Data Science - Lecture 7

Introduction To Data Science

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What is today’s agenda?

Today we are going to learn following things :

- Data Visualization

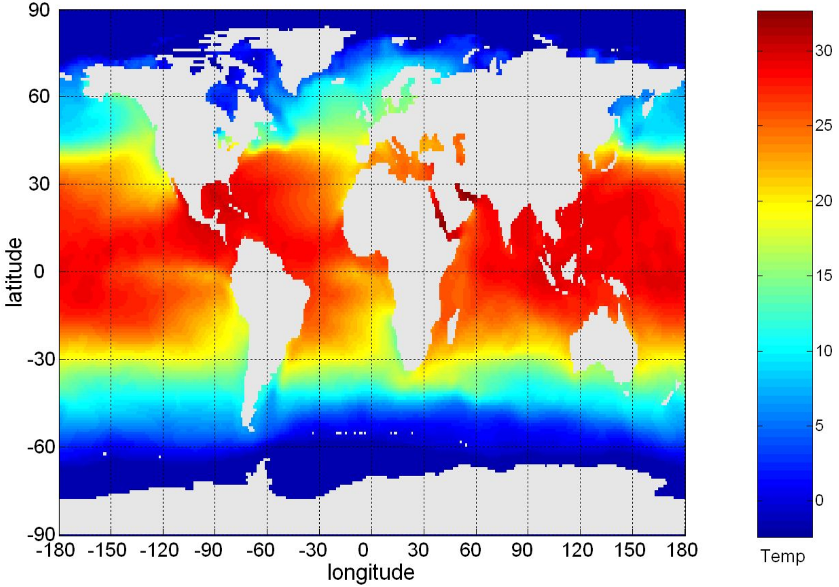
Visualization

Visualization is the conversion of data into a visual or tabular format so that the characteristics of the data and the relationships among data items or attributes can be analyzed or reported.

- Visualization of data is one of the most powerful and appealing techniques for data exploration.
  - Humans have a well developed ability to analyze large amounts of information that is presented visually
  - Can detect general patterns and trends
  - Can detect outliers and unusual patterns

Example : Sea Surface Temperature

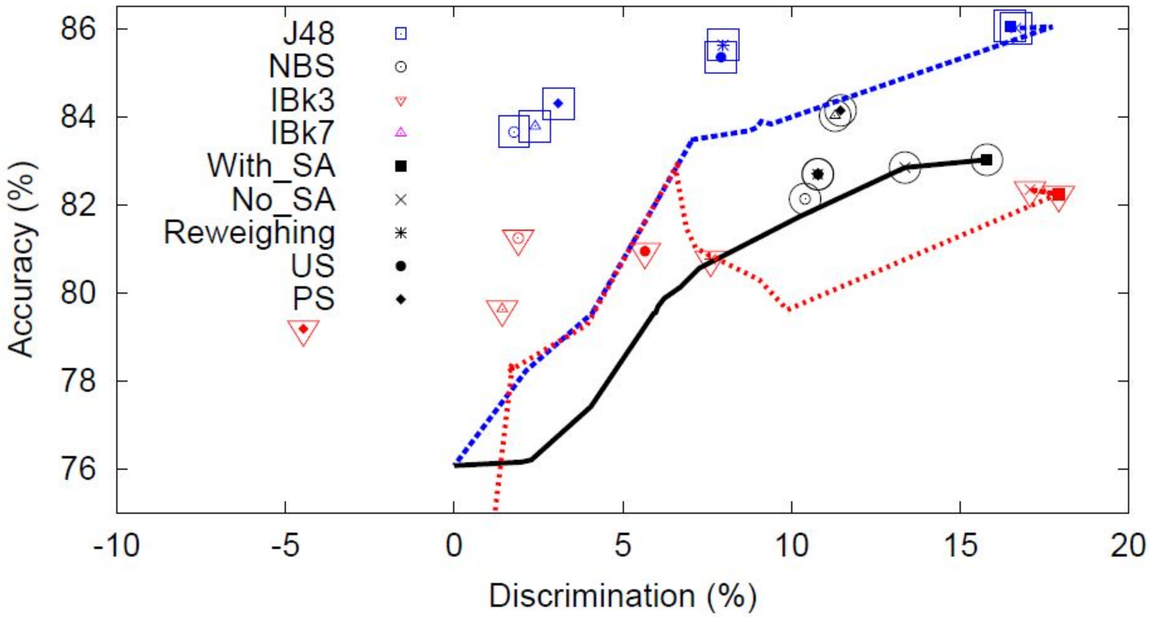
- The following shows the Sea Surface Temperature (SST) for July 1982
  - Tens of thousands of data points are summarized in a single figure



Representation

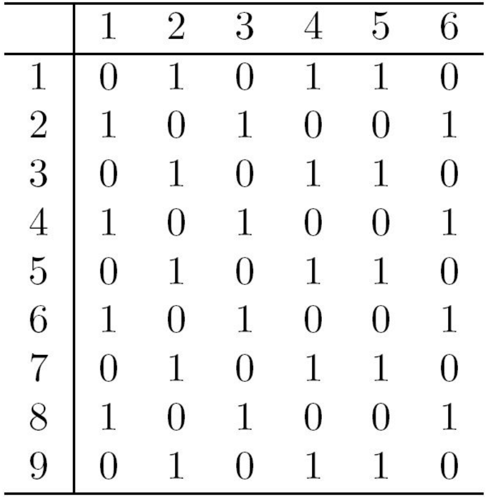
- Is the mapping of information to a visual format
- Data objects, their attributes, and the relationships among data objects are translated into graphical elements such as points, lines, shapes, and colors.
- Example:
  - Objects are often represented as points
  - Their attribute values can be represented as the position of the points or the characteristics of the points, e.g., color, size, and shape
  - If position is used, then the relationships of points, i.e., whether they form groups or a point is an outlier, is easily perceived.

Representation

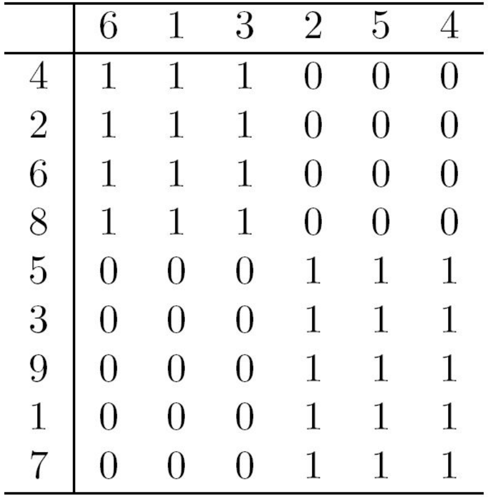


Arrangement

- Is the placement of visual elements within a display
- Can make a large difference in how easy it is to understand the data
- Example:

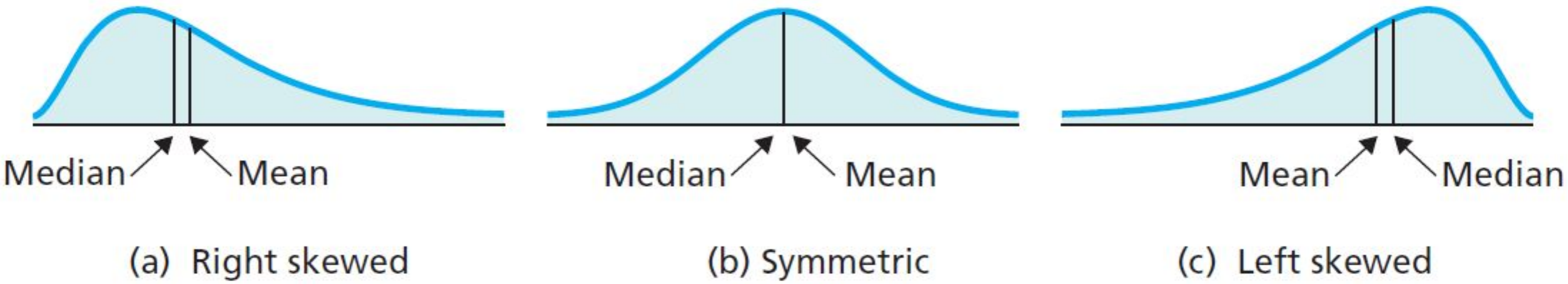


	1	2	3	4	5	6
1	0	1	0	1	1	0
2	1	0	1	0	0	1
3	0	1	0	1	1	0
4	1	0	1	0	0	1
5	0	1	0	1	1	0
6	1	0	1	0	0	1
7	0	1	0	1	1	0
8	1	0	1	0	0	1
9	0	1	0	1	1	0



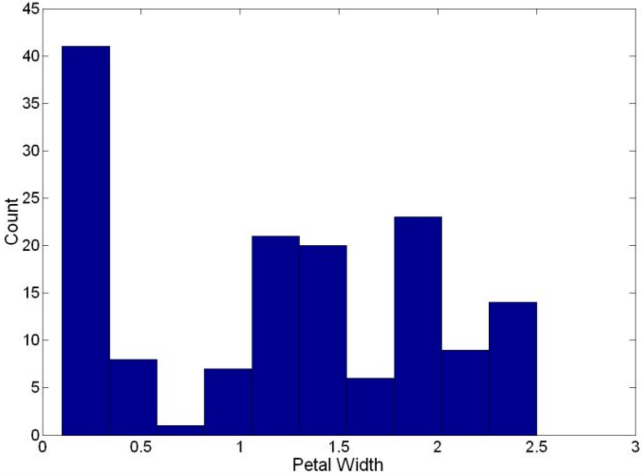
	6	1	3	2	5	4
4	1	1	1	0	0	0
2	1	1	1	0	0	0
6	1	1	1	0	0	0
8	1	1	1	0	0	0
5	0	0	0	1	1	1
3	0	0	0	1	1	1
9	0	0	0	1	1	1
1	0	0	0	1	1	1
7	0	0	0	1	1	1

Data Distribution Shapes

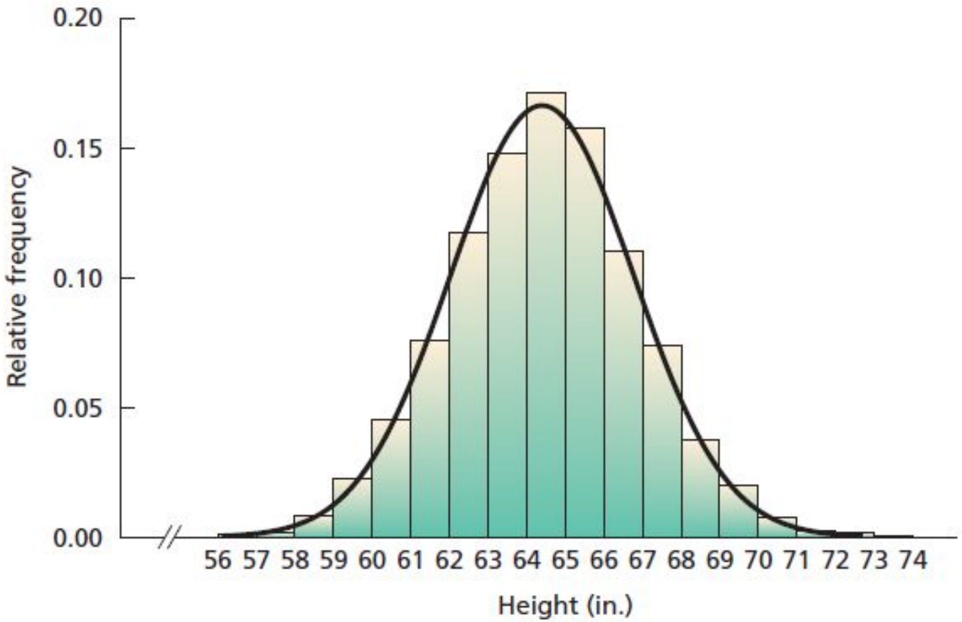


Visualization Techniques : Histograms

- Histogram
  - Usually shows the distribution of values of a single variable
  - Divide the values into bins and show a bar plot of the number of objects in each bin.
  - The height of each bar indicates the number of objects
  - Shape of histogram depends on the number of bins
- Example: Petal Width

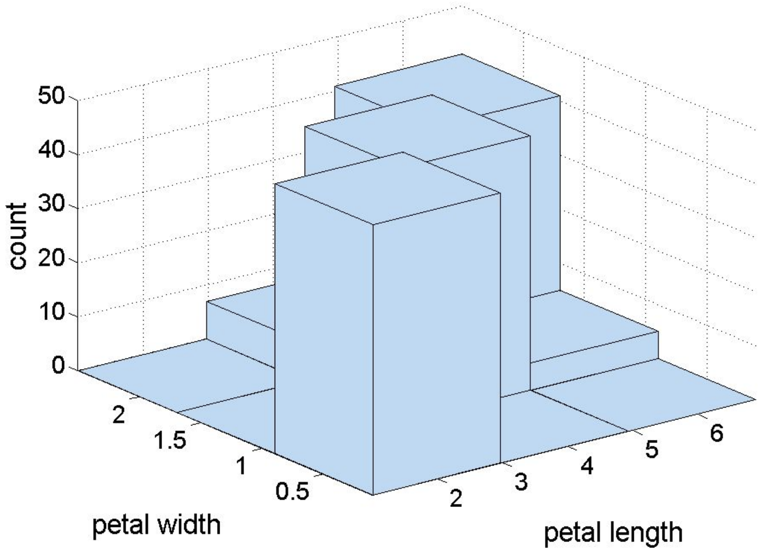


Visualization Techniques : Histograms



Two - Dimensional Histograms

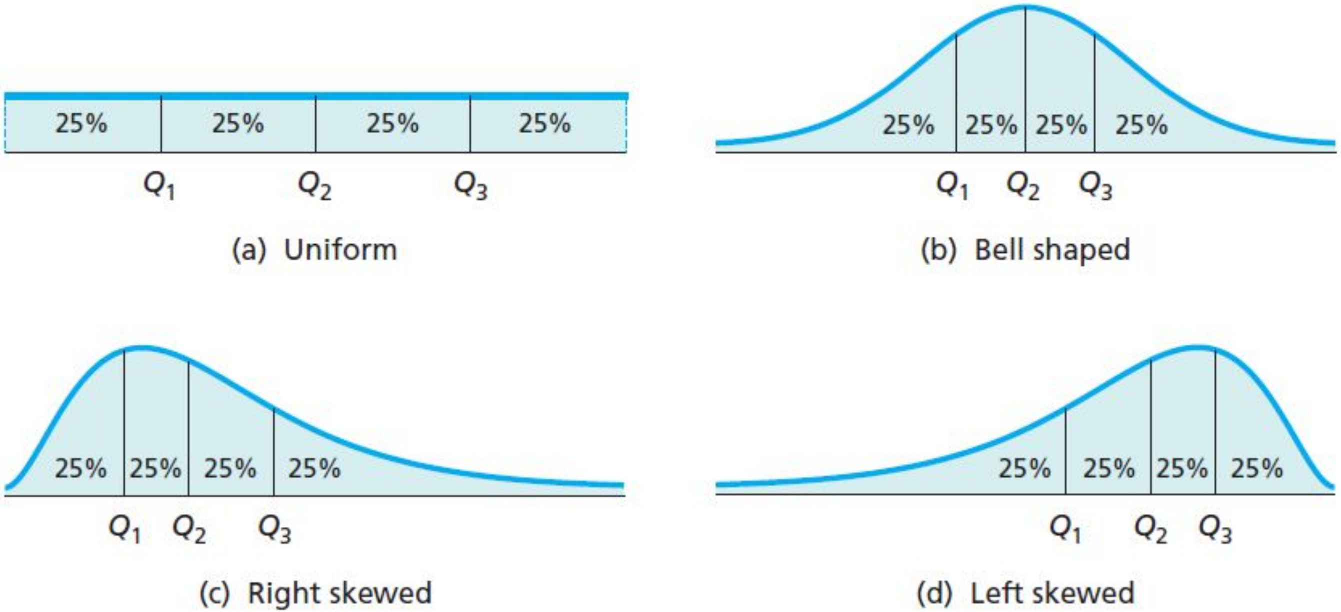
- Show the joint distribution of the values of two attributes
- Example: petal width and petal length
  - What does this tell us?



Visualization Techniques : Quartiles

- **Percentile:** divides the data into hundredths (100 equal parts) P_1, P_2,…,P_{99}
- **Deciles:** divides the data into tenths (10 equal parts)
- **Quintiles:** divides the data into fifths (5 equal parts)
- **Quartiles:** divides the data into quarters (4 equal parts) Q_1, Q_2,Q_3

Visualization Techniques : Quartiles



(a) Uniform

(b) Bell shaped

(c) Right skewed

(d) Left skewed

Five Number Summary

- **Five-Number Summary: min, Q_1, Q_2, Q_3, Max**

- **Interquartile range (IQR):**

  IQR = Q3-Q1

- **Limits of the dataset:**
  - Lower limit = Q_1 - 1.5 x IQR
  - Upper limit = Q_3 + 1.5 x IQR

- **Outliers:** The objects below the lower limit and above the upper limit are potential outliers.

Five Number Summary

Find the 5 Number Summary of the following numbers:

3 12 7 40 9 14 18 15 17

- **Step 1: Sort the numbers from lowest to highest**

  3 7 9 12 14 15 17 18 40

- **Step 2: Identify the Median**

  3 7 9 12 14 15 17 18 40

- **Step 3: Identify the Smallest and Largest numbers**

  3 7 9 12 14 15 17 18 40

- **Step 4: Identify the Median between the smallest number and the Median for the entire set of data, and between that Median and the largest number in the set.**

  3 7 9 12 14 15 17 18 40

Five Number Summary

These are the five numbers in the 5 Number Summary

3 7 9 12 14 15 17 18 40

3 - Smallest number in the set

9 - Median between the smallest number and the median

14 - Median of the entire set

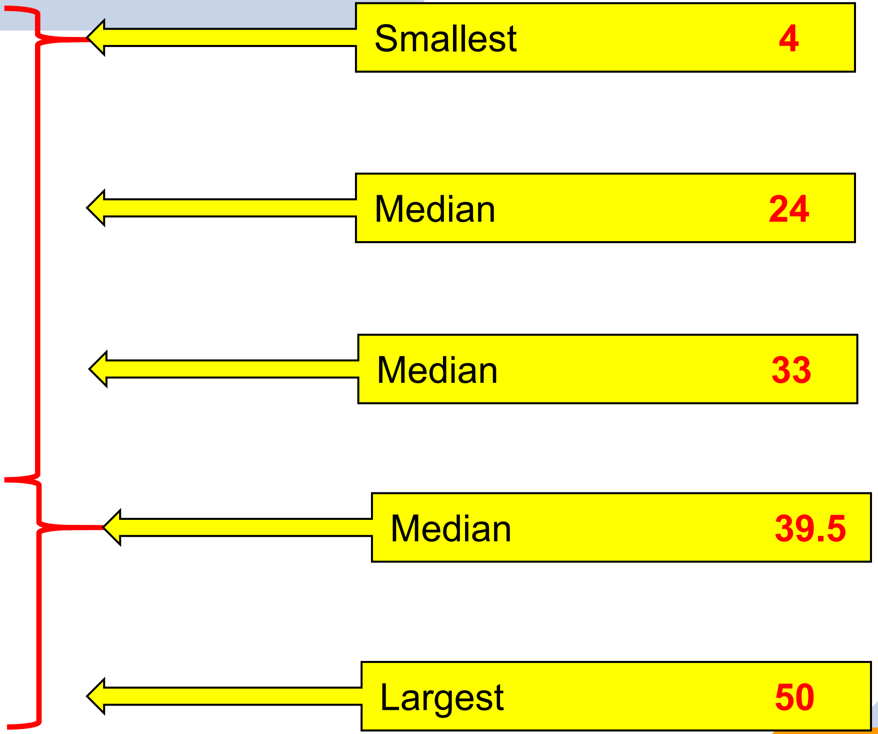
17 - Median between the largest number and the median

40 - Largest number in the set

Five Number Summary

42
16
38
50
24
29
41
36
18
4
33
37
24
27
45

4
16
18
24
24
27
29
33
36
37
38
41
42
45
50



Smallest 4

Median 24

Median 33

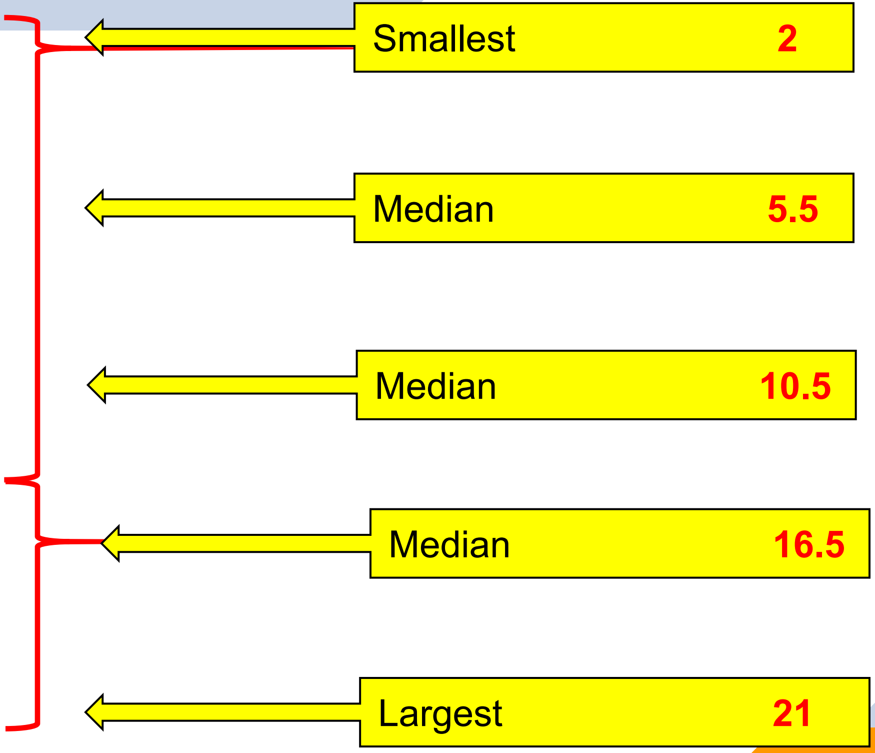
Median 39.5

Largest 50

Five Number Summary

4
8
2
19
11
6
21
13
5
7
10
20
14
15
18
3

2
3
4
5
6
7
8
10
11
13
14
15
18
19
20
21



Smallest 2

Median 5.5

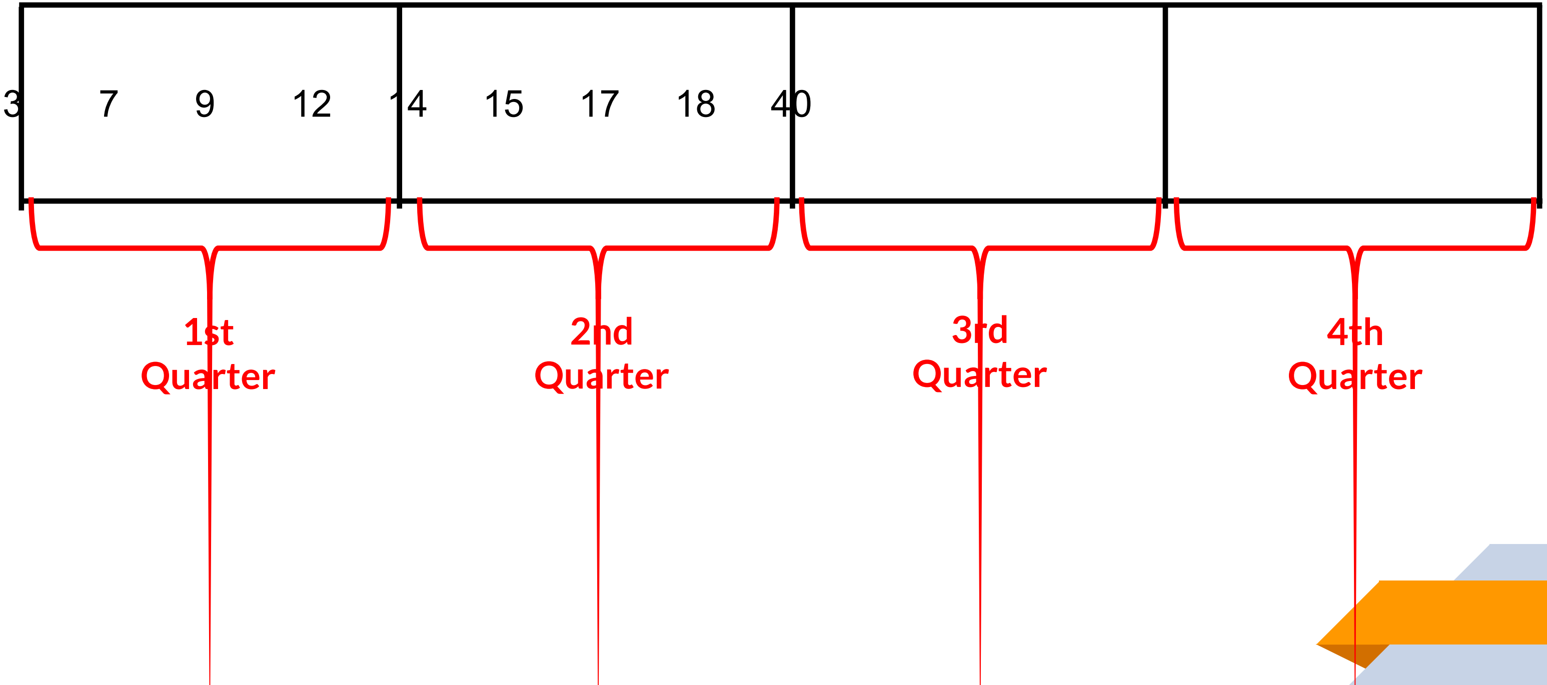
Median 10.5

Median 16.5

Largest 21

Five Number Summary

A 5 Number Summary divides your data into four quarters.



3 7 9 12 14 15 17 18 40

1st Quarter

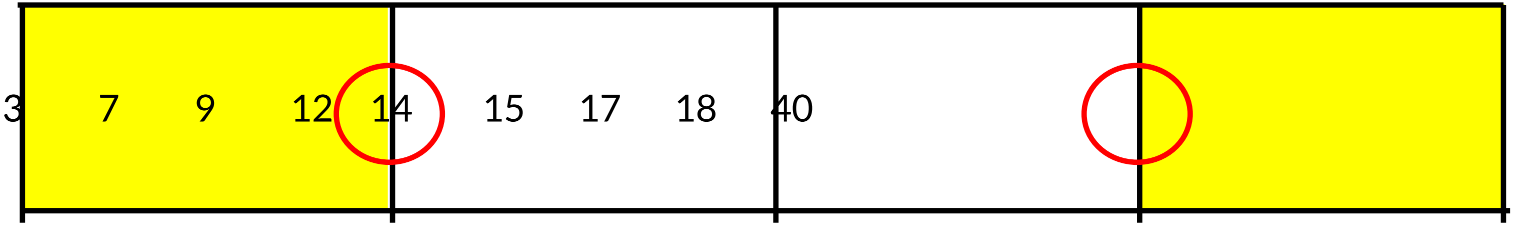
2nd Quarter

3rd Quarter

4th Quarter

InterQuartile Range

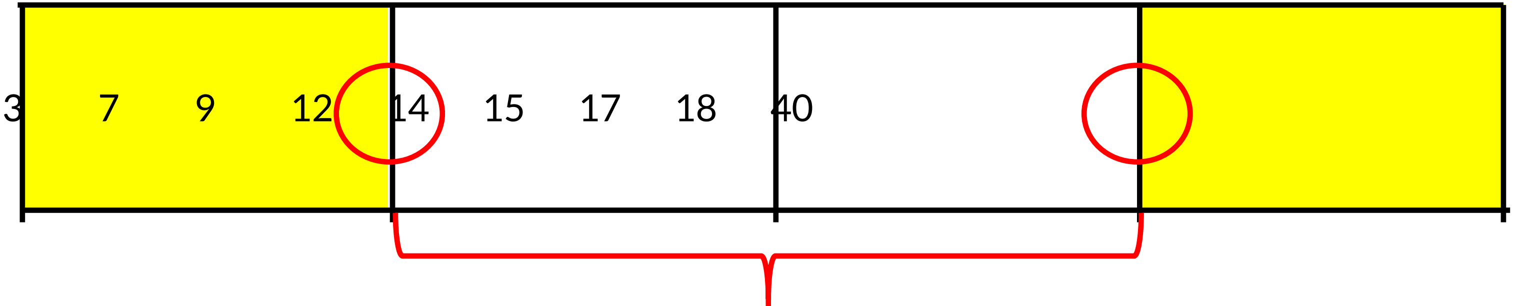
- The Lower Quartile (Q1) is the second number in the 5 Number Summary
  - 25% of all the numbers in the set are smaller than Q1



- The Upper Quartile (Q3) is the fourth number in the 5 Number Summary
  - 25% of all the numbers in the set are larger than Q3

InterQuartile Range

- What percent of all the numbers are between Q1 and Q3?
  - 50% of all the numbers are between Q1 and Q3

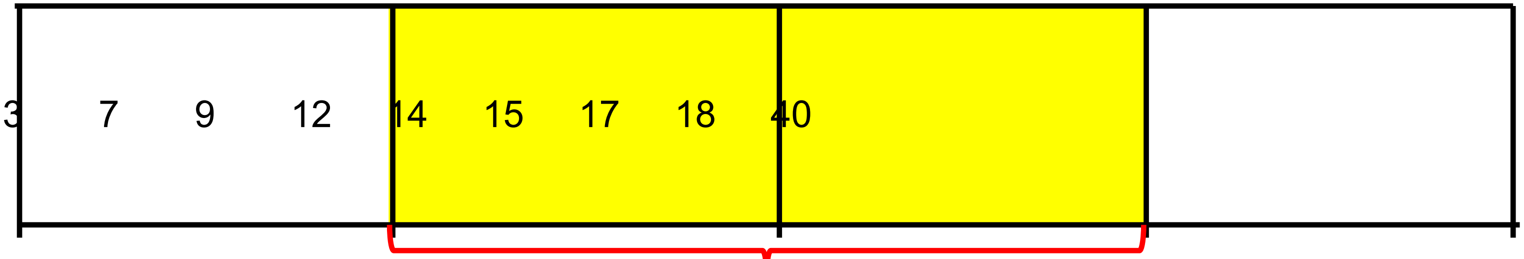


3 7 9 12 14 15 17 18 40

- This is called the Inter-Quartile Range (IQR)
  - The size of the IQR is the distance between Q1 and Q3
  - 17 - 9 = 8

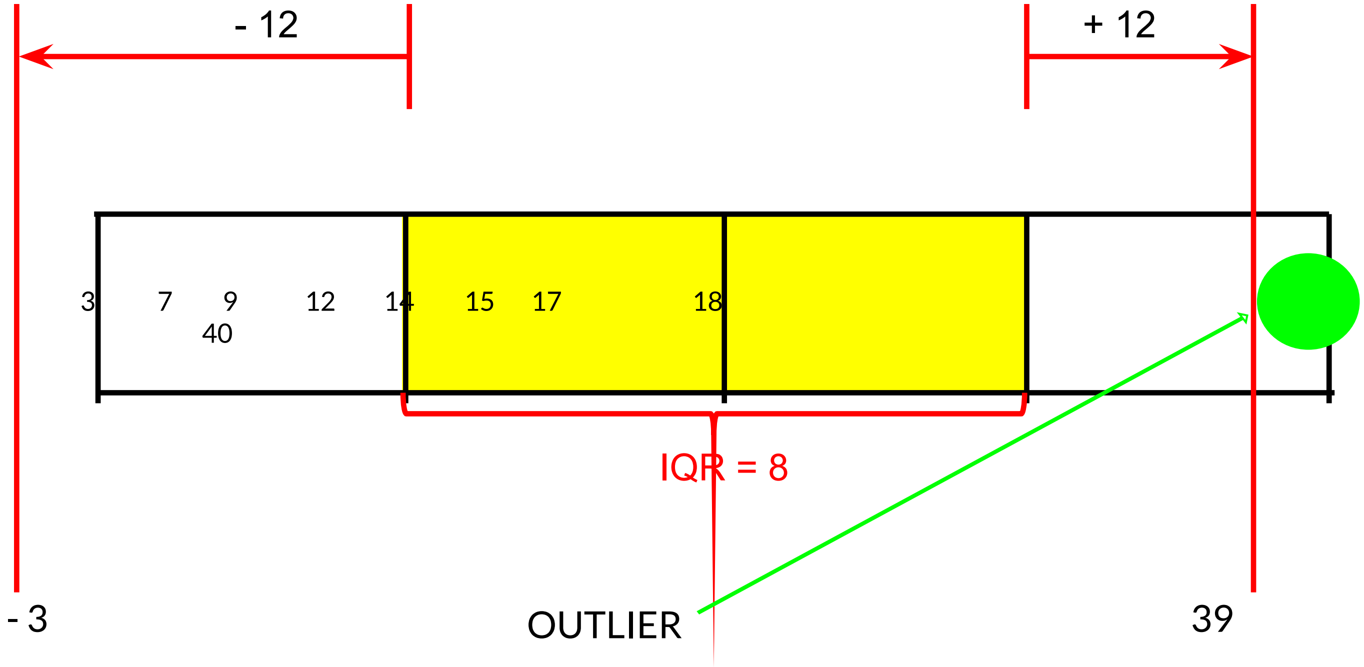
Outlier Detection Using IQR

- To determine if a number is an outlier, multiply the IQR by 1.5
  - 8 • 1.5 = 12 where 8 is IQR



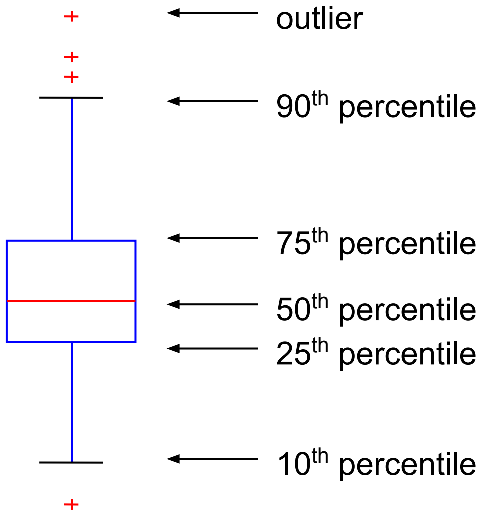
- An outlier is any number that is 12 less than Q1 or 12 more than Q3

Outlier Detection Using IQR



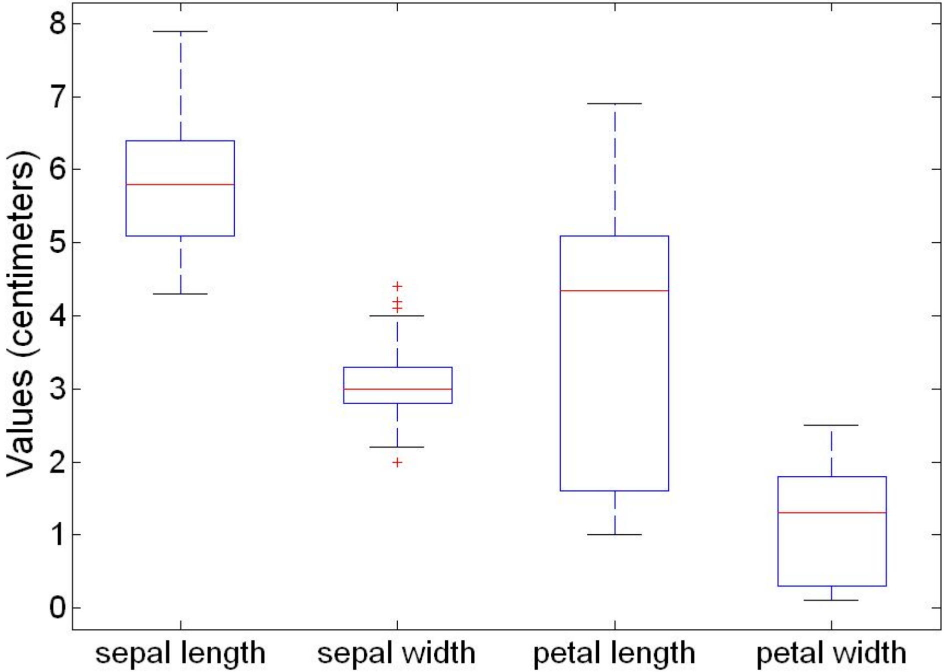
Visualization Techniques : Box Plots

- Box Plots
  - Invented by J. Tukey
  - Another way of displaying the distribution of data
  - Following figure shows the basic part of a box plot

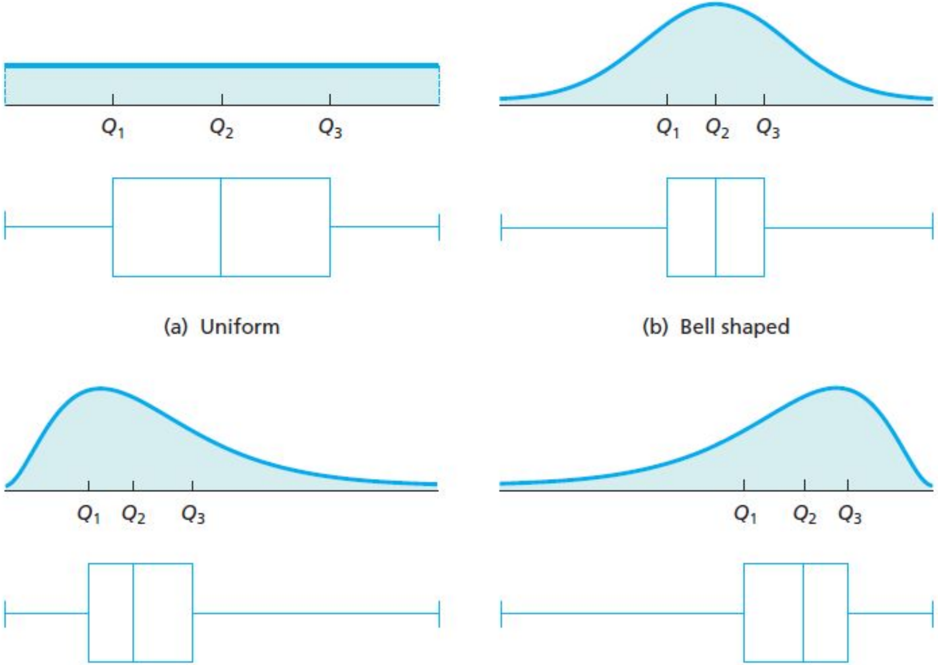


Example of Box Plots

- Box plots can be used to compare attributes



Comparing Data By Box Plots



(a) Uniform

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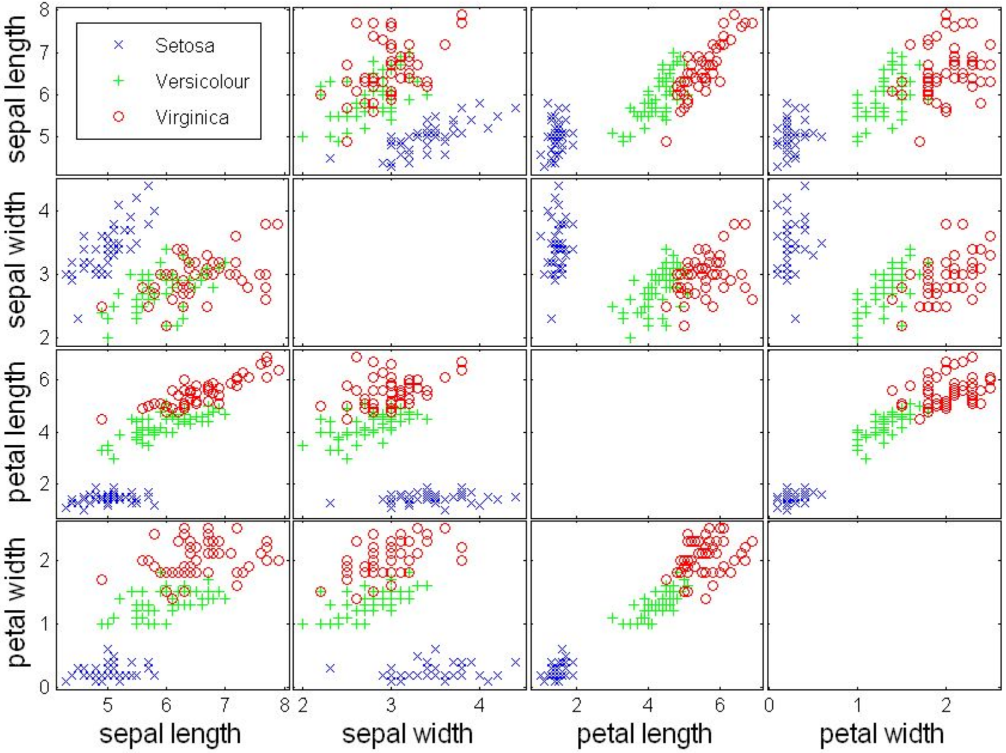
Visualization Techniques : Scatter Plots

- Scatter plots
  - Attributes values determine the position
  - Two-dimensional scatter plots most common, but can have three-dimensional scatter plots
  - Often additional attributes can be displayed by using the size, shape, and color of the markers that represent the objects
  - It is useful to have arrays of scatter plots can compactly summarize the relationships of several pairs of attributes
    - See example on the next slide

Scatter Plot of Iris Attributes



“Questions ?