheet and develop tables to help you prepare charts and analyze your data. Begin your discussion for categorical data with the example on p. 43 concerning the percentage of the time millennials use different devices for watching television and then if you wish, explain that you can sometimes organize the data into a two-way table that has one variable in the row and another in the column.

Continue with organizing data (but now for numerical data) by referring to the cost of a restaurant meal on p. 46. Show the simple ordered array and how a frequency distribution, percentage distribution, or cumulative distribution can summarize the raw data in a way that is more useful.

Now you are ready to tackle the Visualize step. A good way of starting this part of the chapter is to display the following quote.

"A picture is worth a thousand words."

Students will almost certainly be familiar with Microsoft® Word and may have already used Excel to construct charts that they have pasted into Word documents. Now you will be using Excel or JMP or Minitab to construct many different types of charts. Return to the data previously discussed on what devices millennials use to watch television and illustrate how a bar chart and pie chart can be constructed. Mention their advantages and disadvantages. A good example is to show the data on incomplete ATM transactions on p. 75 and how the Pareto chart enables you to focus on the vital few categories. If time permits, you can discuss the side-by-side bar chart for a contingency table.

To examine charts for numerical variables you can either use the restaurant data previously mentioned or data that you have collected from your class. You may want to begin with a simple stem-and-leaf display that both organizes the data and shows a bar type chart. Then move on to the histogram and the various polygons, pointing out the advantages and disadvantages of each.

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If time permits, you can discuss the scatter plot and the time-series plot for two numerical variables. Otherwise, you can wait until you get to regression analysis. Also, you may want to discuss how multidimensional tables allow you to see several variables simultaneously.

If the opportunity is available, we believe that it is worth the time to cover Section 2.9 on Pitfalls in Organizing and Visualizing Data. This is a topic that students very much enjoy because it allows for a great deal of classroom interaction. After discussing the fundamental principles of good graphs, try to illustrate the improper display shown in Figure 2.31. Ask students what is "bad" about this figure. Follow up with a homework assignment involving Problems 2.69 – 2.73 (*USA Today* is a great source).

You will find that the chapter review problems provide large data sets with numerous variables. Report writing exercises provide the opportunity for students to integrate written and/or oral presentation with the statistics they have learned.

The *Managing Ashland MultiComm Services* case enables students to examine the use of statistics in an actual business environment. The Digital Case refers to the EndRun Financial Services and claims that have been made. The CardioGood Fitness case focuses on developing a customer profile for a market research team. The Choice *Is* Yours Follow-up expands on the chapter discussion of the mutual funds data. The Clear Mountain State Student Survey provides data collected from a sample of undergraduate students and a separate sample of graduate students.

The Excel, JMP, and Minitab Guides for this and the remaining chapters are organized according to the sections of the chapter. They are quite extensive because they cover both organizing and visualizing many different graphs. The Excel Guide includes instructions for Workbook, PHStat, and the Analysis ToolPak. Pick and choosing among these choices enables you to choose the approaches that you prefer.

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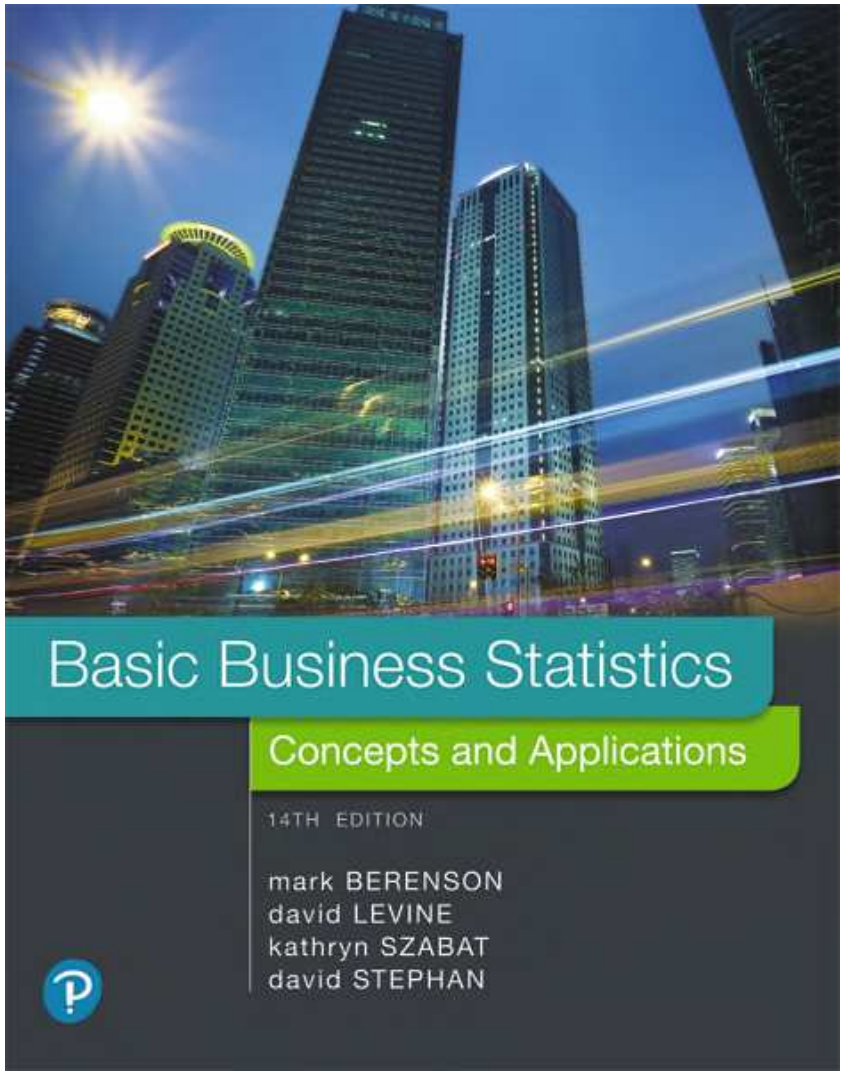

Chapter 2

Organizing and Visualizing Variables

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Objectives

In this chapter you learn:

- How to organize and visualize categorical variables.
- How to organize and visualize numerical variables.
- How to summarize a mix of variables.
- How to avoid making common errors when organizing and visualizing variables.

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Organizing Data Creates Both Tabular And Visual Summaries

DCOVA

- Summaries both guide further exploration and sometimes facilitate decision making.

- Visual summaries enable rapid review of larger amounts of data & show possible significant patterns.

- Often, the **O**rganize and **V**isualize step in **DCOVA** occur concurrently.

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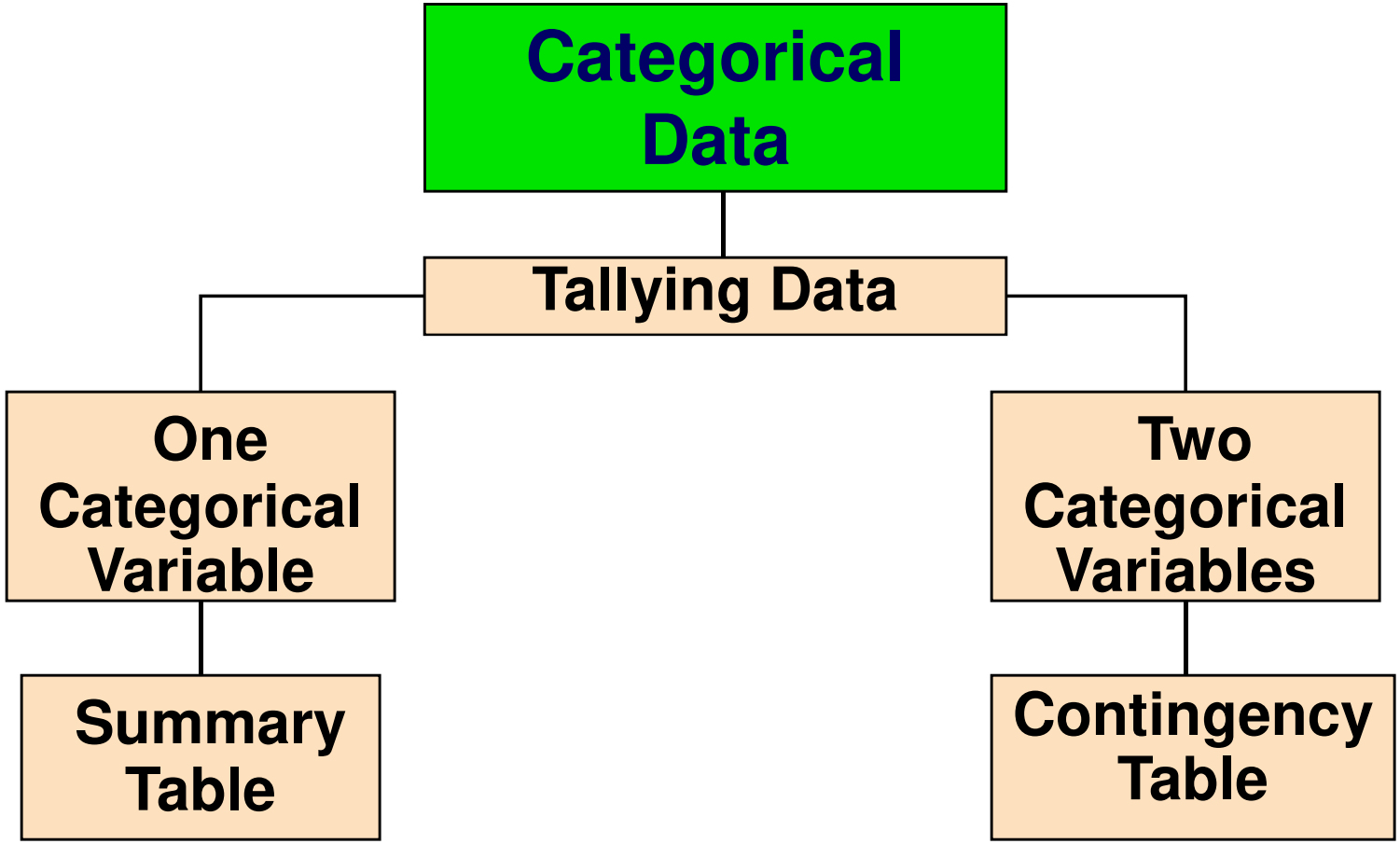
Categorical Data Are Organized By Utilizing Tables

DCOVA



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Organizing Categorical Data: Summary Table

DCOVA

- A **summary table** tallies the frequencies or percentages of items in a set of categories so that you can see differences between categories.

Devices Millennials Use to Watch Movies or Television Shows

Devices Used To Watch Movies or TV Shows	Percent
Television Set	49%
Tablet	9%
Smartphone	10%
Laptop / Desktop	32%

Source: Data extracted and adapted from A. Sharma, "Big Media Needs to Embrace Digital Shift Not Fight It," Wall Street Journal, June 22, 2016, p. 1-2.

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A Contingency Table Helps Organize Two or More Categorical Variables

DCOVA

- Used to study patterns that may exist between the responses of two or more categorical variables.
- Cross tabulates or tallies jointly the responses of the categorical variables.
- For two variables the tallies for one variable are located in the rows and the tallies for the second variable are located in the columns.

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Contingency Table - Example

DCOVA

- A random sample of 400 invoices is drawn.
- Each invoice is categorized as a small, medium, or large amount.
- Each invoice is also examined to identify if there are any errors.
- This data are then organized in the contingency table to the right.

Contingency Table Showing Frequency of Invoices Categorized By Size and The Presence Of Errors

	No Errors	Errors	Total
Small Amount	170	20	190
Medium Amount	100	40	140
Large Amount	65	5	70
Total	335	65	400

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Contingency Table Based On Percentage Of Overall Total

DCOVA

	No Errors	Errors	Total
Small Amount	170	20	190
Medium Amount	100	40	140
Large Amount	65	5	70
Total	335	65	400

42.50% = 170 / 400
25.00% = 100 / 400
16.25% = 65 / 400

	No Errors	Errors	Total
Small Amount	42.50%	5.00%	47.50%
Medium Amount	25.00%	10.00%	35.00%
Large Amount	16.25%	1.25%	17.50%
Total	83.75%	16.25%	100.0%

83.75% of sampled invoices have no errors and 47.50% of sampled invoices are for small amounts.

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Contingency Table Based On Percentage of Row Totals

DCOVA

	No Errors	Errors	Total
Small Amount	170	20	190
Medium Amount	100	40	140
Large Amount	65	5	70
Total	335	65	400

89.47% = 170 / 190
71.43% = 100 / 140
92.86% = 65 / 70

	No Errors	Errors	Total
Small Amount	89.47%	10.53%	100.0%
Medium Amount	71.43%	28.57%	100.0%
Large Amount	92.86%	7.14%	100.0%
Total	83.75%	16.25%	100.0%

Medium invoices have a larger chance (28.57%) of having errors than small (10.53%) or large (7.14%) invoices.

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Contingency Table Based On Percentage Of Column Totals

DCOVA

	No Errors	Errors	Total
Small Amount	170	20	190
Medium Amount	100	40	140
Large Amount	65	5	70
Total	335	65	400

50.75% = 170 / 335
30.77% = 20 / 65

	No Errors	Errors	Total
Small Amount	50.75%	30.77%	47.50%
Medium Amount	29.85%	61.54%	35.00%
Large Amount	19.40%	7.69%	17.50%
Total	100.0%	100.0%	100.0%

There is a 61.54% chance that invoices with errors are of medium size.

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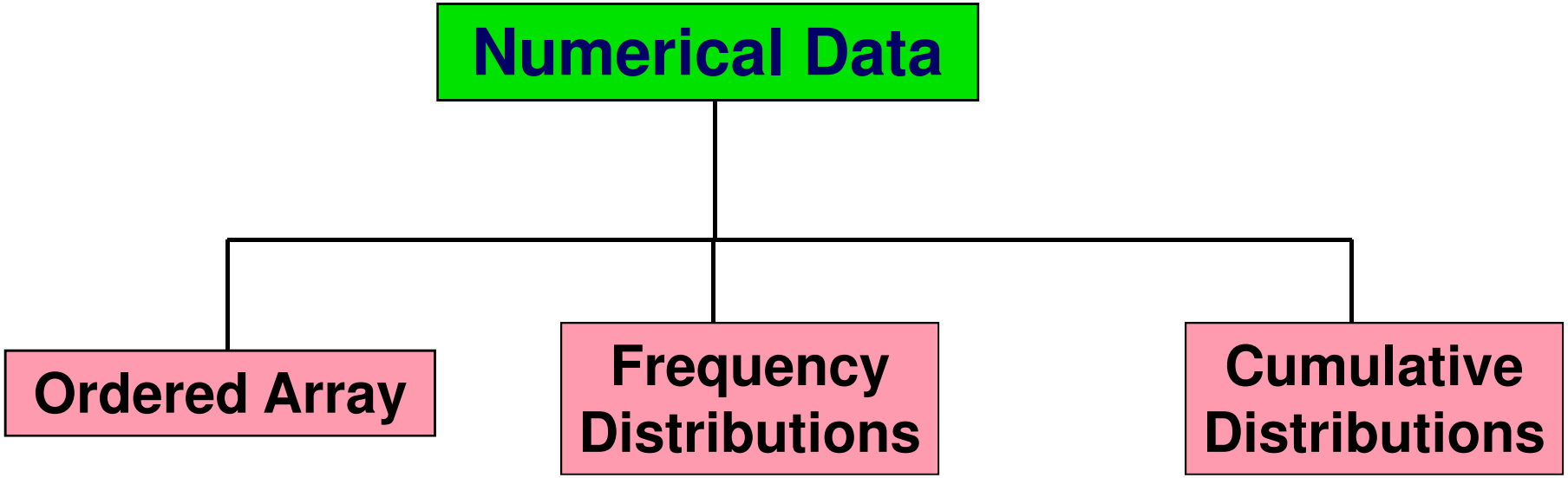
Tables Used For Organizing Numerical Data

DCOVA



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Organizing Numerical Data: Ordered Array

DCOVA

- An **ordered array** is a sequence of data, in rank order, from the smallest value to the largest value.
- Shows range (minimum value to maximum value).
- May help identify outliers (unusual observations).

Age of Surveyed College Students	**Day Students**					
	16	17	17	18	18	18
	19	19	20	20	21	22
	22	25	27	32	38	42
	Night Students					
	18	18	19	19	20	21
	23	28	32	33	41	45

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Organizing Numerical Data: Frequency Distribution

DCOVA

- The **frequency distribution** is a summary table in which the data are arranged into numerically ordered classes.

- You must give attention to selecting the appropriate *number* of **class groupings** for the table, determining a suitable *width* of a class grouping, and establishing the *boundaries* of each class grouping to avoid overlapping.

- The number of classes depends on the number of values in the data. With a larger number of values, typically there are more classes. In general, a frequency distribution should have at least 5 but no more than 15 classes.

- To determine the **width of a class interval,** you divide the **range** (Highest value–Lowest value) of the data by the number of class groupings desired.

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Organizing Numerical Data: Frequency Distribution Example

DCOVA

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

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Organizing Numerical Data: Frequency Distribution Example

DCOVA

- 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 15).**
- Compute class interval (width): **10 (46/5 then round up).**
- Determine class boundaries (limits):
  - **Class 1: 10 but less than 20.**
  - **Class 2: 20 but less than 30.**
  - **Class 3: 30 but less than 40.**
  - **Class 4: 40 but less than 50.**
  - **Class 5: 50 but less than 60.**
- Compute class midpoints: **15, 25, 35, 45, 55.**
- Count observations & assign to classes.

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Organizing Numerical Data: Frequency Distribution Example

DCOVA

Data in ordered array:

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

Class	Midpoints	Frequency
10 but less than 20	15	3
20 but less than 30	25	6
30 but less than 40	35	5
40 but less than 50	45	4
50 but less than 60	55	2
Total		20

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Organizing Numerical Data: Relative & Percent Frequency Distribution Example

DCOVA

Class	Frequency	Relative Frequency	Percentage
10 but less than 20	3	.15	15%
20 but less than 30	6	.30	30%
30 but less than 40	5	.25	25%
40 but less than 50	4	.20	20%
50 but less than 60	2	.10	10%
Total	20	1.00	100%

Relative Frequency = Frequency / Total, e.g. 0.10 = 2 / 20

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Organizing Numerical Data: Cumulative Frequency Distribution Example

DCOVA

Class	Frequency	Percentage	Cumulative Frequency	Cumulative Percentage
10 but less than 20	3	15%	3	15%
20 but less than 30	6	30%	9	45%
30 but less than 40	5	25%	14	70%
40 but less than 50	4	20%	18	90%
50 but less than 60	2	10%	20	100%
Total	20	100%	20	100%

Cumulative Percentage = Cumulative Frequency / Total * 100 e.g. 45% = 100*9/20

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Why Use a Frequency Distribution?

DCOVA

- It condenses the raw data into a more useful form.
- It allows for a quick visual interpretation of the data.
- It enables the determination of the major characteristics of the data set including where the data are concentrated / clustered.

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Frequency Distributions: Some Tips

DCOVA

- Different class boundaries may provide different pictures for the same data (especially for smaller data sets).
- Shifts in data concentration may show up when different class boundaries are chosen.
- As the size of the data set increases, the impact of alterations in the selection of class boundaries is greatly reduced.
- When comparing two or more groups with different sample sizes, you must use either a relative frequency or a percentage distribution.

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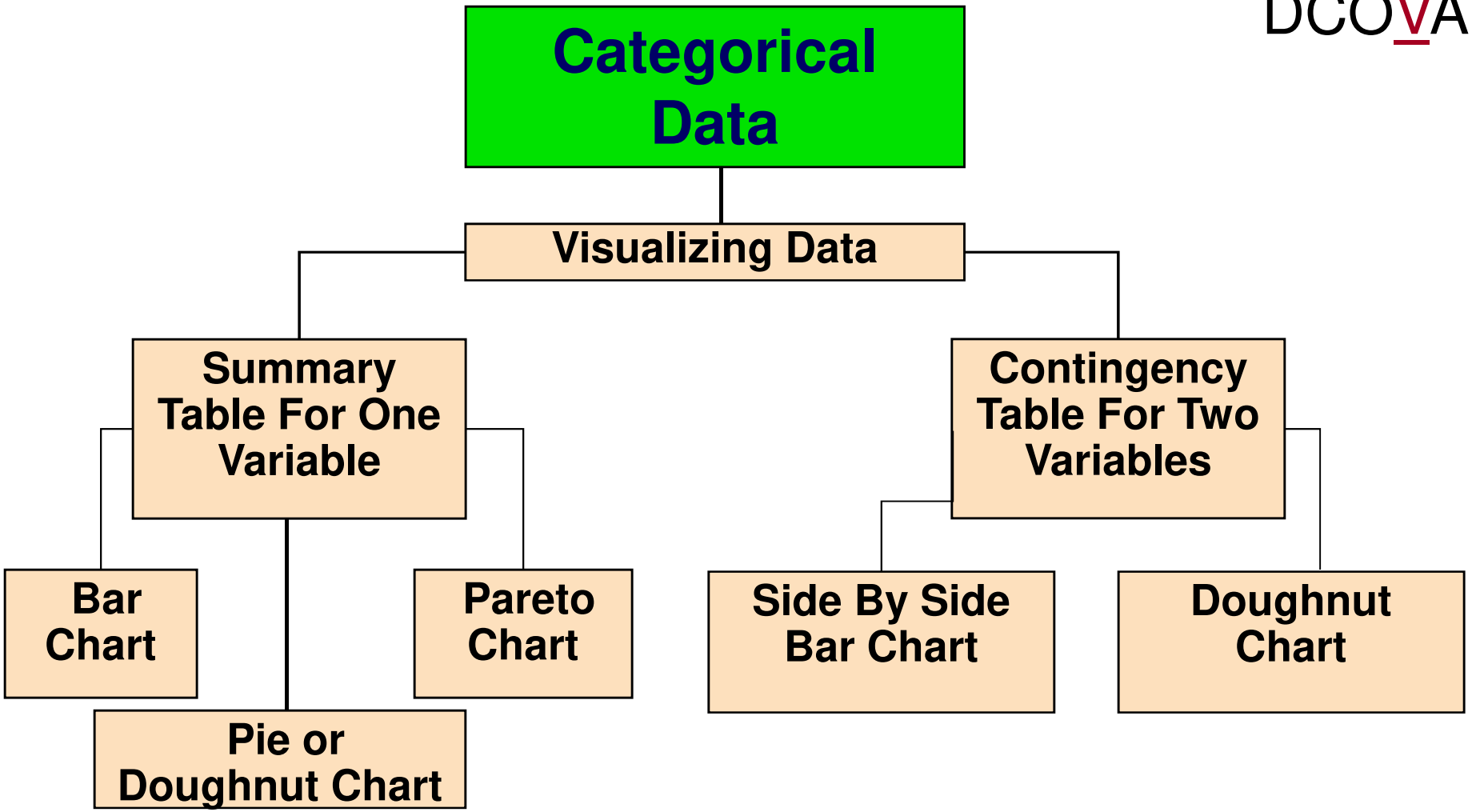
Visualizing Categorical Data Through Graphical Displays

DCOVA



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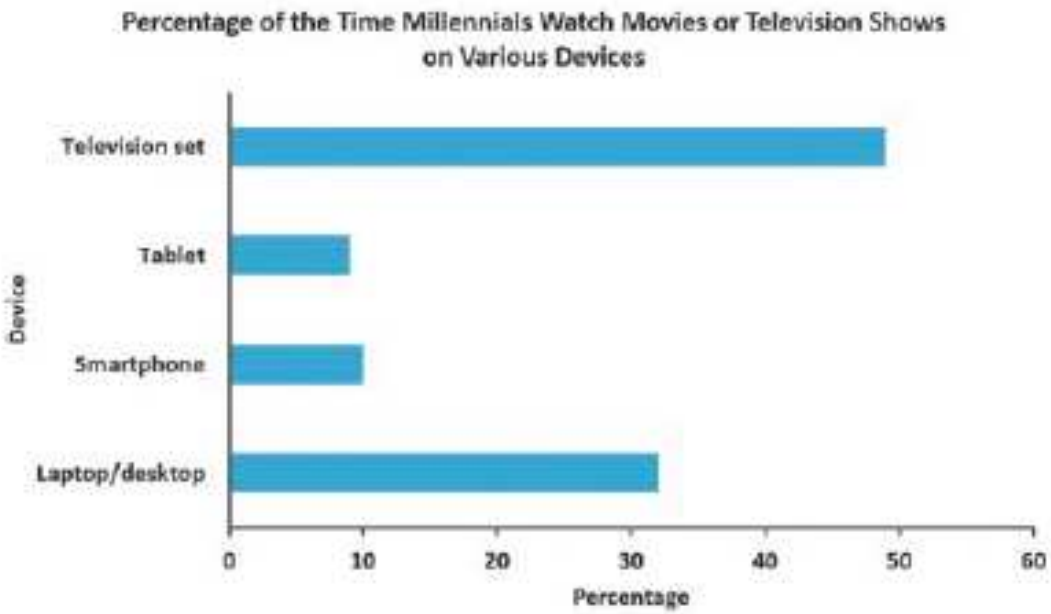
Visualizing Categorical Data: The Bar Chart

DCOVA

- The **bar chart** visualizes a categorical variable as a series of bars. The length of each bar represents either the frequency or percentage of values for each category. Each bar is separated by a space called a gap.

Devices Used to Watch	Percent
Television Set	49%
Tablet	9%
Smartphone	10%
Laptop / Desktop	32%



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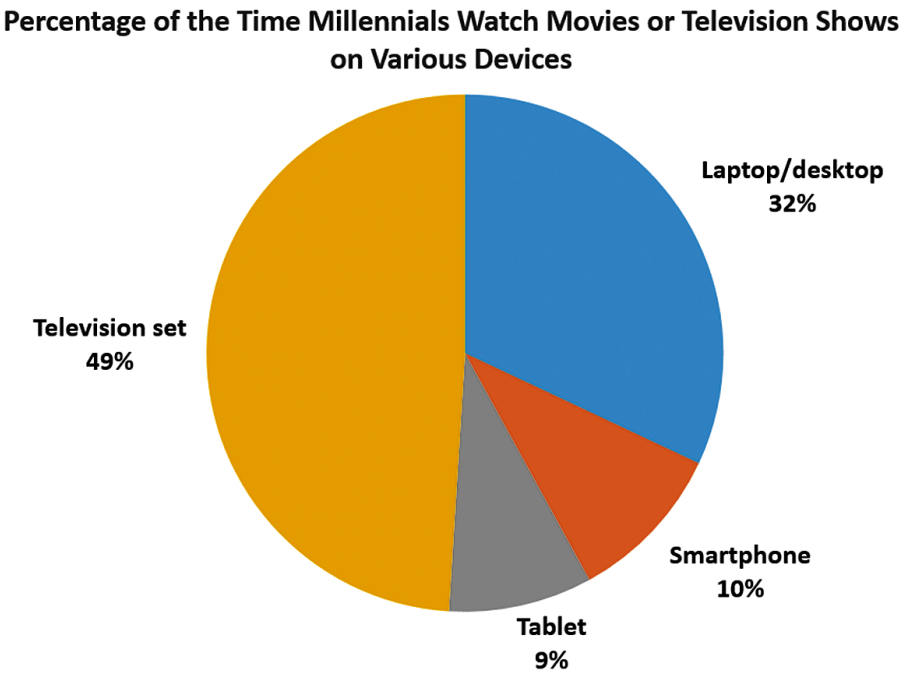
Visualizing Categorical Data: The Pie Chart

DCOVA

- The **pie chart** is a circle broken up into slices that represent categories. The size of each slice of the pie varies according to the percentage in each category.

Devices Used to Watch	Percent
Television Set	49%
Tablet	9%
Smartphone	10%
Laptop / Desktop	32%



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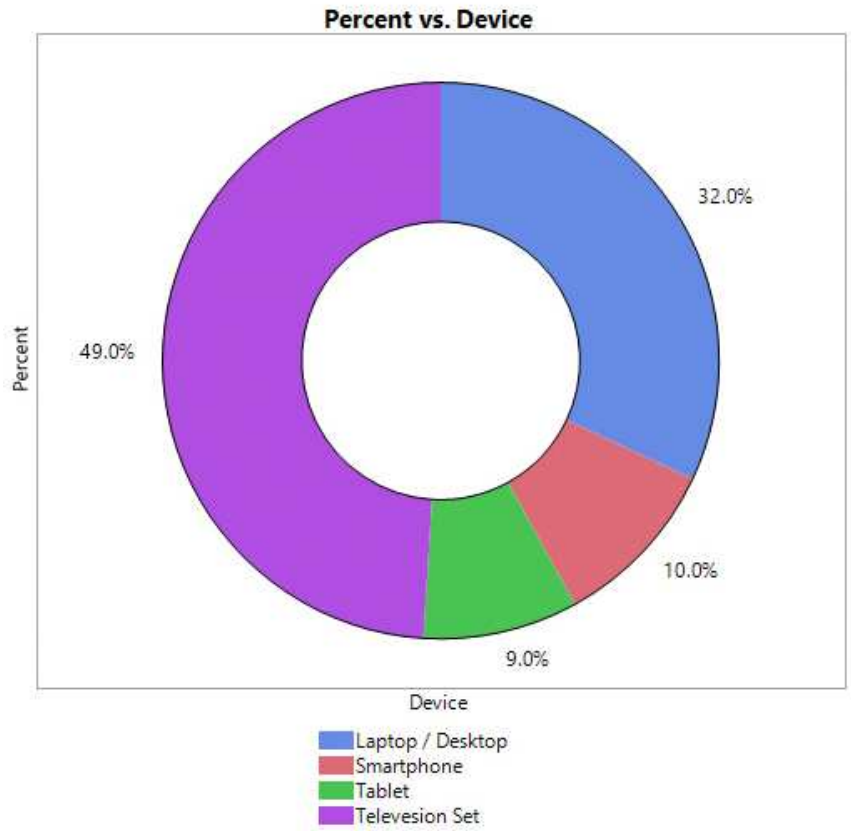
Visualizing Categorical Data: The Doughnut Chart

DCOVA

- The **doughnut chart** is the outer part of a circle broken up into pieces that represent categories. The size of each piece of the doughnut varies according to the percentage in each category.

Devices Used to Watch	Percent
Television Set	49%
Tablet	9%
Smartphone	10%
Laptop / Desktop	32%



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Visualizing Categorical Data: The Pareto Chart

DCOVA

- Used to portray categorical data (nominal scale).
- A vertical bar chart, where categories are shown in descending order of frequency.
- A cumulative polygon is shown in the same graph.
- Used to separate the “vital few” from the “trivial many.”

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Visualizing Categorical Data: The Pareto Chart (con't)

DCOVA

Ordered Summary Table For Causes Of Incomplete ATM Transactions

Cause	Frequency	Percent	Cumulative Percent
Warped card jammed	365	50.41%	50.41%
Card unreadable	234	32.32%	82.73%
ATM malfunctions	32	4.42%	87.15%
ATM out of cash	28	3.87%	91.02%
Invalid amount requested	23	3.18%	94.20%
Wrong keystroke	23	3.18%	97.38%
Lack of funds in account	19	2.62%	100.00%
Total	**724**	**100.00%**	

Source: Data extracted from A. Bhalla, "Don't Misuse the Pareto Principle," *Six Sigma Forum Magazine, May 2009, pp. 15–18.*

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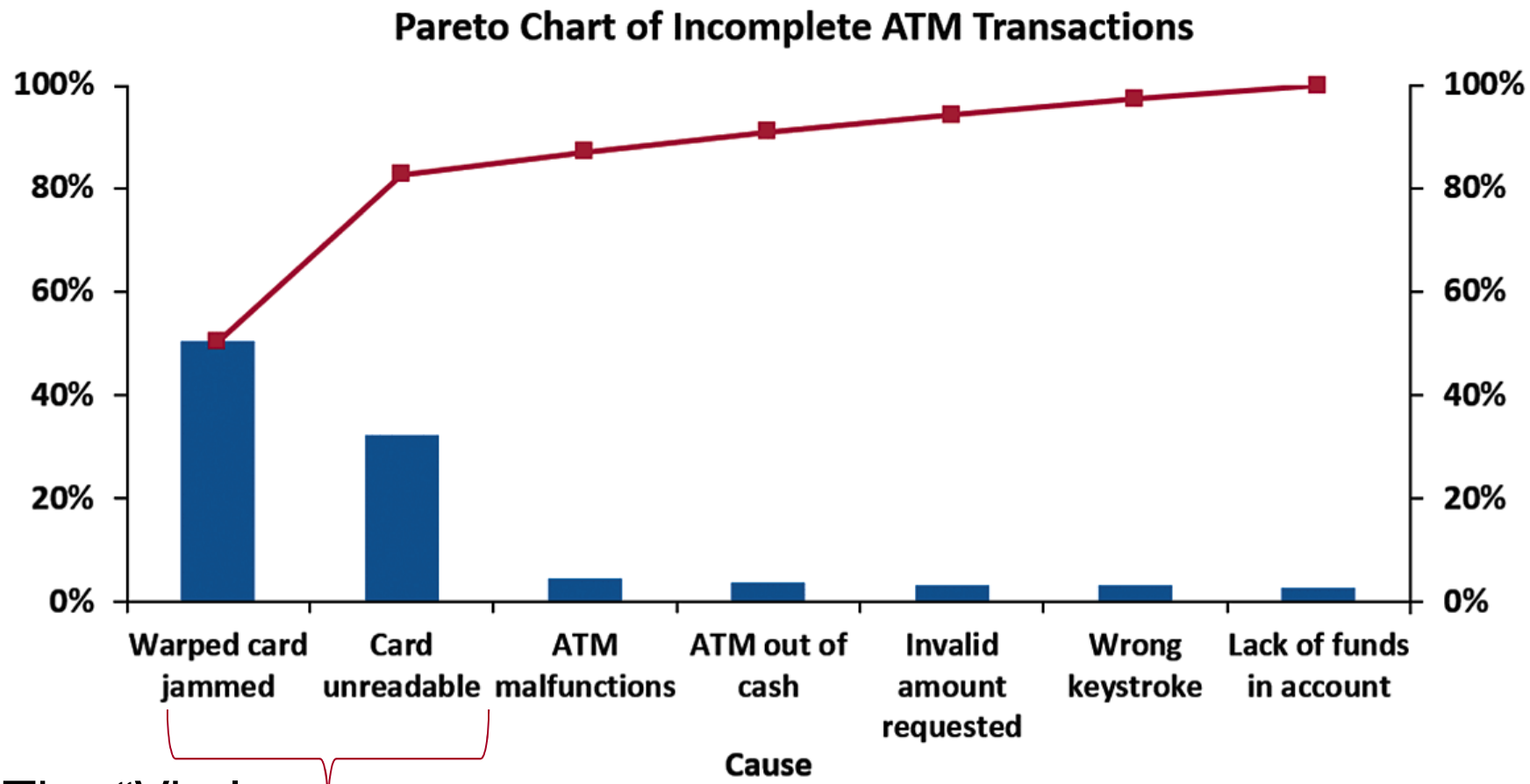
Visualizing Categorical Data: The Pareto Chart (con't)

DCOVA



The "Vital Few"

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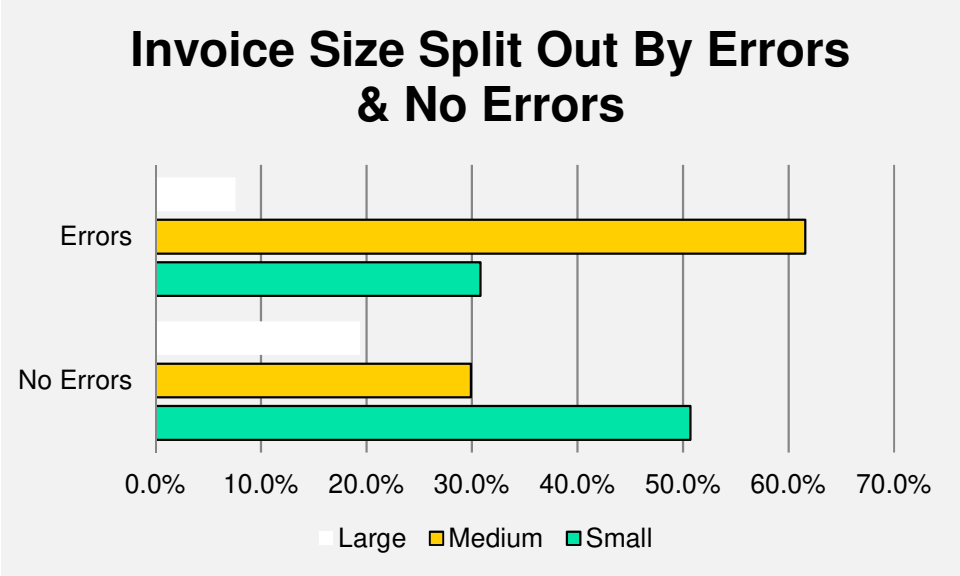
Visualizing Categorical Data: Side By Side Bar Charts

DCOVA

- The **side by side bar chart** represents the data from a contingency table.

	No Errors	Errors	Total
Small Amount	50.75%	30.77%	47.50%
Medium Amount	29.85%	61.54%	35.00%
Large Amount	19.40%	7.69%	17.50%
Total	100.0%	100.0%	100.0%



Invoices with errors are much more likely to be of medium size (61.5% vs 30.8% & 7.7%).

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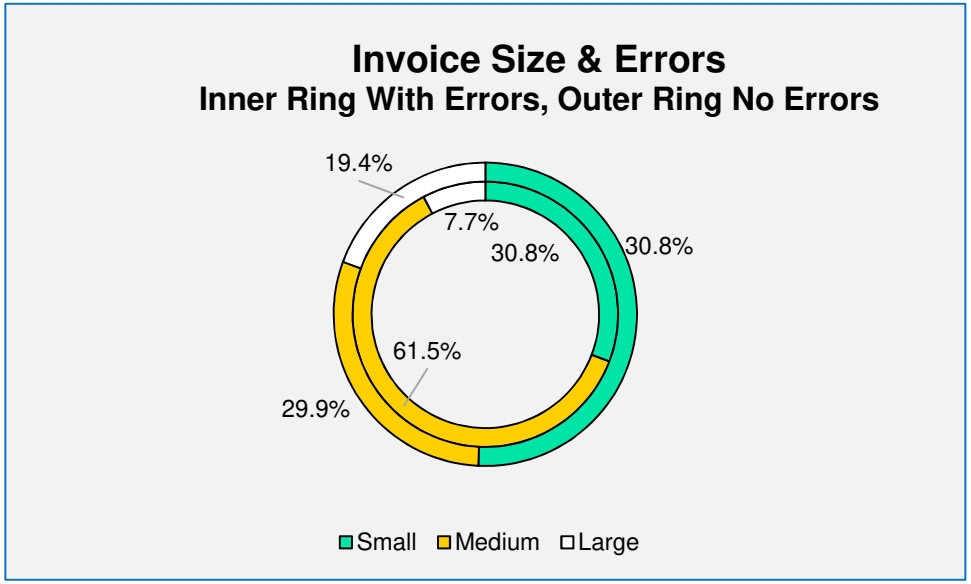
Visualizing Categorical Data: Doughnut Charts

DCOVA

- A **Doughnut Chart** can be used to represent the data from a contingency table.

	No Errors	Errors	Total
Small Amount	50.75%	30.77%	47.50%
Medium Amount	29.85%	61.54%	35.00%
Large Amount	19.40%	7.69%	17.50%
Total	100.0%	100.0%	100.0%



Invoices with errors are much more likely to be of medium size (61.5% vs 30.8% & 7.7%).

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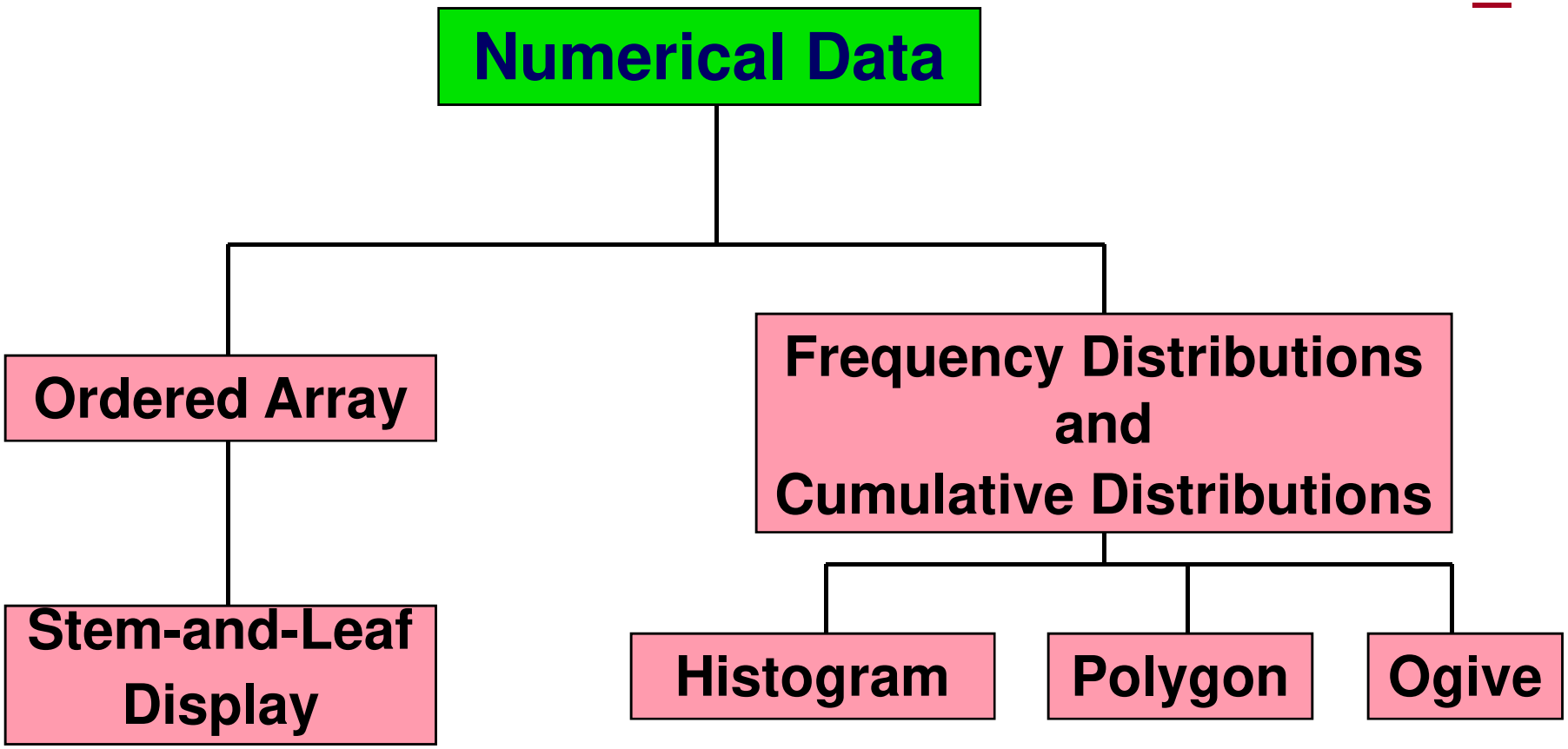
Visualizing Numerical Data By Using Graphical Displays

DCOVA



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Stem-and-Leaf Display

DCOVA

- A simple way to see how the data are distributed and where concentrations of data exist.

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

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Organizing Numerical Data: Stem and Leaf Display

DCOVA

- A **stem-and-leaf display** organizes data into groups (called stems) so that the values within each group (the leaves) branch out to the right on each row.

Age of Surveyed College Students						
	Day Students					
	16	17	17	18	18	18
	19	19	20	20	21	22
	22	25	27	32	38	42
	Night Students					
	18	18	19	19	20	21
	23	28	32	33	41	45

Age of College Students

Day Students

Stem	Leaf
1	67788899
2	0012257
3	28
4	2

Night Students

Stem	Leaf
1	8899
2	0138
3	23
4	15

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Visualizing Numerical Data: The Histogram

DCOVA

- A vertical bar chart of the data in a frequency distribution is called a **histogram.**
- In a histogram there are no gaps between adjacent bars.
- The **class boundaries** (or **class midpoints**) are shown on the horizontal axis.
- The vertical axis is either **frequency, relative frequency,** or **percentage**.
- The height of the bars represent the frequency, relative frequency, or percentage.

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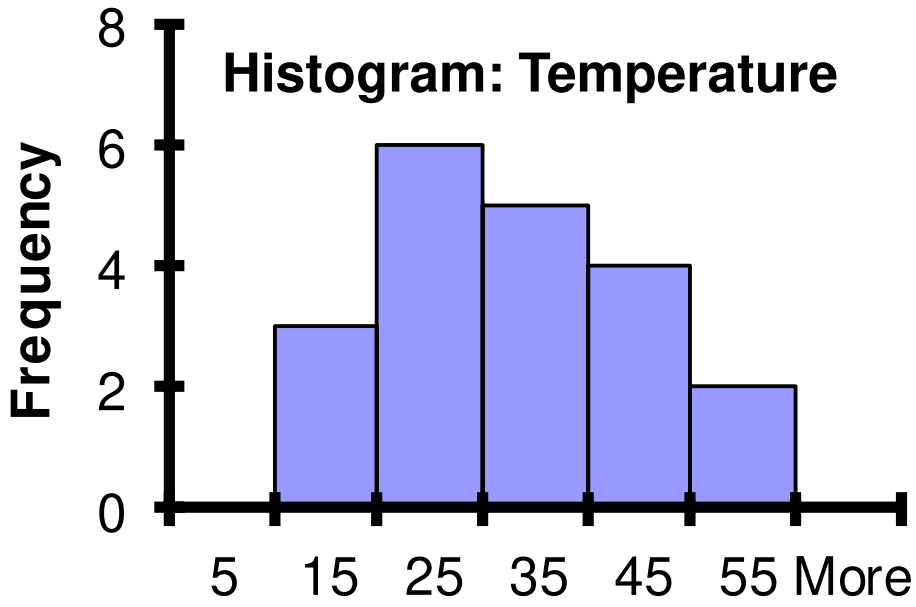
Visualizing Numerical Data: The Histogram

DCOVA

Class	Frequency	Relative Frequency	Percentage
10 but less than 20	3	.15	15
20 but less than 30	6	.30	30
30 but less than 40	5	.25	25
40 but less than 50	4	.20	20
50 but less than 60	2	.10	10
Total	20	1.00	100

(In a percentage histogram the vertical axis would be defined to show the percentage of observations per class).



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Visualizing Numerical Data: The Percentage Polygon

DCOVA

- A **percentage polygon** is formed by having the midpoint of each class represent the data in that class and then connecting the sequence of midpoints at their respective class percentages.

- The **cumulative percentage polygon,** or **ogive,** displays the variable of interest along the *X* axis, and the cumulative percentages along the *Y* axis.

- Useful when there are two or more groups to compare.

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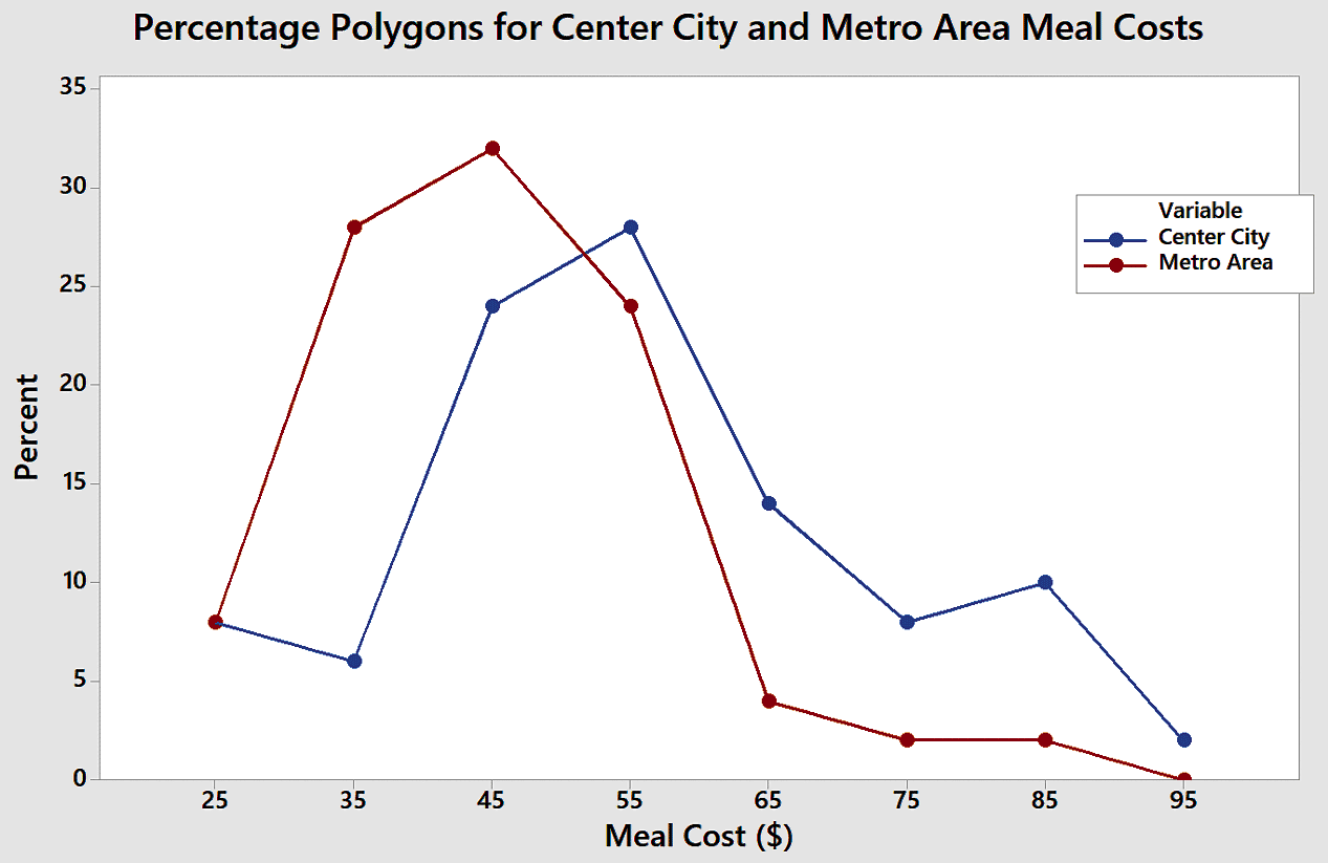
Visualizing Numerical Data: The Frequency Polygon

DCOVA

Useful When Comparing Two or More Groups



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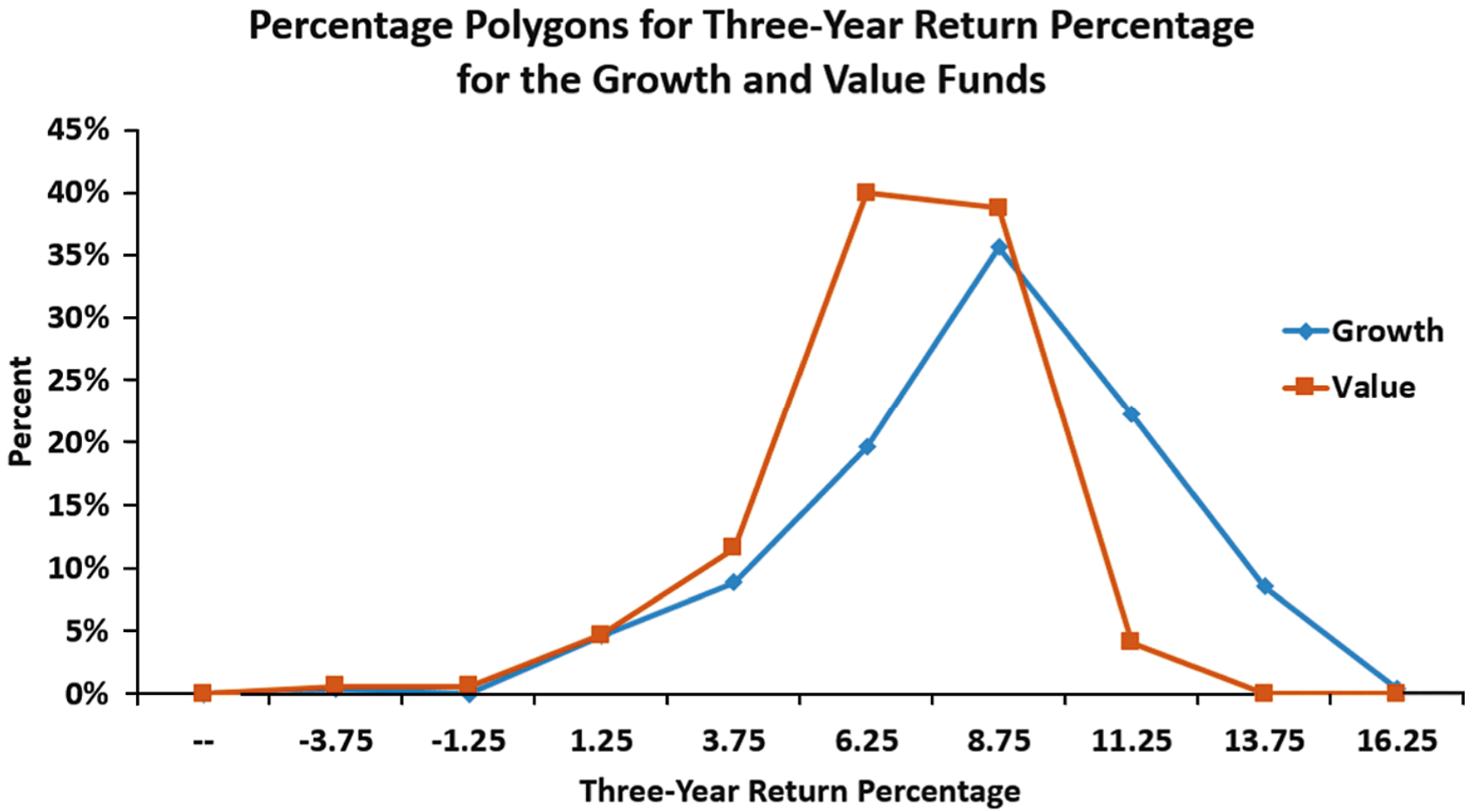
Visualizing Numerical Data: The Percentage Polygon

DCOVA



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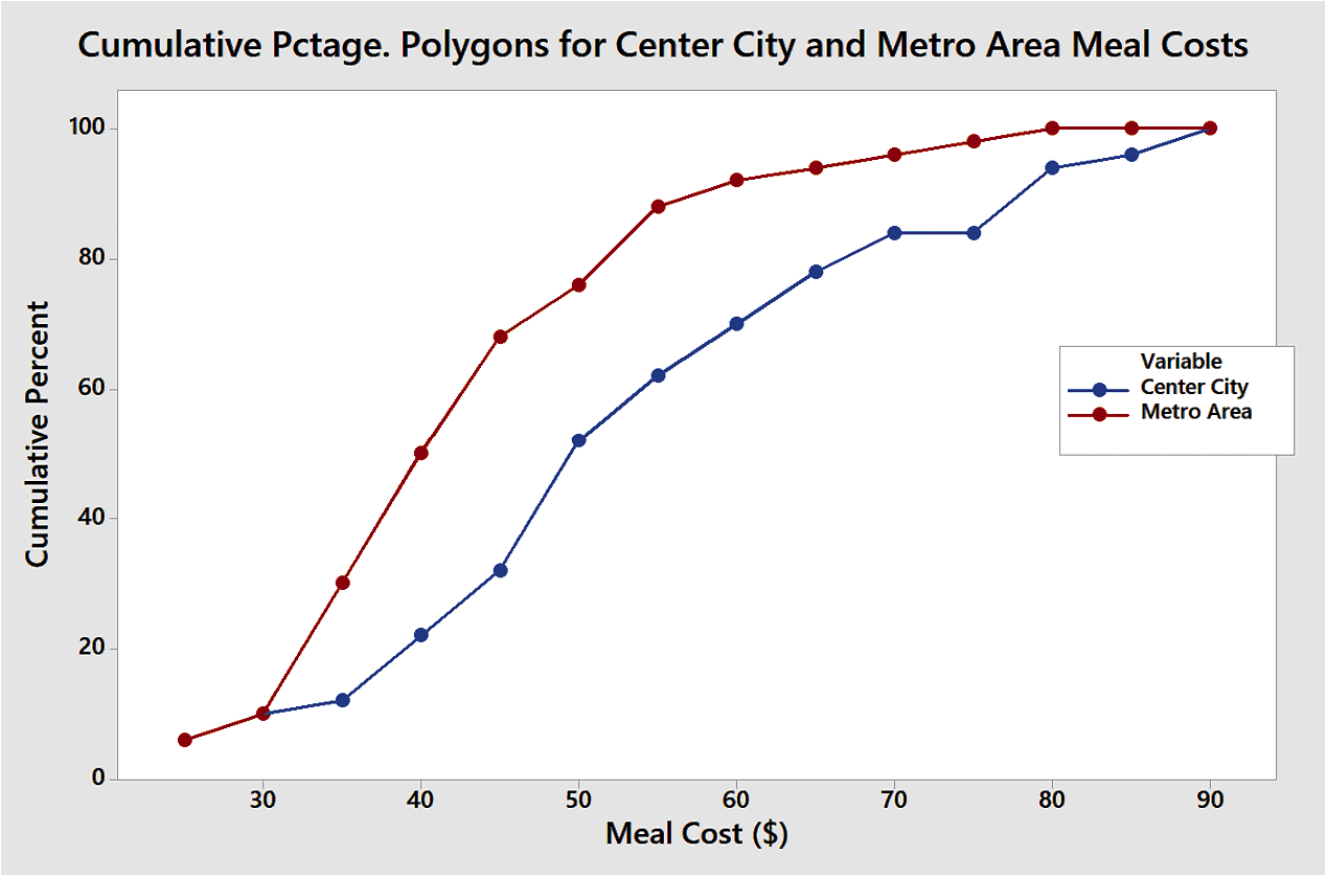
Visualizing Numerical Data: The Cumulative Percentage Polygon (Ogive)

DCOVA

Useful When Comparing Two or More Groups



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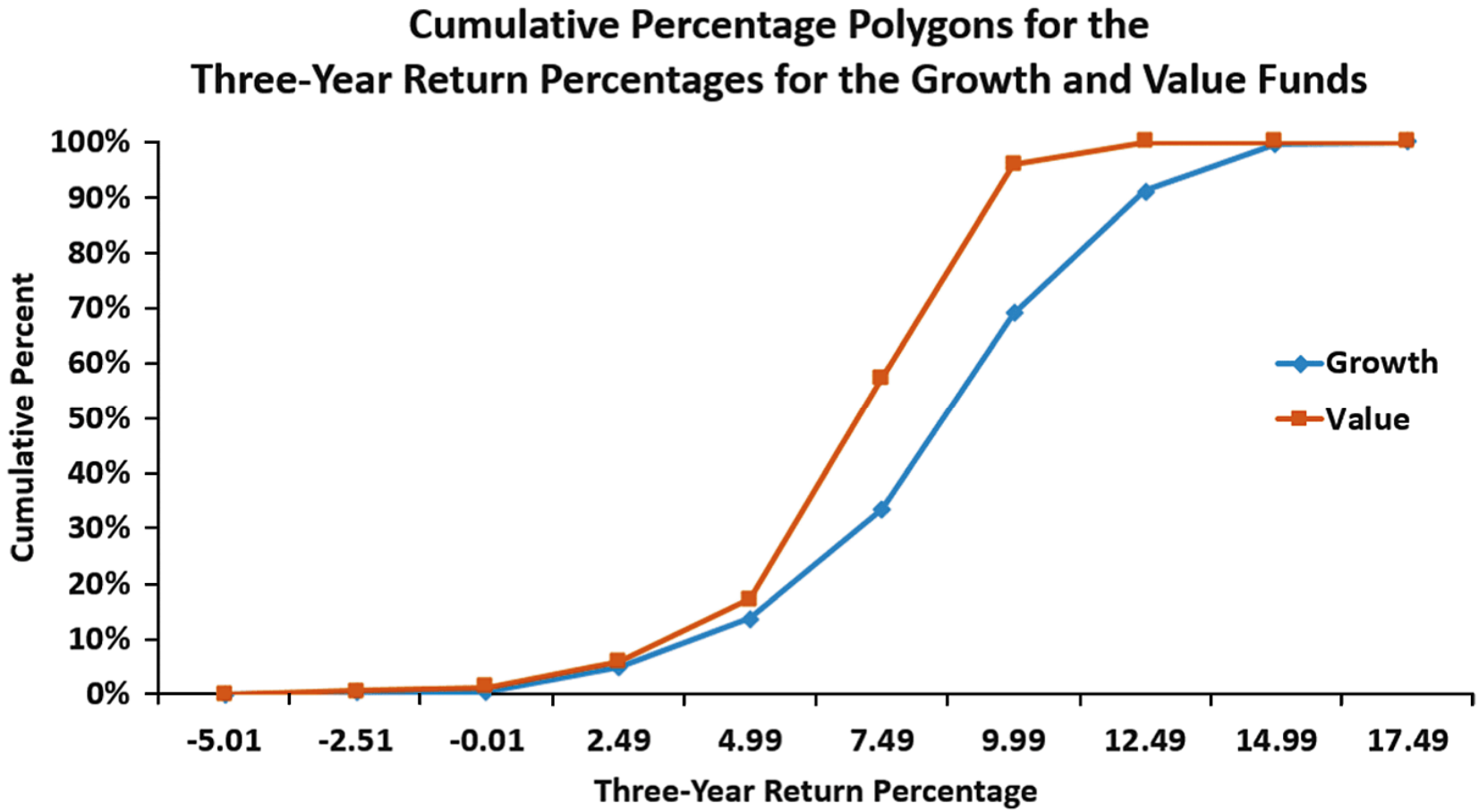
Visualizing Numerical Data: The Cumulative Percentage Polygon (Ogive)

DCOVA



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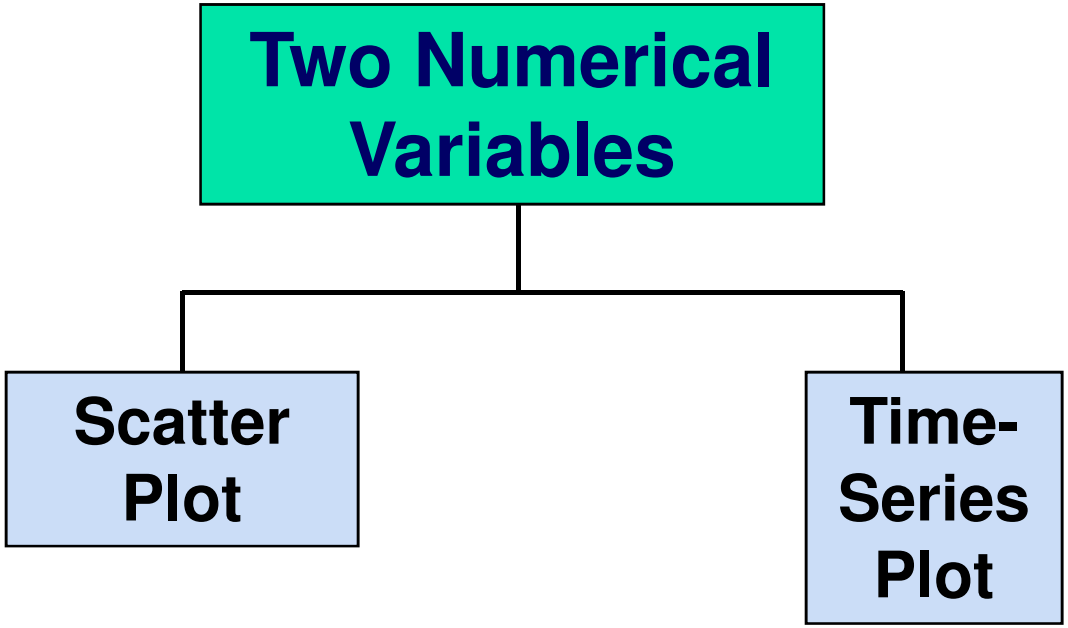
Visualizing Two Numerical Variables By Using Graphical Displays

DCOVA



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Visualizing Two Numerical Variables: The Scatter Plot

DCOVA

- **Scatter plots** are used for numerical data consisting of paired observations taken from two numerical variables.

- One variable's values are displayed on the horizontal or X axis and the other variable's values are displayed on the vertical or Y axis.

- Scatter plots are used to examine possible relationships between two numerical variables.

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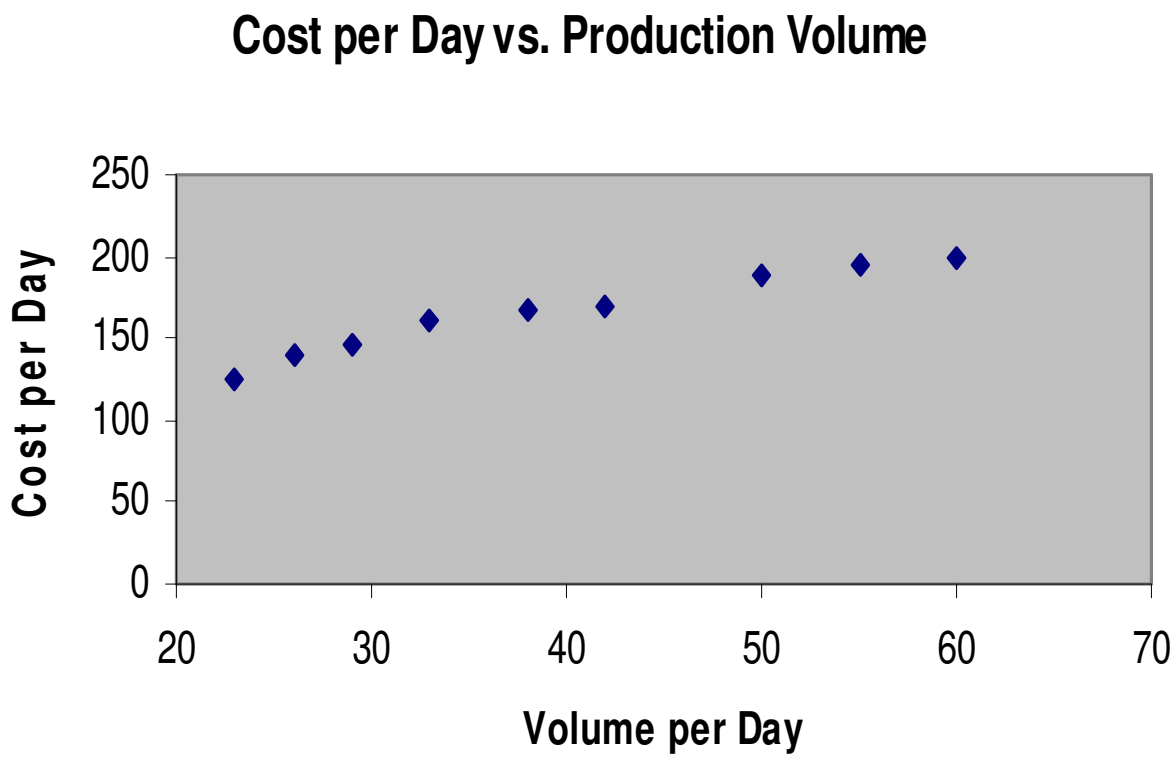
Scatter Plot Example

DCOVA

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



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Visualizing Two Numerical Variables: The Time Series Plot

DCOVA

- A Time-Series Plot is used to study patterns in the values of a numeric variable over time.

- The Time-Series Plot:
  - Numeric variable's values are on the vertical axis and the time period is on the horizontal axis.

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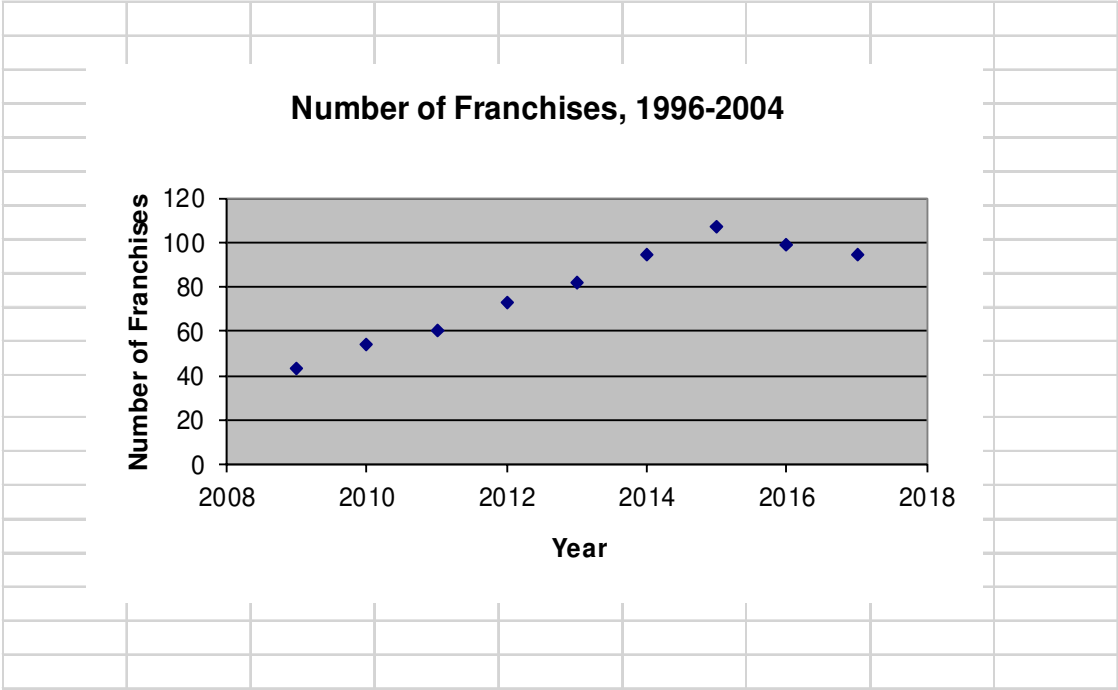
Time Series Plot Example

DCOVA

Year	Number of Franchises
2009	43
2010	54
2011	60
2012	73
2013	82
2014	95
2015	107
2016	99
2017	95



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Organizing A Mix Of Variables: The Multidimensional Contingency Table

DCOVA

- A multidimensional contingency table is constructed by tallying the responses of three or more categorical variables.
  - Can be used to discover possible patterns and relationships in multidimensional data that simpler tables and charts would fail to make apparent.

- As a practical rule, tables should be limited to no more than three or four variables.

- In typical use, these tables:
  - Extend contingency tables to two or more row or column variables, or
  - Replace the frequencies found in a contingency table with summary information about a numeric variable.

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A Multidimensional Contingency Table Tallies Responses Of Three or More Categorical Variables

DCOVA

Two Dimensional Table Showing Fund Type and Risk Level for sample of 479 retirement funds.

	Risk Level			
Fund Type	Low	Average	High	Grand Total
Growth	13.15%	31.73%	19.00%	63.88%
Value	17.54%	15.03%	3.55%	36.12%
Grand Total	30.69%	46.76%	22.55%	100.00%

Three Dimensional Table Showing Fund Type, Market Cap, and Risk Level for the sample of the 479 retirement funds.

	Risk Level			
Fund Type	Low	Average	High	Grand Total
⊟Growth	13.2%	31.7%	19.0%	63.88%
Large	9.6%	19.0%	3.5%	32.2%
MidCap	3.3%	9.4%	5.2%	18.0%
Small	0.2%	3.3%	10.2%	13.8%
⊟Value	17.5%	15.0%	3.5%	36.1%
Large	14.6%	7.9%	0.6%	23.2%
MidCap	2.1%	3.5%	0.8%	6.5%
Small	0.8%	3.5%	2.1%	6.5%
Grand Total	30.69%	46.76%	22.55%	100.00%

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Excel, Minitab, and JMP Can Be Used To Create Multidimensional Contingency Tables

DCOVA

- In Excel creating a Pivot Table yields an interactive display of this type.
- In JMP you can create a table that is also interactive.
- In Minitab you can create such a table but it is not interactive.
- JMP and Minitab have many specialized statistical & graphical procedures (not covered in this book) to analyze & visualize multidimensional data.

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Drilling-Down On A Table Reveals The Data The Table Summarizes

DCOVA

- Clicking a cell in an Excel table displays the rows of data associated with that cell.
- Clicking a cell in a JMP table highlights those the rows of data that are the source for that cell.
- Drill-down is perhaps the simplest form of data discovery.

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Drill-Down Reveals The Data Underlying A Higher-Level Summary

DCOVA

Mean 10YrReturn	Risk Level			
Fund Type	Average	High	Low	Grand Total
Growth	7.78	7.19	8.06	7.66
Large	7.91	7.88	8.04	7.94
MidCap	7.41	6.60	8.10	7.30
Small	8.14	7.25	8.47	7.49
Value	6.52	5.97	6.45	6.43
Large	5.87	4.18	6.30	6.10
MidCap	7.69	6.15	6.99	7.27
Small	6.79	6.43	7.61	6.78
Grand Total	7.38	7.00	7.14	7.22

Results of drilling down to the details about small value funds with low risk revealing the ten-year return ranges from 4.83% to 9.44%.

	F	G	H	I	J	K	L	M	N	O
1	Turnover Ratio	SD	Sharpe Ratio	Beta	1YrReturn	3YrReturn	5YrReturn	10YrReturn	Expense Ratio	Star Rating
2	75.00	4.67	0.53	0.20	4.74	2.53	4.82	9.44	1.40	Four
3	23.00	9.61	0.72	0.84	7.74	6.95	8.17	7.30	1.28	Four
4	30.10	10.71	0.70	0.55	5.88	7.60	7.74	4.83	1.70	Two
5	37.00	11.73	0.71	0.79	6.02	8.45	9.29	8.85	0.81	Four

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Displays To Visualize A Mix Of Many Variables

DCOVA

- Displays are more useful than a multidimensional contingency table with many row and column variables.
- The data (not just summary statistics) can be shown for numerical variables.
- Multiple numerical variables can be presented in one summarization.
- Visualizations can reveal patterns that can be hard to see in tables.

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Colored Scatter Plots Visualize Both Numerical Variables & Categorical Variable(s)

DCOVA

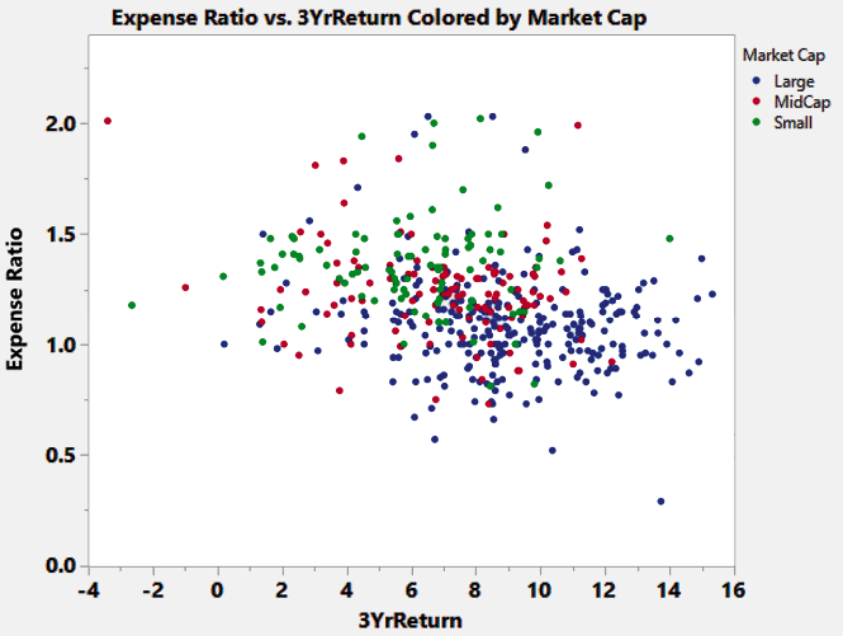
Observations:

- Large Market Capitalization Funds (red dots)

  1. Relatively have best returns and lowest expense ratios.

  2. Some have either low returns or high expense ratios or both.

JMP Colored Scatter Plot



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Bubble Charts Extend Scatter Plots

DCOVA

- Use the size of points (called bubbles) to represent the value of an additional variable.
- In Excel and Minitab the additional variable must be numerical.
- In JMP the variable can be either numerical or categorical.

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An Excel PivotChart Visualizes Specific Categories From A PivotTable Summary

DCOVA

Mean 10YrReturn	Risk Level			
Fund Type	Average	High	Low	Grand Total
Growth	7.78	7.19	8.06	7.66
Large	7.91	7.88	8.04	7.94
MidCap	7.41	6.60	8.10	7.30
Small	8.14	7.25	8.47	7.49
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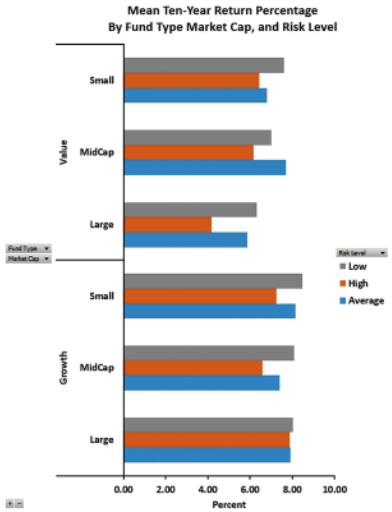
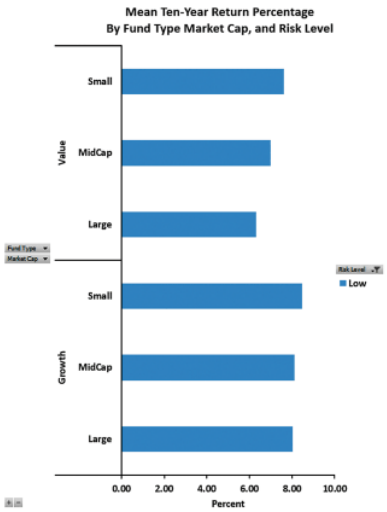
Large	5.87	4.18	6.30	6.10
MidCap	7.69	6.15	6.99	7.27
Small	6.79	6.43	7.61	6.78
Grand Total	7.38	7.00	7.14	7.22

Low Risk Small Market Cap Funds Have The Highest Mean Return Among Low Risk Funds.





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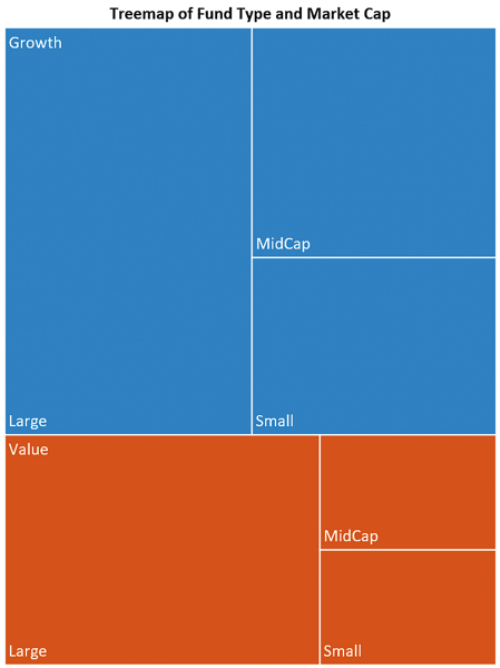
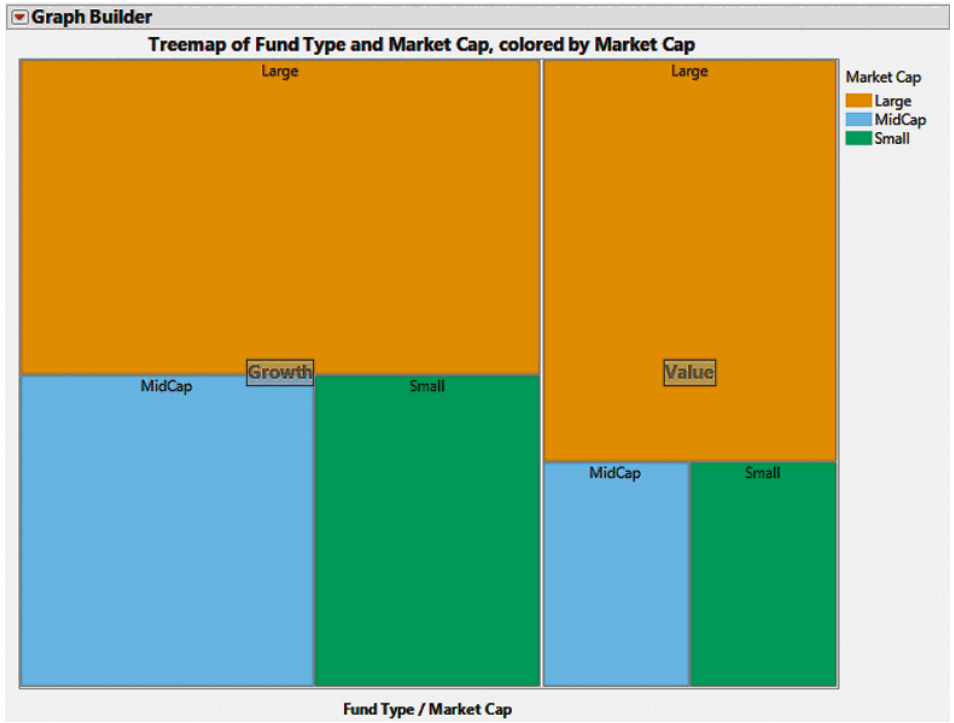
Treemaps Are Graphical Displays Of Contingency Tables

DCOVA

Excel Treemap:
Size of tiles correspond to the frequency in a cell.



JMP Treemap:
Size of tiles correspond to the value of the numeric variable Market Cap.



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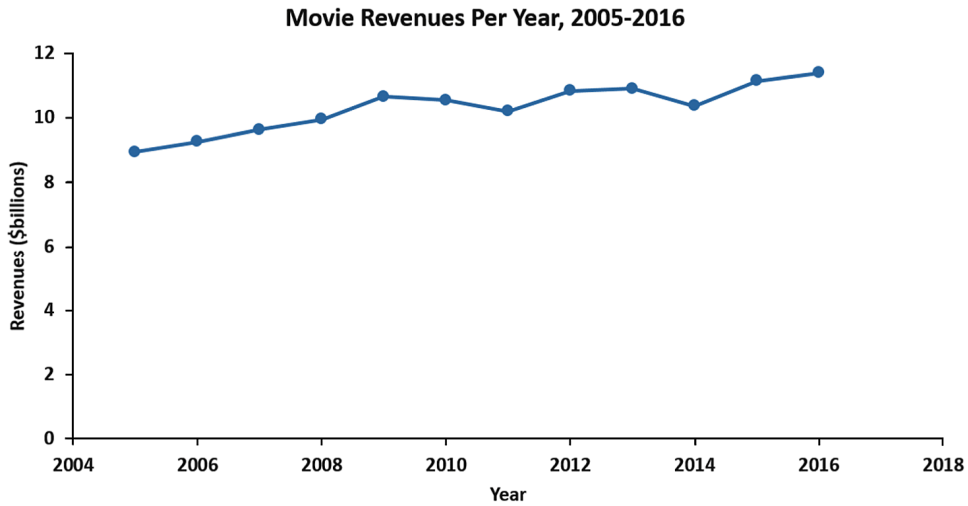
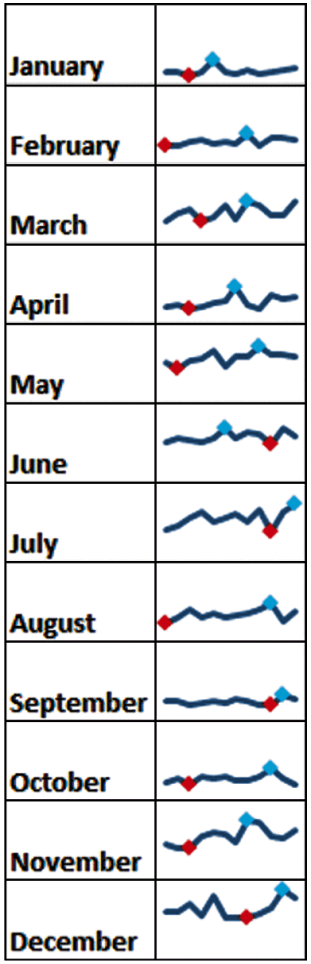
Sparklines Are Compact Time-Series Visualizations Of Numerical Variables

DCOVA



Movie revenues by week per month



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Filtering and Querying Data

DCOVA

- Two operations associated with preparing tabular or visual summaries are Data Filtering and Querying.
- Data filtering selects rows of data that match criteria; specified value(s) for specific variable(s).
- Data Querying is similar but may not select all of the columns of the matching rows.
- Excel, JMP, and Minitab all have various filtering & query features.

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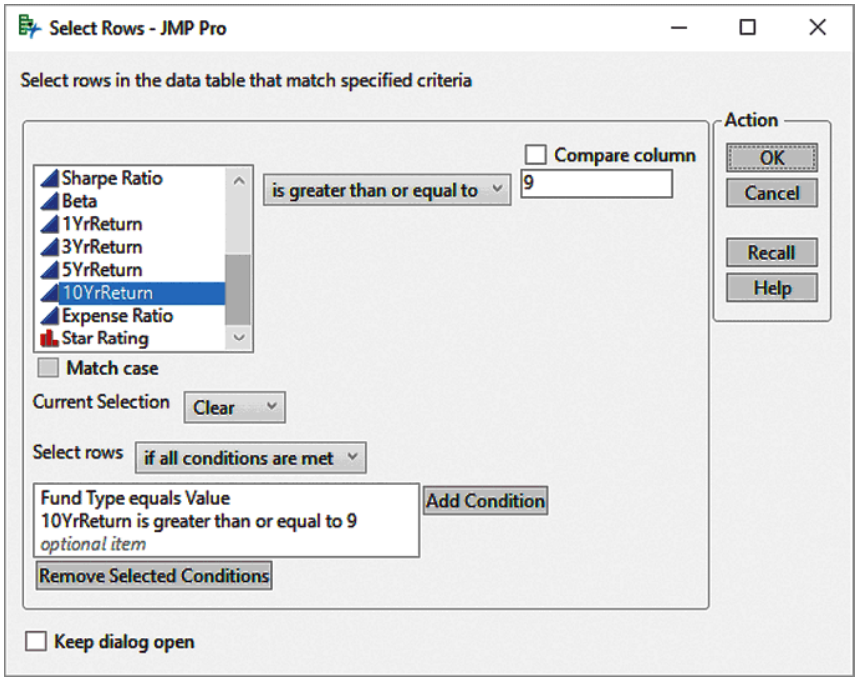
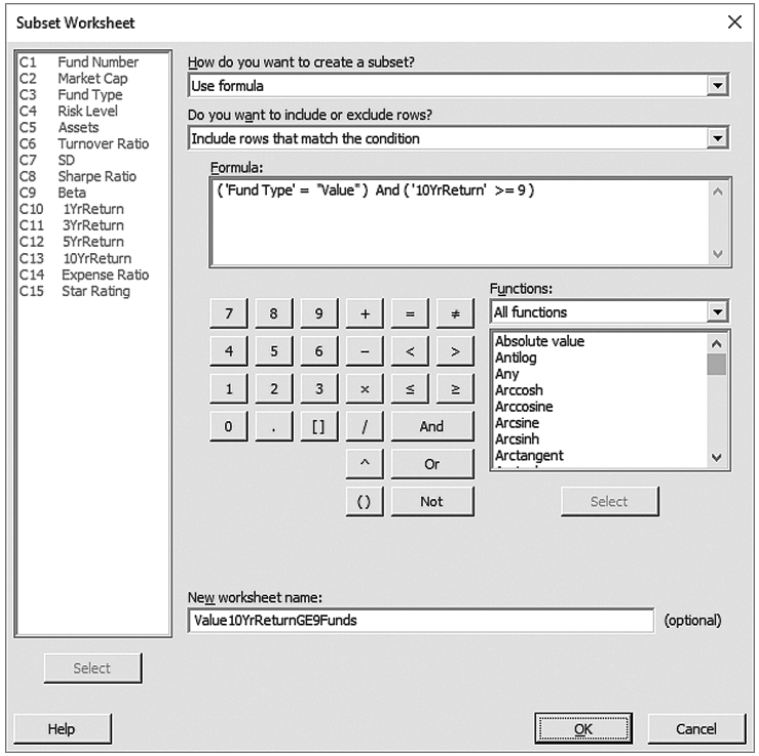
Example Of JMP & Minitab Filtering / Querying

DCOVA

Selecting all rows in value retirement funds that have ten-year return percentages that are greater than or equal to 9.





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Excel Slicers Filter & Query Data From A Pivot Table

DCOVA

- A slicer is a panel of clickable buttons superimposed over a worksheet.
- Each button in a slicer represents a unique value of a variable found in a the source data of a PivotTable.
- By clicking buttons in the slicer panels, you query the data.

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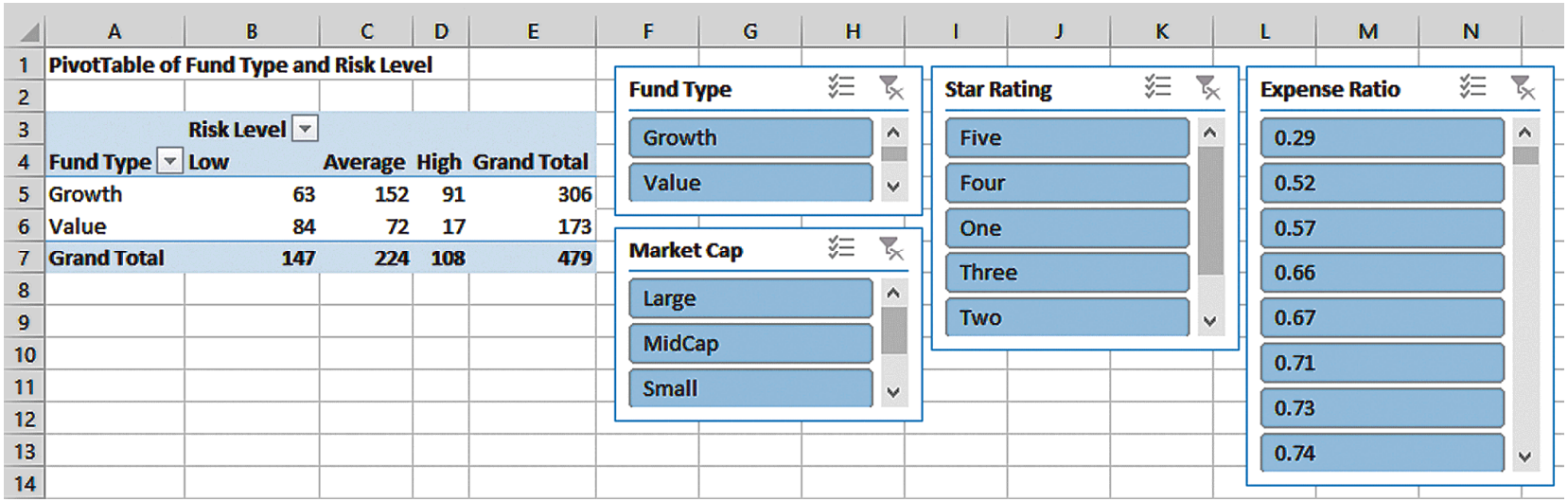
Example Of Slicers For The Retirement Funds Workbook

DCOVA

With the four slicers below, you can ask questions such as:

1. What are the attributes of the fund(s) with the lowest expense ratio?
2. What are the expense ratios associated with large market cap value funds that have a star rating of five?



PivotTable of Fund Type and Risk Level

Fund Type	Risk Level: Low	Average	High	Grand Total
Growth	63	152	91	306
Value	84	72	17	173
Grand Total	147	224	108	479

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Answering The Questions

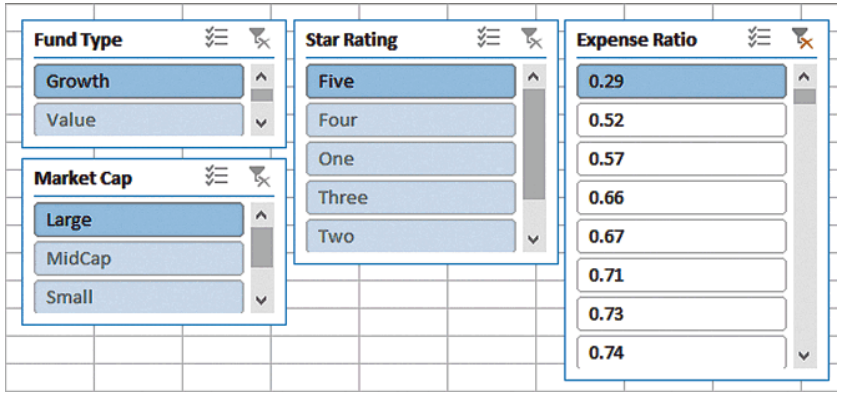
DCOVA

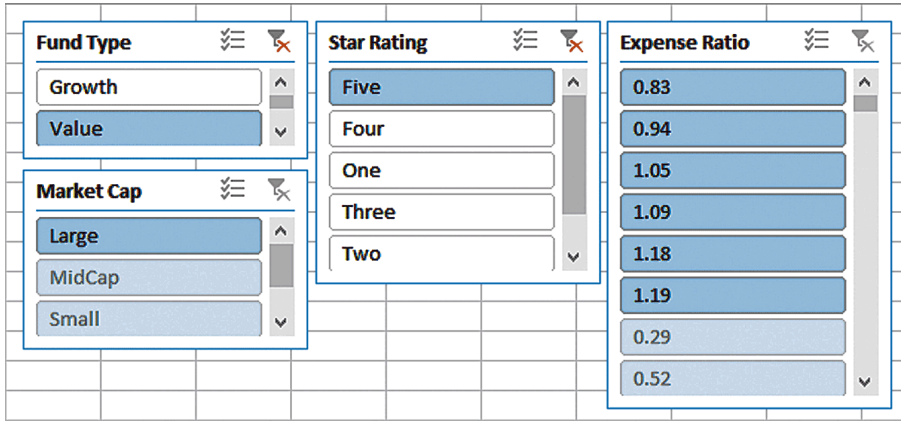
What are the attributes of the fund(s) with the lowest expense ratio?

The updated PivotTable (not shown below) reveals only one such fund.

What are the expense ratios associated with large market cap value funds that have a star rating of five?

The expense ratios for these funds are: 0.83, 094, 1.05, 1.09, 1.18, and 1.19.





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The Challenges in Organizing and Visualizing Variables

DCOVA

- When organizing and visualizing data need to be mindful of:
  - The limits of other's ability to perceive and comprehend.
  - Presentation issues that can undercut the usefulness of methods from this chapter.
- It is easy to create summaries that:
  - Obscure the data or
  - Create false impressions.
  - Contain Chartjunk

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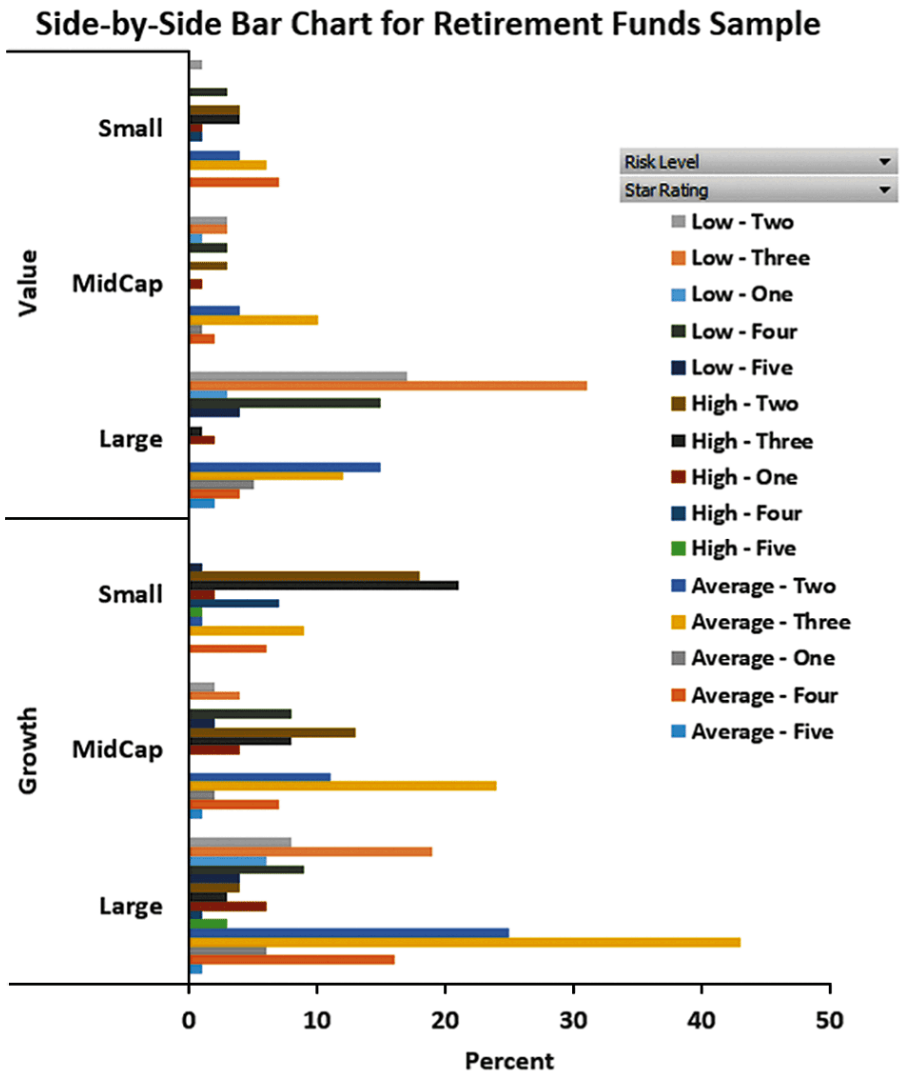
An Example Of Obscuring Data, Information Overload

DCOVA



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False Impressions Can Be Created In Many Ways

DCOVA

- Selective summarization:
  - Presenting only part of the data collected.
- Improperly constructed charts:
  - Potential pie chart issues.
  - Improperly scaled axes.
  - A Y axis that does not begin at the origin or is a broken axis missing intermediate values.
- Chartjunk.

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An Example of Selective Summarization, These Two Summarizations Tell Totally Different Stories

DCOVA

Company	Change from Prior Year
A	+7.2%
B	+24.4%
C	+24.9%
D	+24.8%
E	+12.5%
F	+35.1%
G	+29.7%

Company	Year 1	Year 2	Year 3
A	-22.6%	-33.2%	+7.2%
B	-4.5%	-41.9%	+24.4%
C	-18.5%	-31.5%	+24.9%
D	-29.4%	-48.1%	+24.8%
E	-1.9%	-25.3%	+12.5%
F	-1.6%	-37.8%	+35.1%
G	+7.4%	-13.6%	+29.7%

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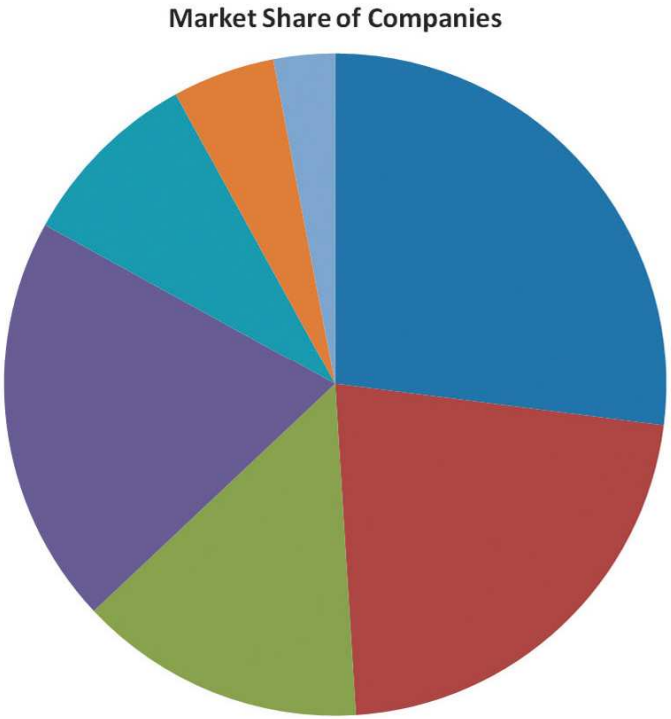
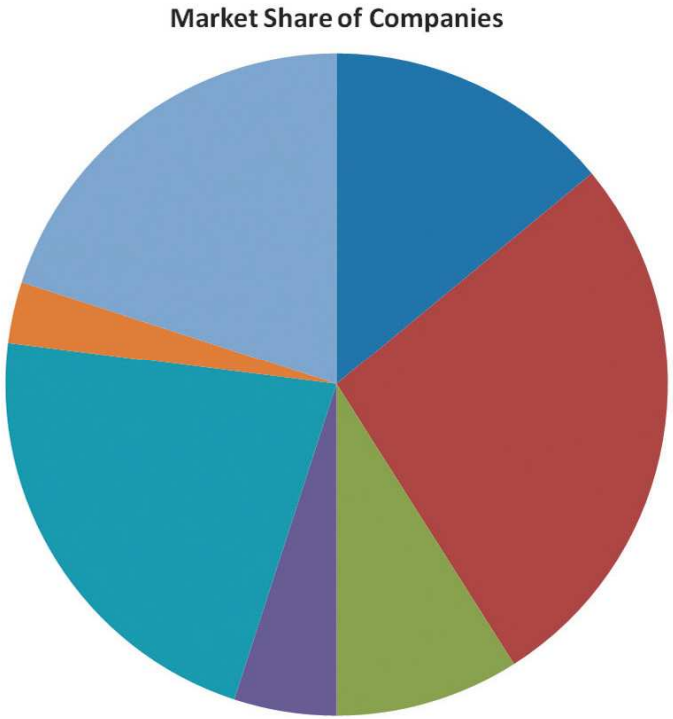
How Obvious Is It That Both Pie Charts Summarize The Same Data?

DCOVA





Why is it hard to tell? What would you do to improve?

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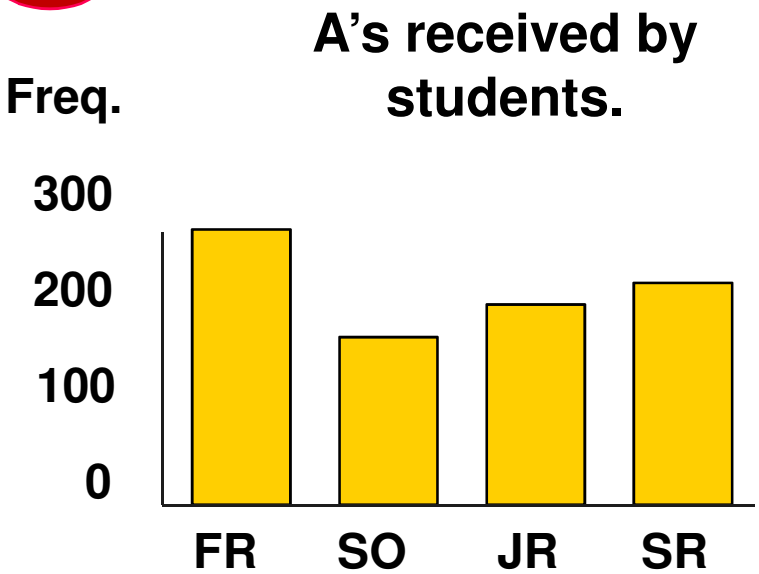
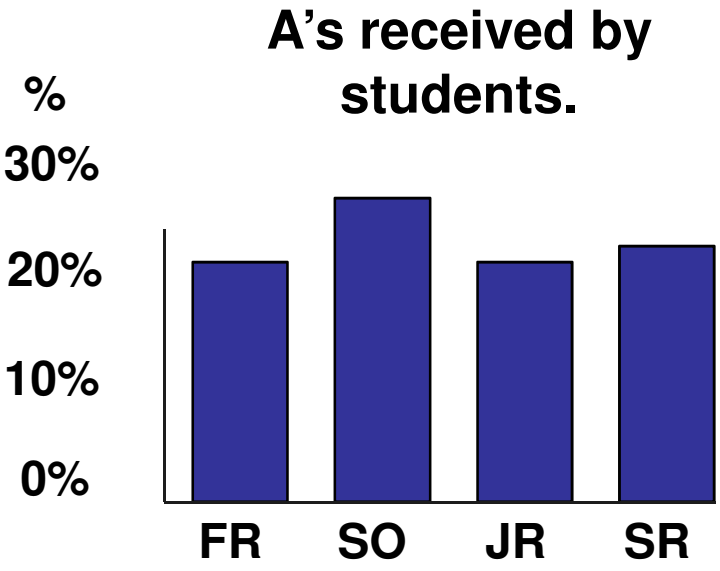
Graphical Errors: No Relative Basis

DCOVA

Bad Presentation



✓ Good Presentation



FR = Freshmen, SO = Sophomore, JR = Junior, SR = Senior

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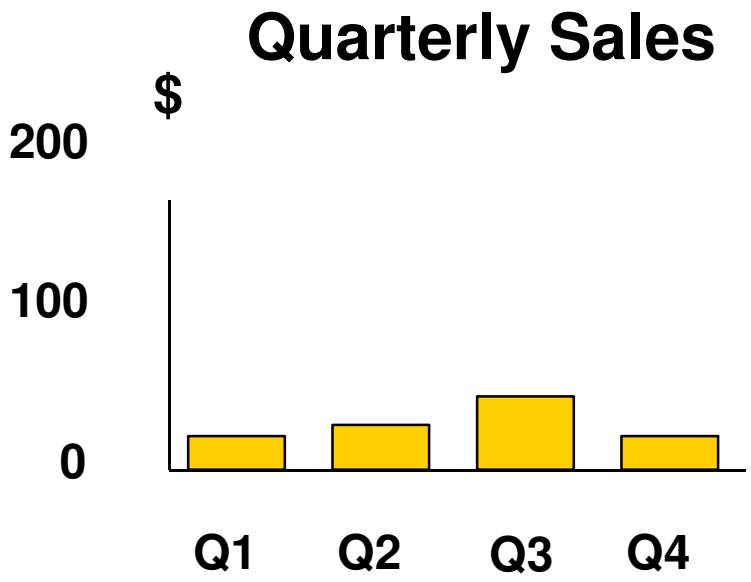
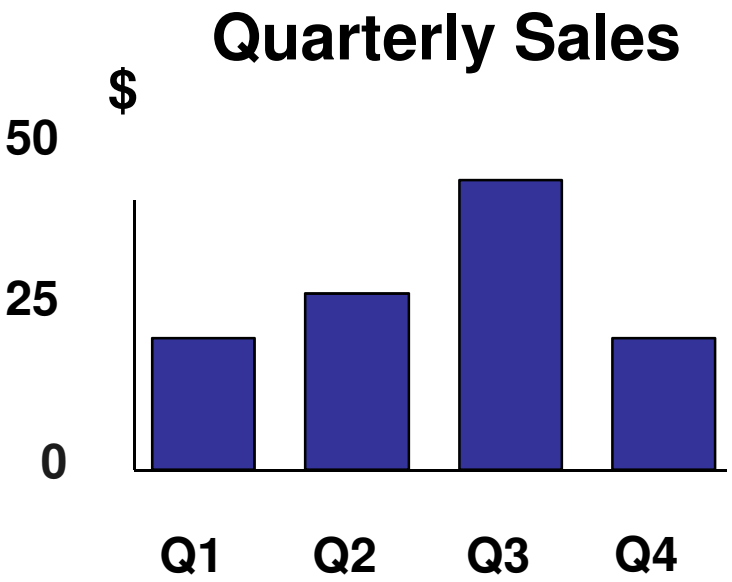
Graphical Errors: Compressing the Vertical Axis

DCOVA

Bad Presentation



Good Presentation



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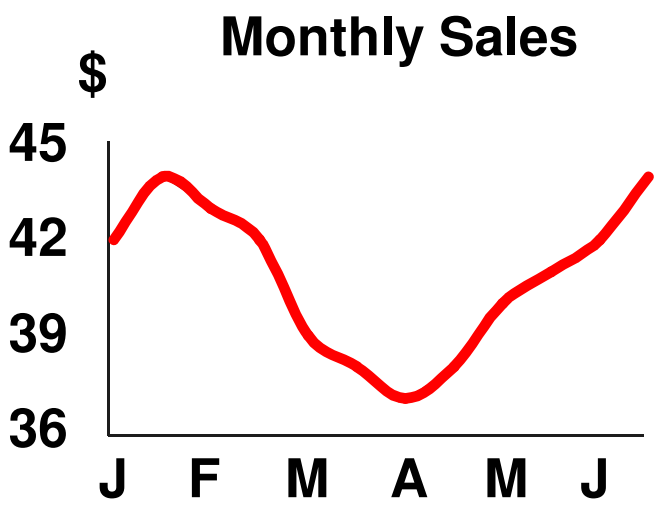
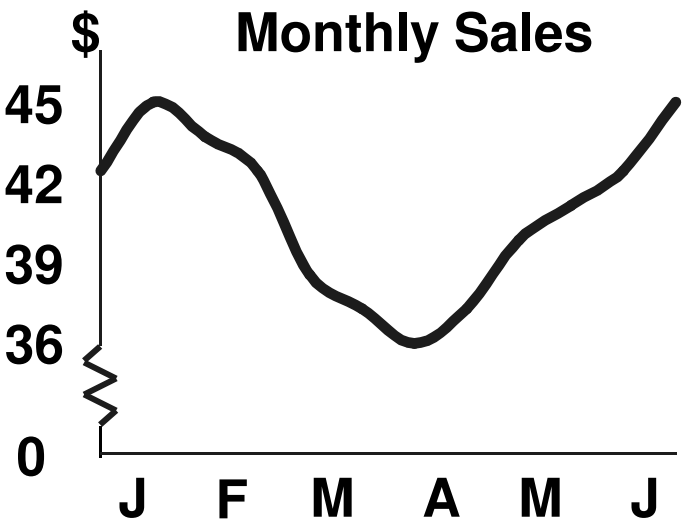
Graphical Errors: No Zero Point on the Vertical Axis

DCOVA

Bad Presentation



Good Presentations



Graphing the first six months of sales

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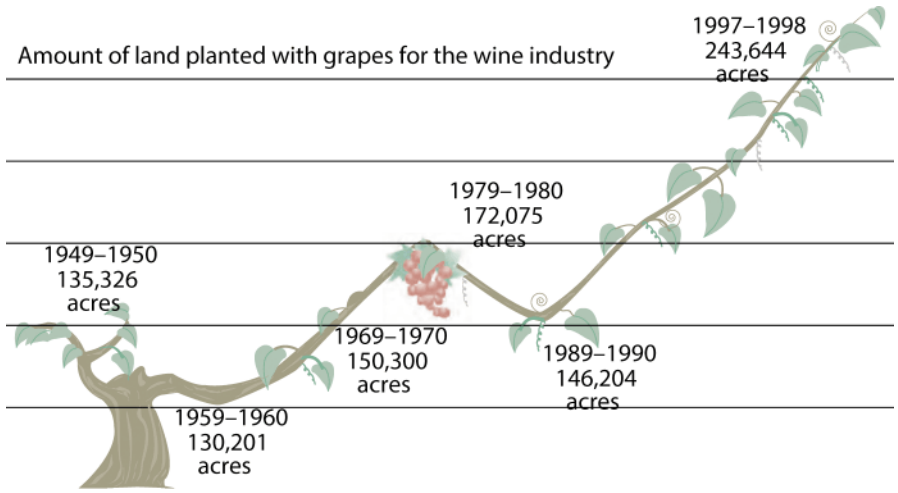
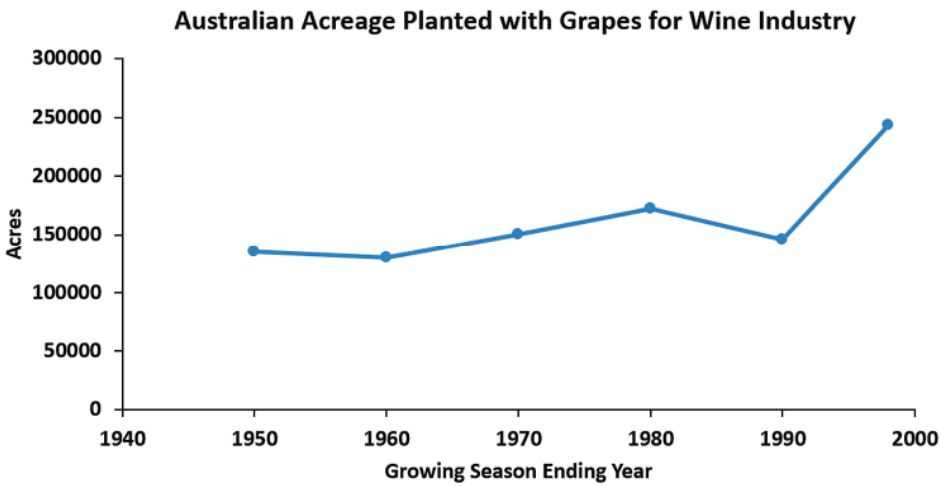
Graphical Errors: Chart Junk, Can You Identify The Junk?

DCOVA

Bad Presentation



✓ Good Presentation



Left illustration adapted from S. Watterson, "Liquid Gold—Australians Are Changing the World of Wine. Even the French Seem Grateful." Time, November 22, 1999, p. 68-69

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Best Practices for Constructing Visualizations

DCOVA

- Use the simplest possible visualization.
- Include a title & label all axes.
- Include a scale for each axis if the chart contains axes.
- Begin the scale for a vertical axis at zero & use a constant scale.
- Avoid 3D or "exploded" effects & the use of chartjunk.
- Use consistent colorings in charts meant to be compared.
- Avoid using uncommon chart types including radar, surface, bubble, cone, and pyramid charts.

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Chapter Summary

In this chapter we covered:

- Organizing and visualizing categorical variables.
- Organizing and visualizing numerical variables.
- Summarizing a mix of variables.
- Avoiding common errors when organizing and visualizing variables.

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