Knowledge Discovery & Data Mining
– Data Exploration: Data Visualization–

Instructor: Yong Zhuang

yong.zhuang@gvsu.edu

Based on the original version by Professor Yizhou Sun

Outline

- Data Visualization
  - Quantile plot
  - Quantile-Quantile (Q-Q) plot
  - Histograms
  - Pie chart
  - Scatter plots

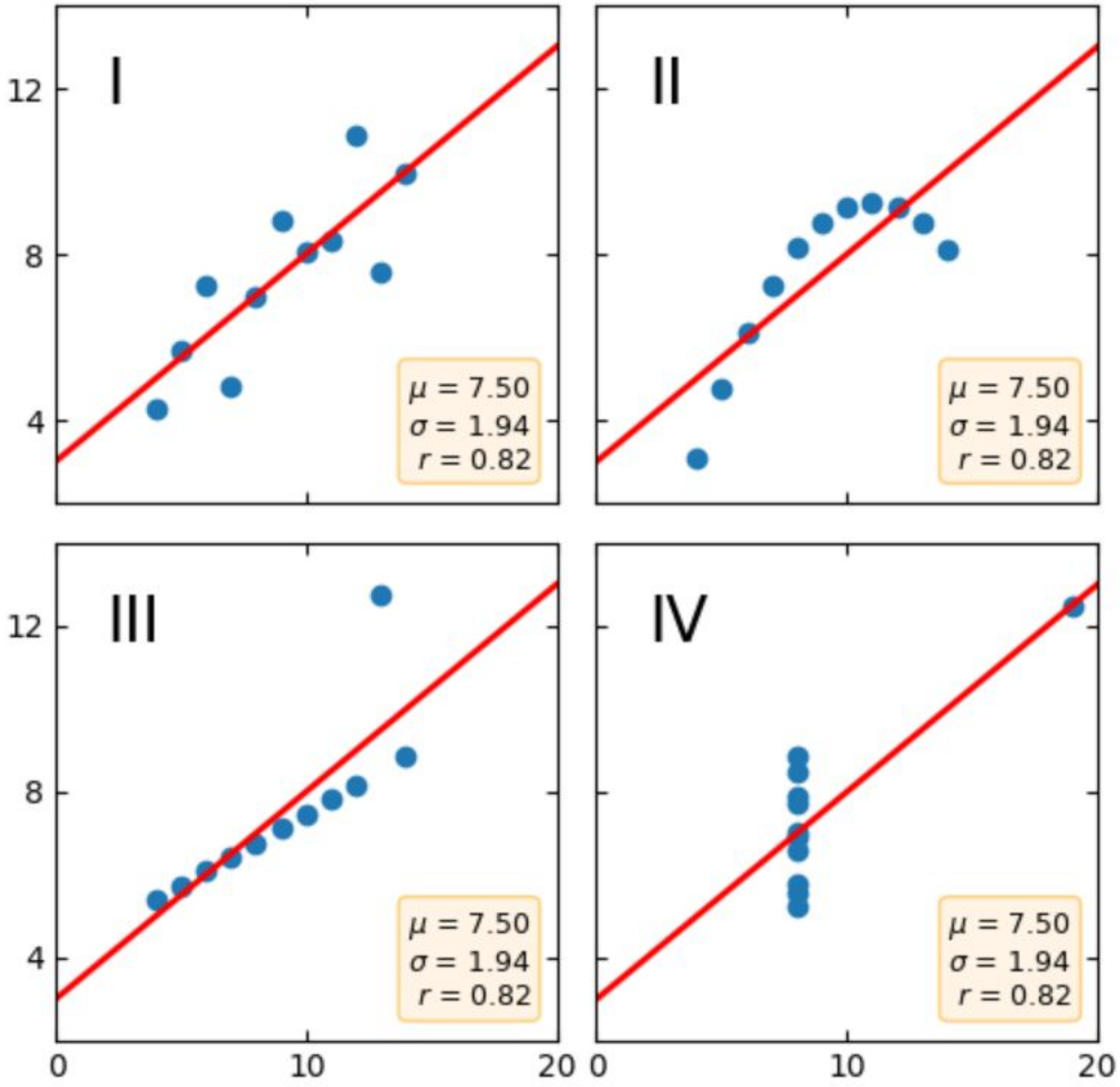
Why Data Visualization?

- The following four data sets comprise the Anscombe's Quartet; all four sets of data have identical simple summary statistics.

	Dataset I		Dataset II		Dataset III		Dataset IV	
	x	y	x	y	x	y	x	y
	10	8.04	10	9.14	10	7.46	8	6.58
	8	6.95	8	8.14	8	6.77	8	5.76
	13	7.58	13	8.74	13	12.74	8	7.71
	9	8.81	9	8.77	9	7.11	8	8.84
	11	8.33	11	9.26	11	7.81	8	8.47
	14	9.96	14	8.1	14	8.84	8	7.04
	6	7.24	6	6.13	6	6.08	8	5.25
	4	4.26	4	3.1	4	5.39	19	12.5
	12	10.84	12	9.13	12	8.15	8	5.56
	7	4.82	7	7.26	7	6.42	8	7.91
	5	5.68	5	4.74	5	5.73	8	6.89
Sum:	99.00	82.51	99.00	82.51	99.00	82.51	99.00	82.51
Avg:	9.00	7.50	9.00	7.50	9.00	7.50	9.00	7.50
Std:	3.32	2.03	3.32	2.03	3.32	2.03	3.32	2.03

Anscombe's Quartet

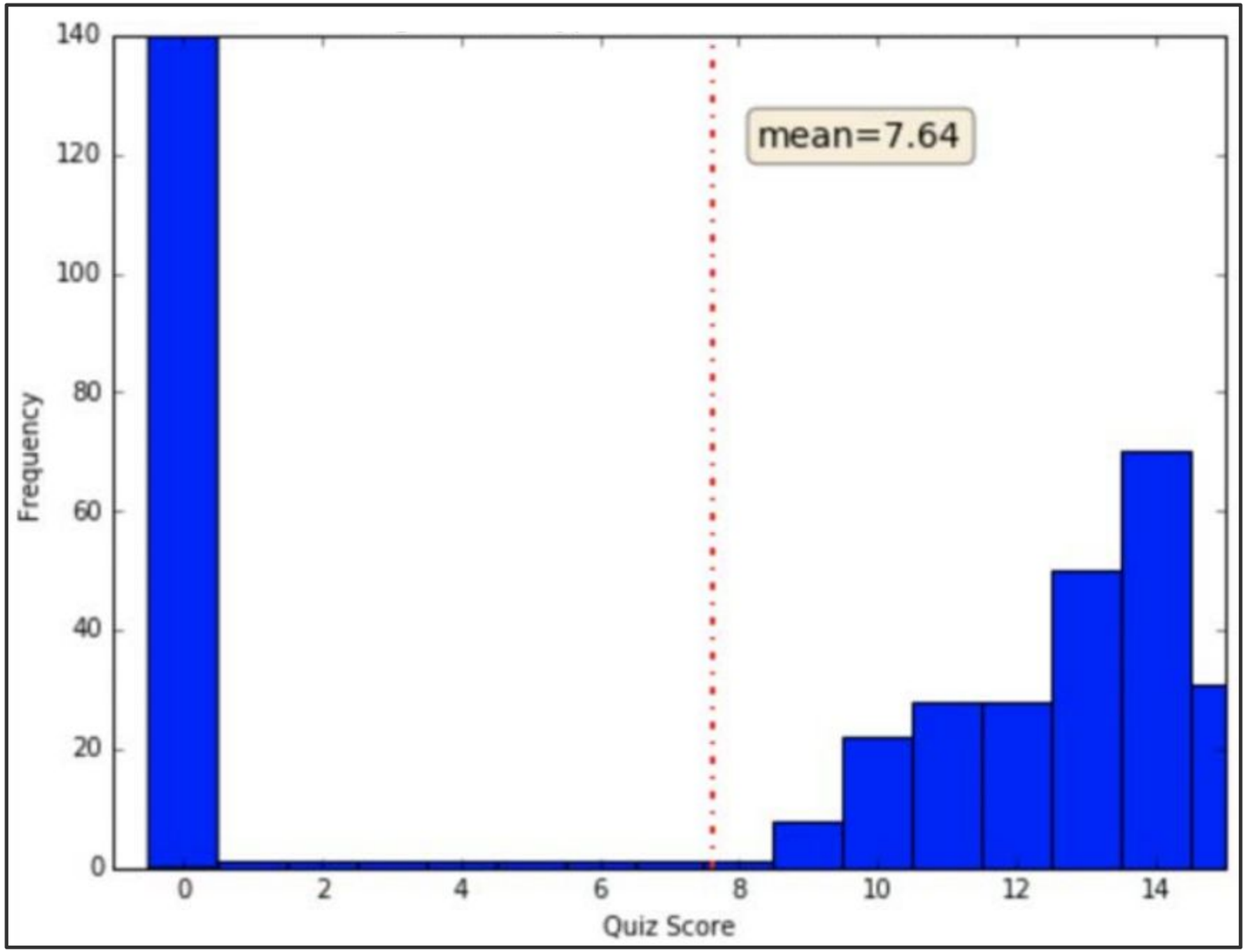
- Summary statistics clearly don’t tell the story of how they differ.
- A picture can be worth a thousand words.



More Visualization Motivation

- If I tell you that the average score for a Homework is: **7.64** / **15** = 50.9%, what does that suggest?

- And what does this graph suggest?



Types of Visualizations

- What do you want your visualization to show about your data?
  - **Distribution:** how a variable or variables in the dataset distribute over a range of possible values.
  - **Relationship:** how the values of multiple variables in the dataset relate
  - **Composition:** how the dataset breaks down into subgroups
  - **Comparison:** how trends in multiple variable or datasets compare

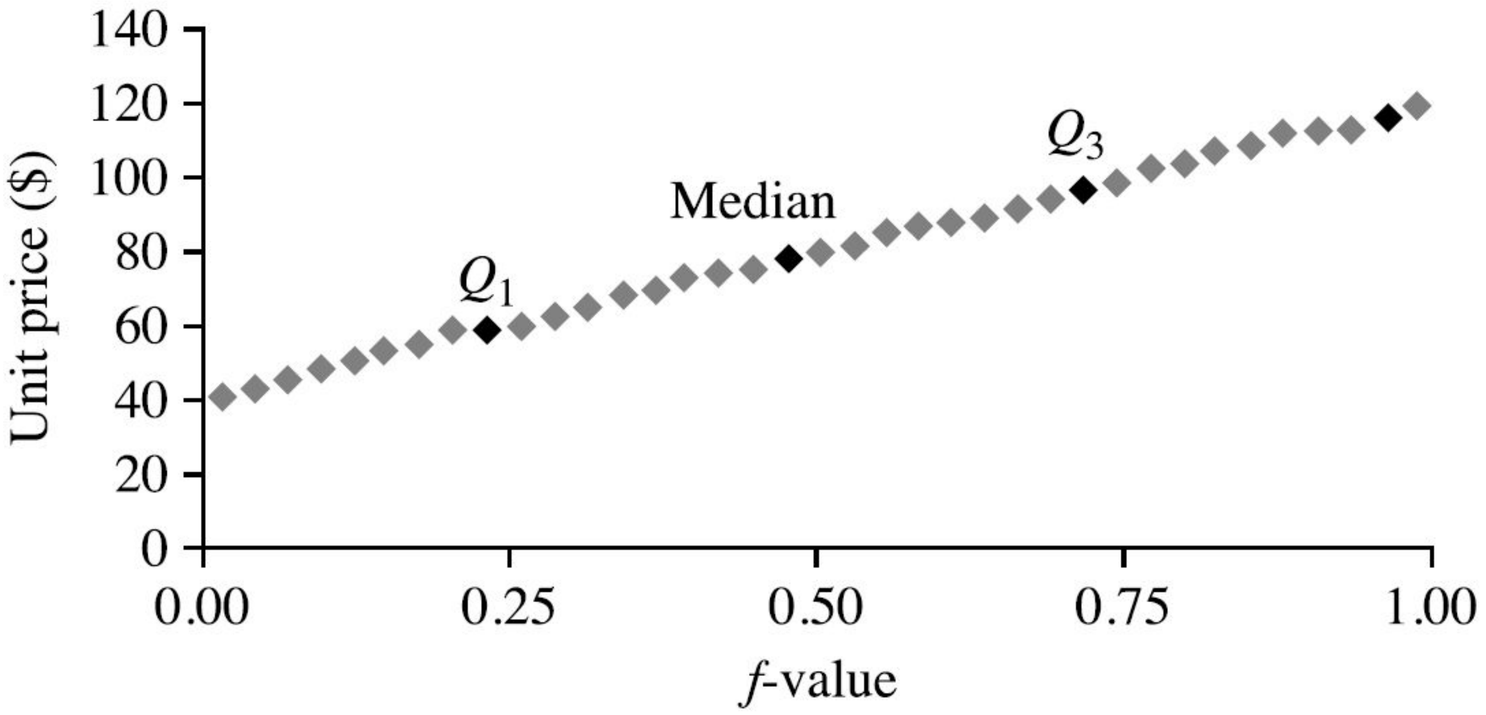
Quantile plot

Quantile plot: is a simple and effective way to have a first look at a univariate data distribution.

- Displays all of the data (allowing the user to assess both the overall behavior and unusual occurrences)
- Plots **quantile** information:
  - For a data x_i data sorted in increasing order, f_i indicates that approximately 100 * f_i% of the data are below or equal to the value x_i

Quantile plot

- **Example.** Plot a quantile plot for the unit price data of Table



A set of unit price data for items sold at a branch of the online store.

Unit price ($)	Count of items sold
40 275	40 275
43 300	43 300
47 250	47 250
...	...
...	...
74 360	74 360
75 515	75 515
78 540	78 540
...	...
...	...
115 320	115 320
117 270	117 270
120 350	120 350

Quantile-Quantile (Q-Q) plot

Quantile-Quantile plot: or q-q plot, graphs the quantiles of one univariate distribution against the corresponding quantiles of another.

Suppose that we have two sets of observations for the attribute or variable *unit price*, taken from two different branch locations. Let $x_1, \ldots, x_N$ be the data from the first branch, and $y_1, \ldots, y_M$ be the data from the second, where each data set is sorted in ascending order. If $M = N$ (i.e., the number of points in each set is the same), then we simply plot y_i against x_i, where y_i and x_i are both $(i - 0.5)/N$ quantiles of their respective data sets. If $M < N$ (i.e., the second branch has fewer observations than the first), there can be only M points on the q-q plot. Here, y_i is the $(i - 0.5)/M$ quantile of the y data, which is plotted against the $(i - 0.5)/M$ quantile of the x data. This computation typically involves interpolation.

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Why is the subtraction of 0.5 needed when calculating the quantiles?

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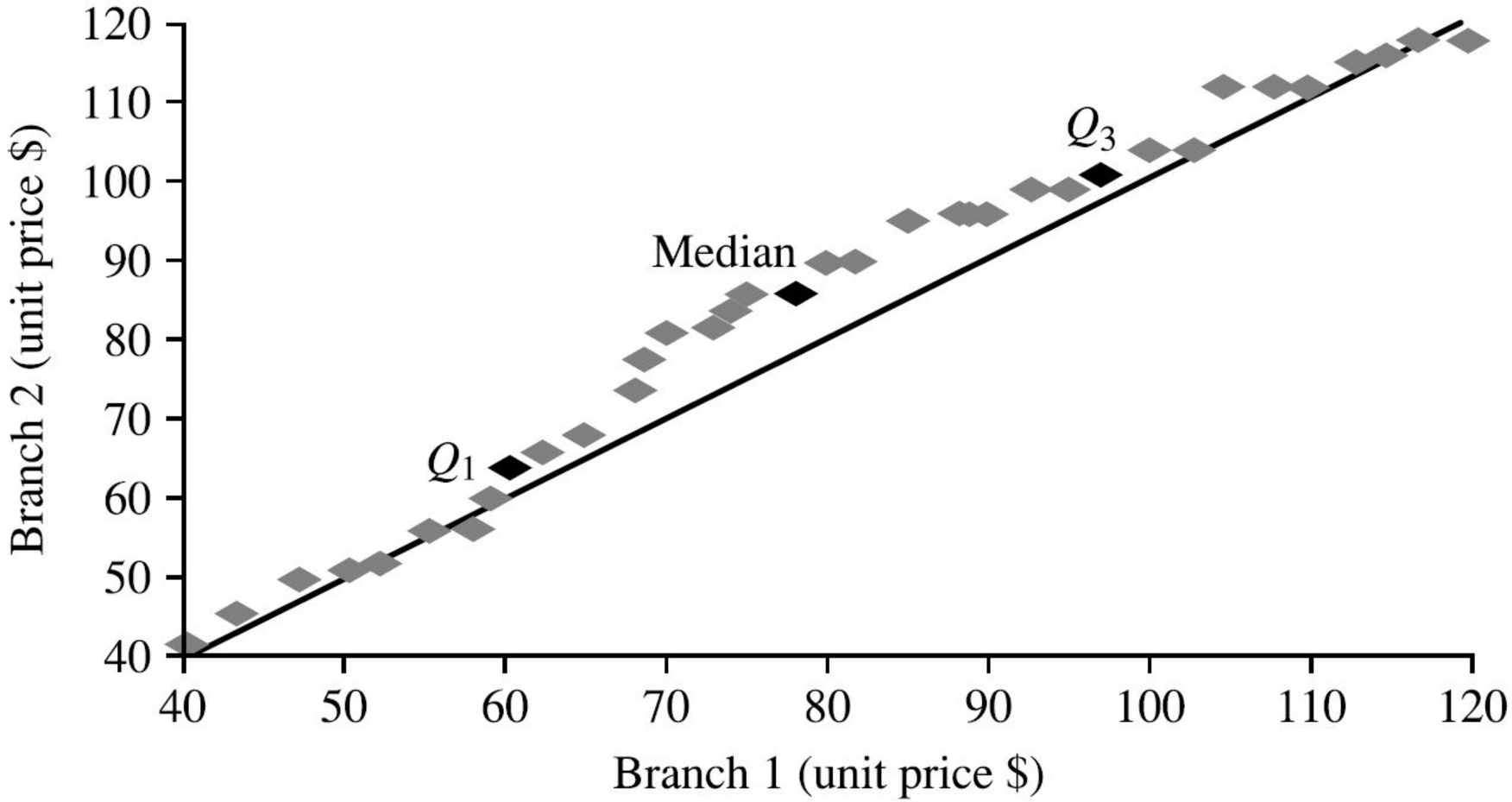
Why is the subtraction of 0.5 needed when calculating the quantiles?

center the data

Quantile-Quantile (Q-Q) plot

Example. The following figure shows unit price of items sold at Branch 1 vs. Branch 2 for each quantile.



Quantile-Quantile (Q-Q) plot

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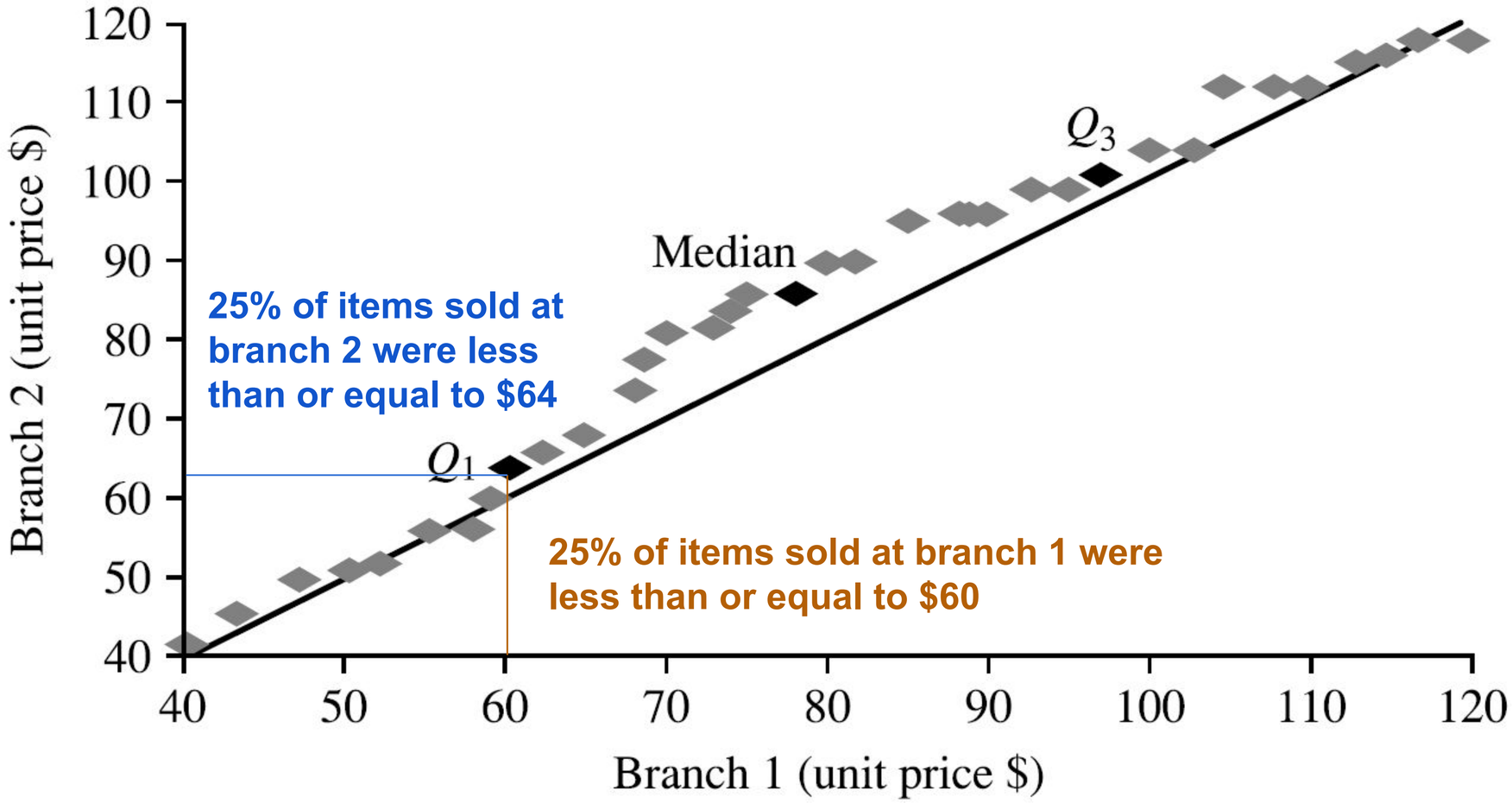
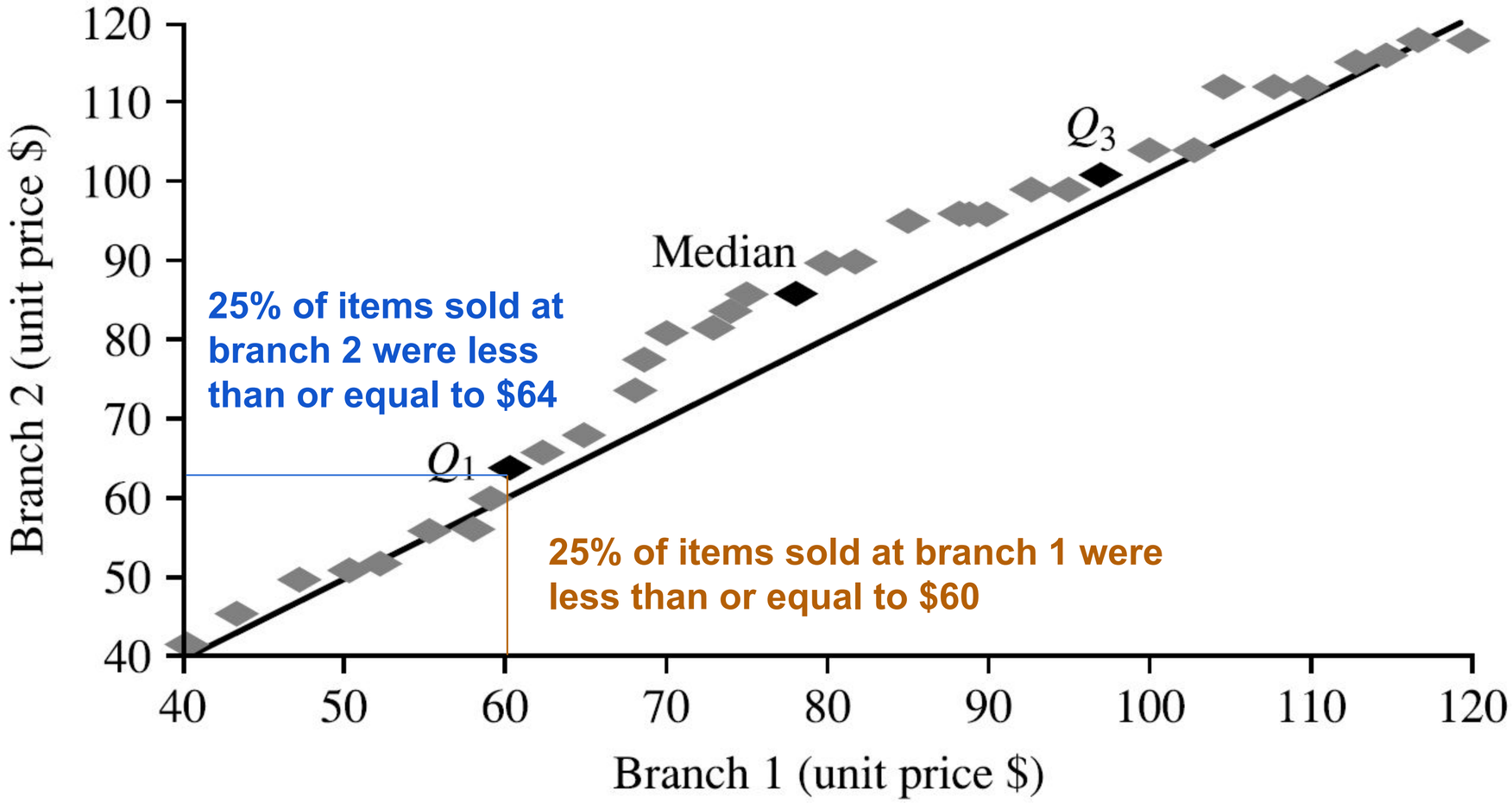


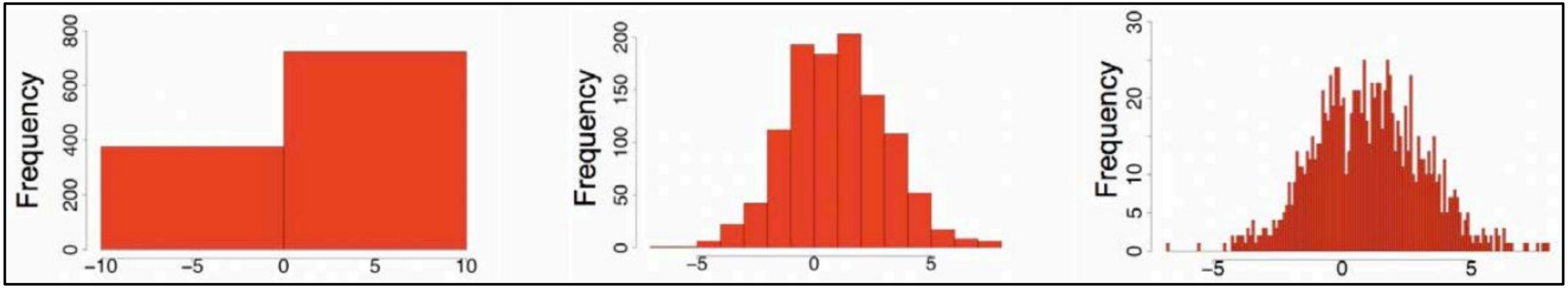
Quantile-Quantile (Q-Q) plot

Example. The following figure shows unit price of items sold at Branch 1 vs. Branch 2 for each quantile. **Unit prices of items sold at Branch 1 tend to be lower than those at Branch 2.**



Histograms to visualize distribution

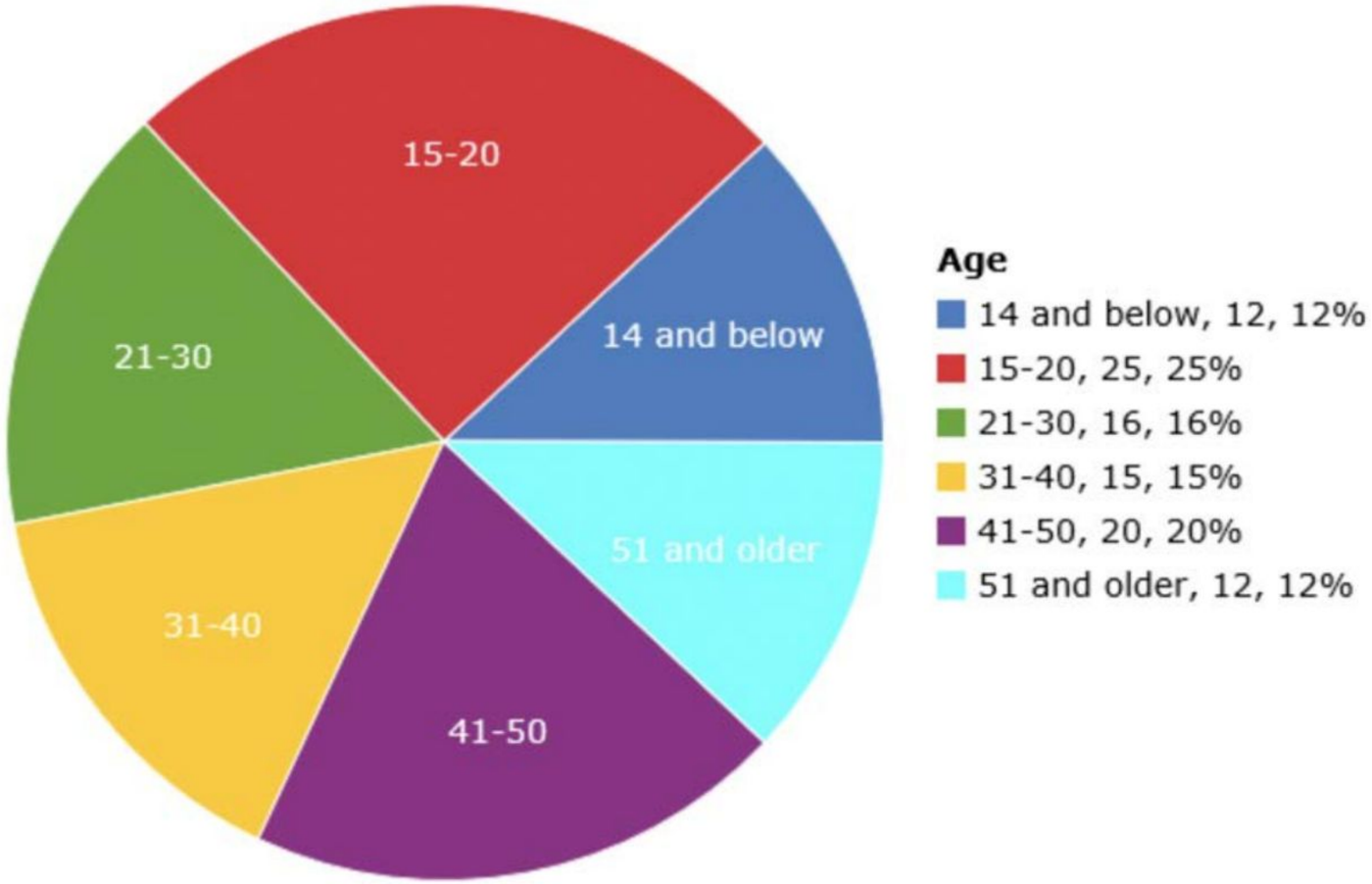
- A **histogram** is a way to visualize how 1- dimensional data is distributed across certain values.



- Note: Trends in histograms are sensitive to number of bins.

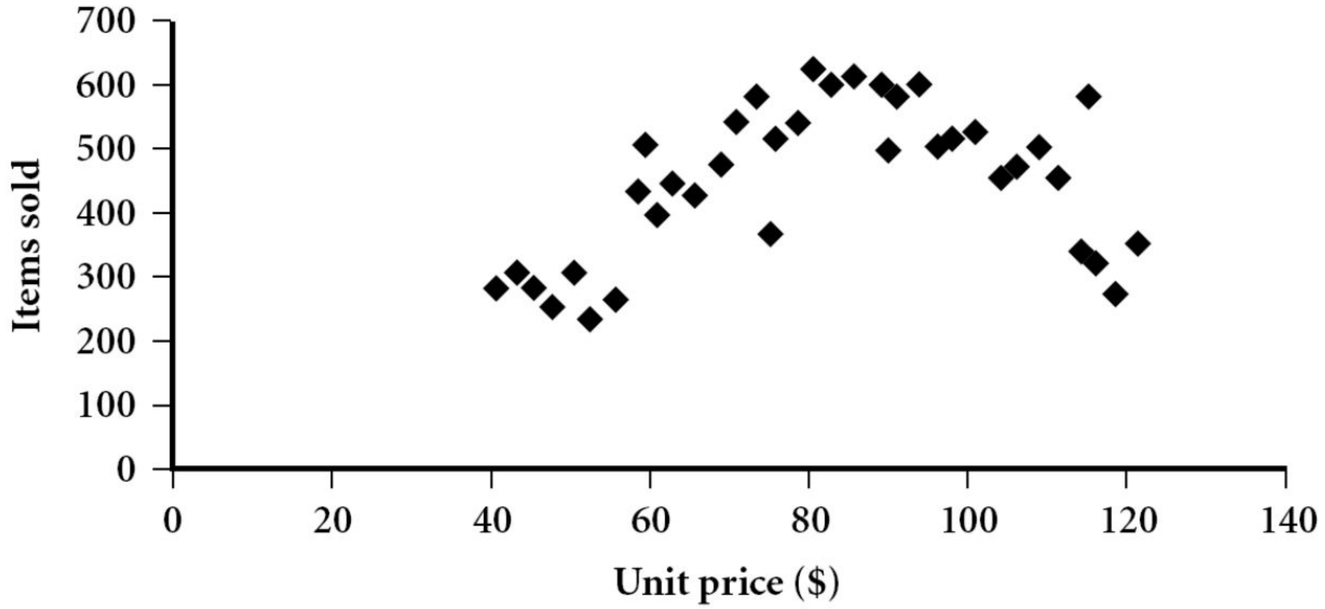
Pie chart for a categorical variable

- A **pie chart** is a way to visualize the static composition (aka, distribution) of a variable (or single group).



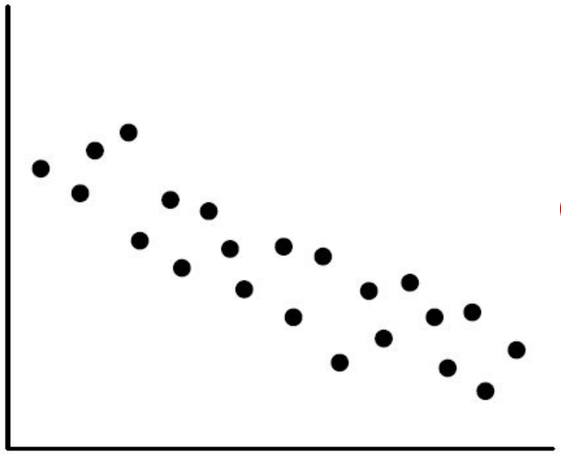
Scatter plots to visualize relationships

- A **scatter plot** is a way to visualize the relationship between two different attributes of multi-dimensional data.
  - Provides a first look at bivariate data to see clusters of points, outliers, or to explore the possibility of correlation relationships
  - Each pair of values is treated as a pair of coordinates and plotted as points in the plane

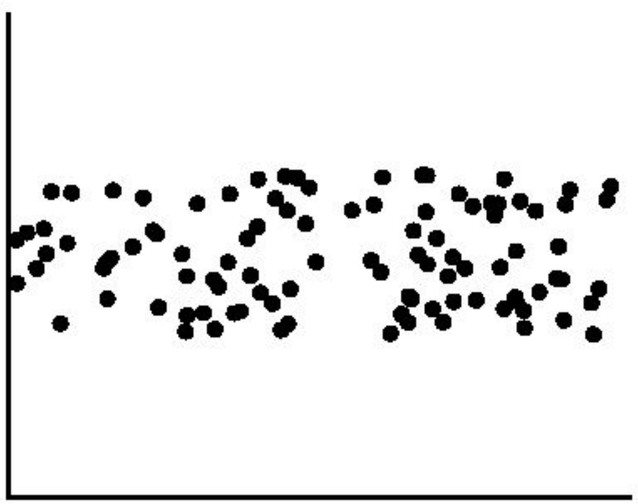


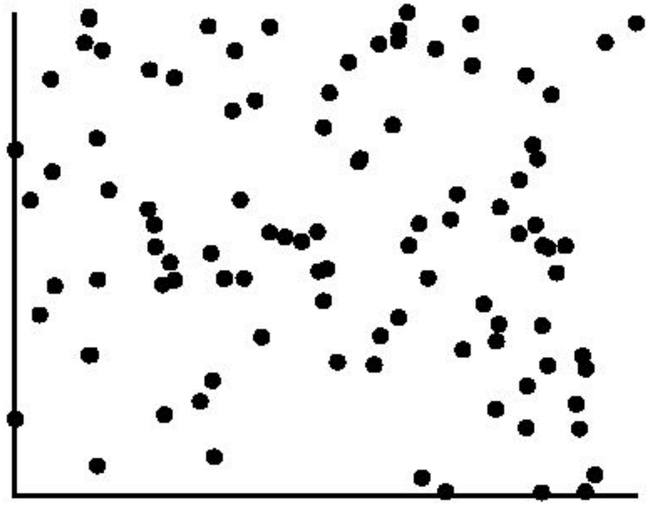
Positively and Negatively Correlated Data

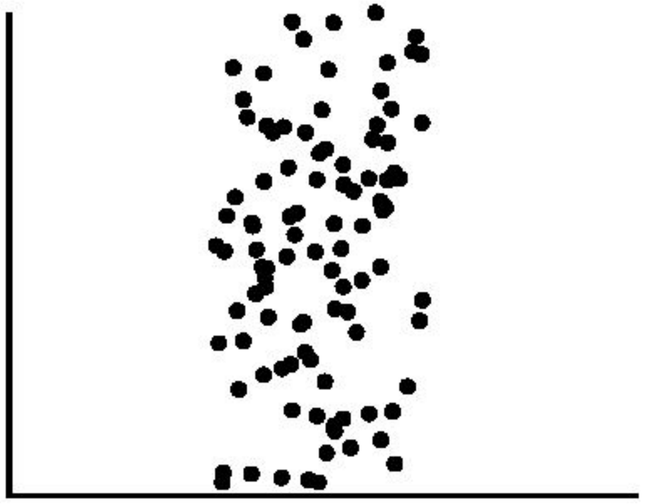
Positive correlation



Negative correlation







No observed correlation

Summary

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