Univariate Graphics

STAT 133

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Looking at one single variable

Univariate Statistical Graphics

Getting started with graphics for exploration requires underdstanding charts and plots for single variables

Univariate graphics by type of variable

Qualitative Variable

- Bar chart
- Dot chart
- Pie chart

Quantitative Variable

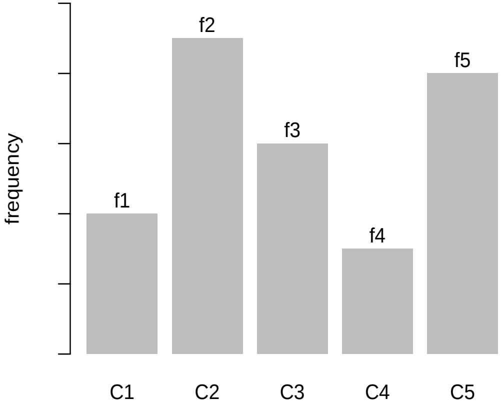
- All of qualitative
- Histogram
- Density curve
- Boxplot
- Ogive

Bar Charts

From Frequency Tables ...

Category	Absolute Frequency	Relative Frequency
C_1	f_1	f_1/n
C_2	f_2	f_2/n
C_3	f_3	f_3/n
$\dots$	$\dots$	$\dots$
C_k	f_k	f_k/n
$total$	n	1

to Bar-charts



Bar-charts

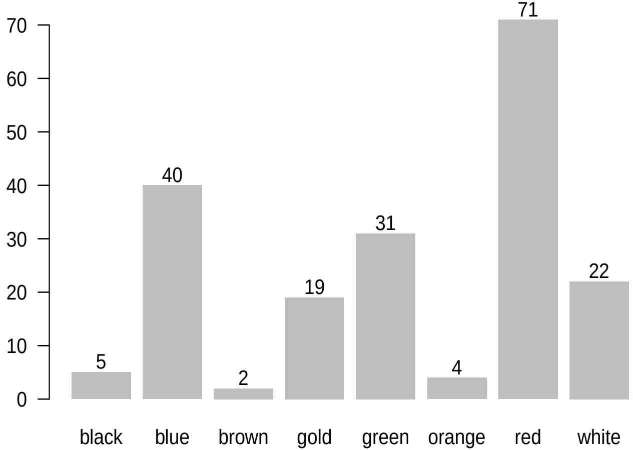
Elements of vertical bar-charts

- categories on horizontal axis
- frequencies on vertical axis
- length of bar equal to frequency

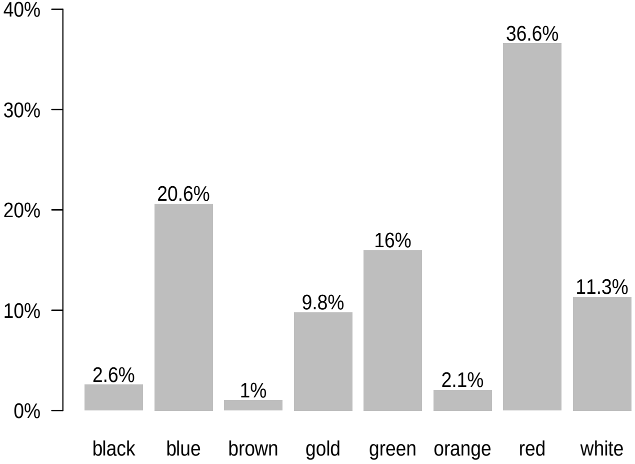
(Note that you can also make a horizontal bar-chart, in which case the axes play inverse roles)

Bar-chart: predominant color in flags

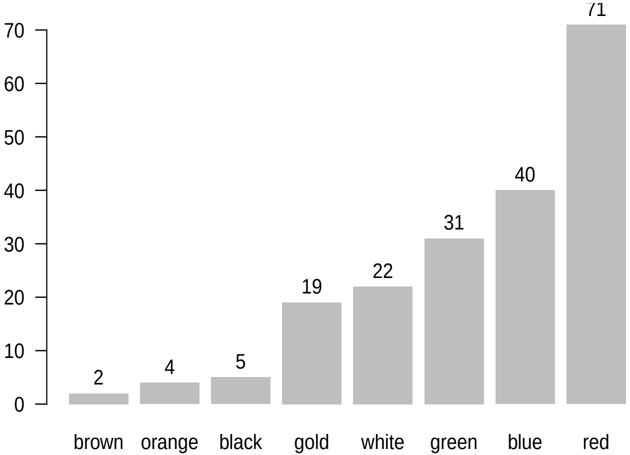
Bar-chart example



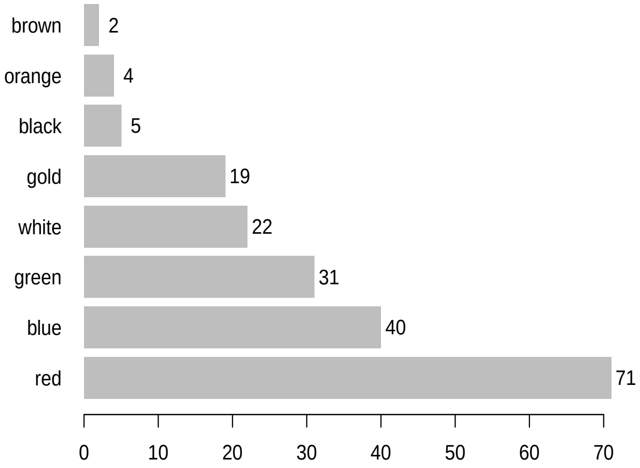
Bar-chart: predominant color in flags



Bar-chart: predominant color in flags



Bar-chart: predominant color in flags

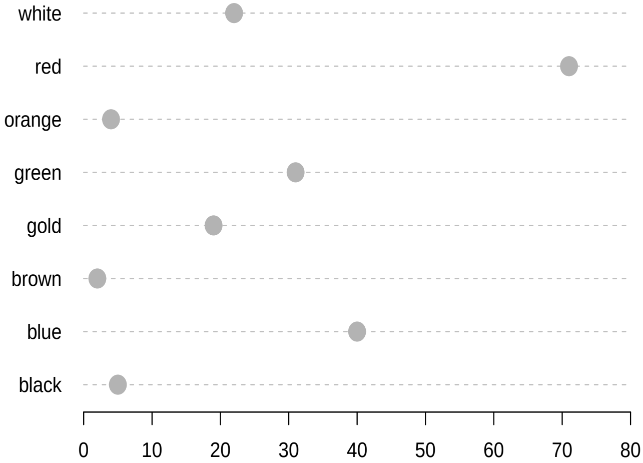


Dot charts

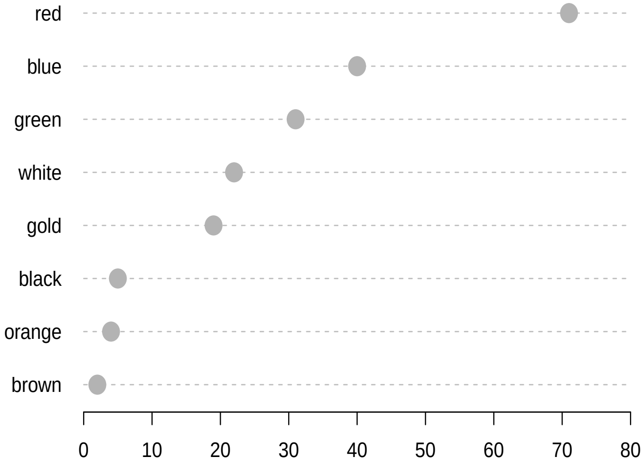
Dot charts

- Dot-charts are very similar to bar charts.
- Instead of using bars, dot-charts display frequencies with dots.
- They are simpler and cleaner than bar charts

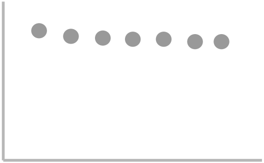
Dot-chart: predominant color in flags



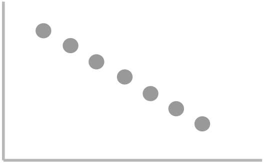
Ranked Dot-charts



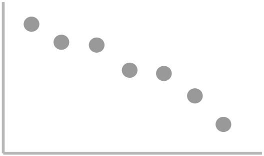
Ranked dot-chart patterns



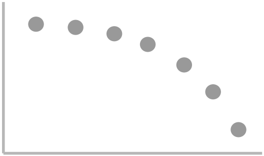
all values roughly the same



differences decrease by roughly the same amount

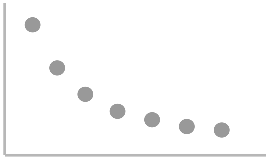


differences from one value to the next vary significantly

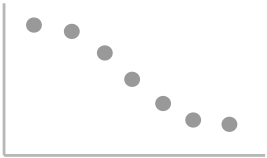


differences from one value to the next increase

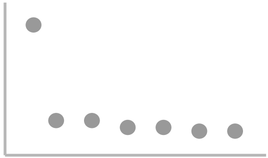
Ranked dot-chart patterns



differences from one value
to the next decrease



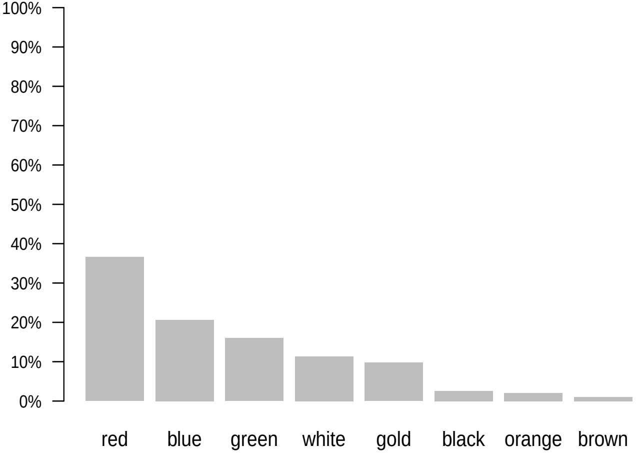
shifting differences from
one value to the next



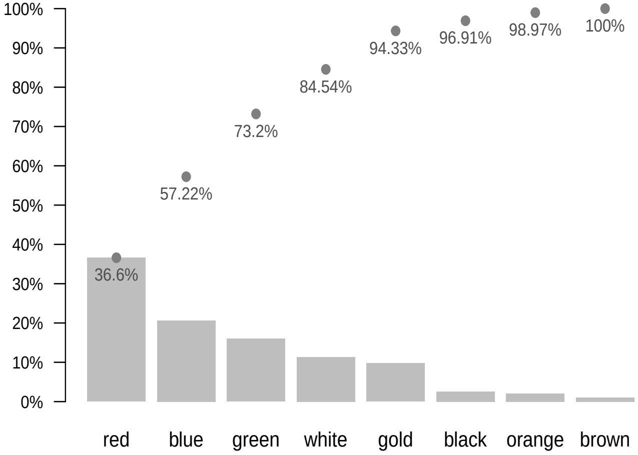
one or more values are extraordinarily
different from the rest

Pareto charts

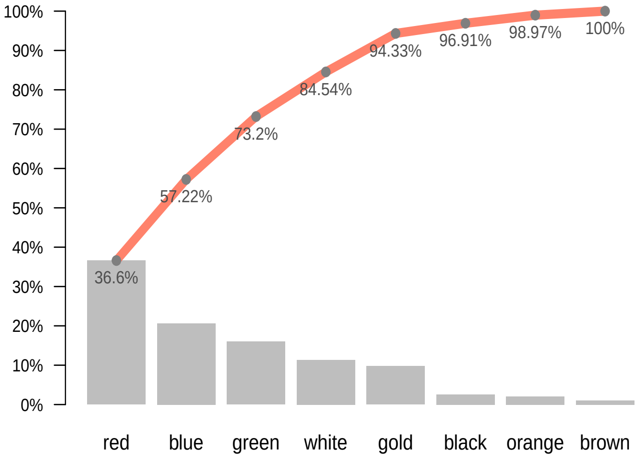
Bar-chart with Pareto Line



Bar-chart with Pareto Line

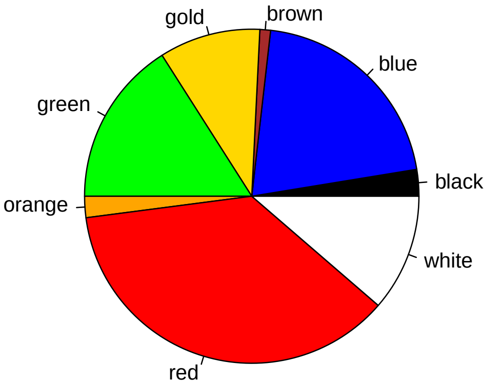


Bar-chart with Pareto Line

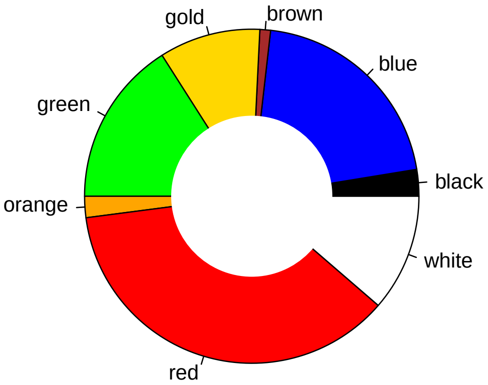


Pie charts

Pie Chart



Donut Chart



Pie charts disadvantages

- Pie charts force us to compare either 2-D areas formed by each slice or the angles formed
- Visual perception handles neitheir of these comparisons easily or accurately

Univariate Quantitative Charts

NFL Ticket prices (2013)

```
##        teams  tickets       teams  tickets
## 1    cowboys   110.20     falcons    83.71
## 2   patriots   117.84     vikings    78.69
## 3     giants   111.69        rams    74.49
## 4      bears   103.60    seahawks    71.21
## 5       jets   110.28   cardinals    79.56
## 6   redskins    94.80    dolphins    71.14
## 7     ravens   100.19     raiders    64.80
## 8     eagles    93.01      titans    65.28
## 9     texans    88.98       lions    67.60
## 10  chargers    84.55     bengals    68.96
## 11  steelers    81.13     jaguars    68.44
## 12   packers    82.61      chiefs    64.92
## 13     49ers    83.54  buccaneers    63.59
## 14    saints    74.99       bills    57.75
## 15   broncos    84.27    panthers    66.84
## 16     colts    86.32      browns    54.20
```

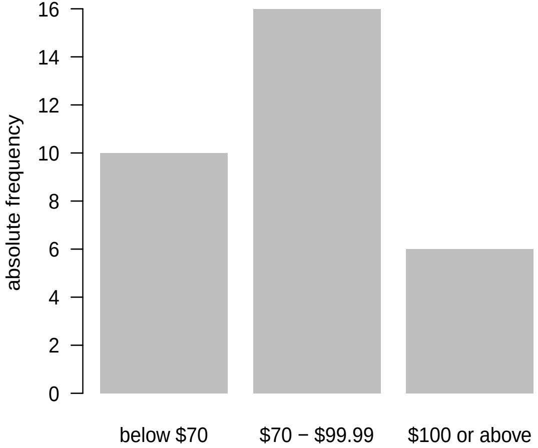
Bar charts for quantitative variables

- We can use bar charts with quantitative variables
- In this case we need to first categorize the variable, and then get a frequency table

Frequency Table of Ticket Prices

Category Name	Absolute Frequency	Relative Frequency
Below $70	10	0.3125
$70 - $99.99	16	0.5000
$100 or above	6	0.1875
Total	32	1.00

NFL Ticket prices (2013)

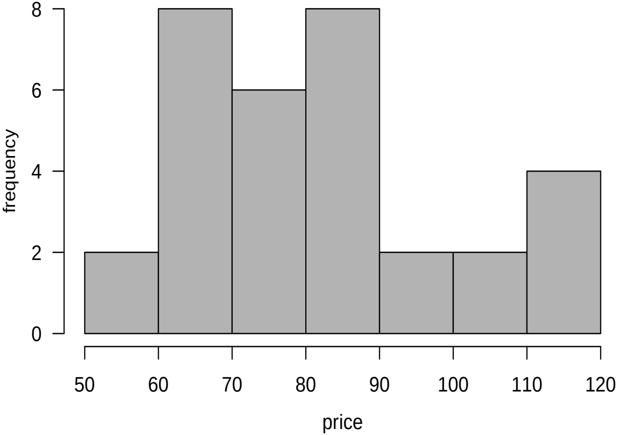


Histograms

Histograms

Histograms provide a way of viewing the general distribution of values in a quantitative variable

NFL Ticket prices (2013)



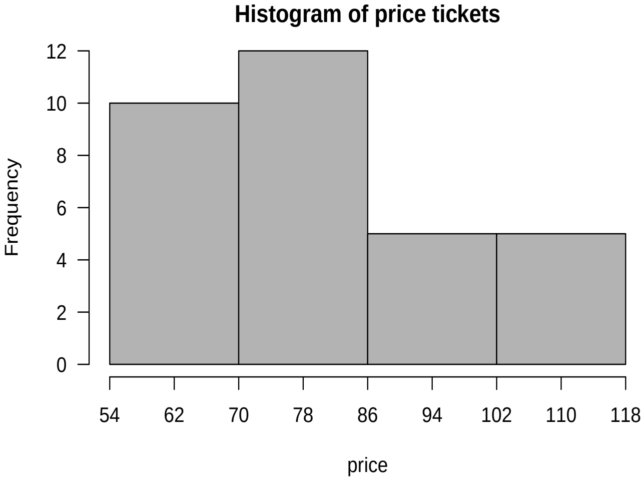
Building a Histogram

1. **Partition of values**: The range of the data values is partitioned into a number of non-overlapping “cells” or bins.
2. **Counting frequencies**: The number of data values falling into each cell is counted (either absolute or relative freqs)
3. **Drawing Bars**: The observations falling into a cell are represented as a “bar” drawn over the cell

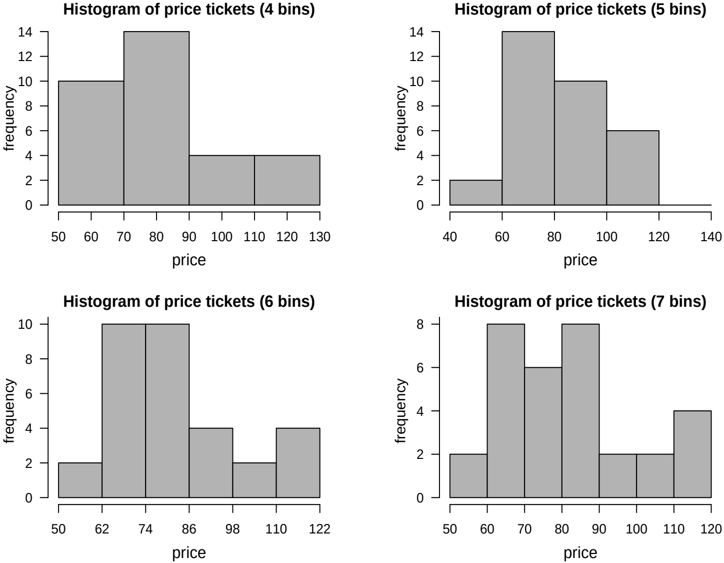
About Histograms

- The bins represent ranges of values
- The bins (intervals) must be adjacent, and usually of equal size
- The bars are adjacent (not discontinuous)
- The areas of the bars are meaningful
- Height of bars equal to the frequency
- Width equal to the bin size
- The area of a bar gives the proportion of data values which fall in the bin

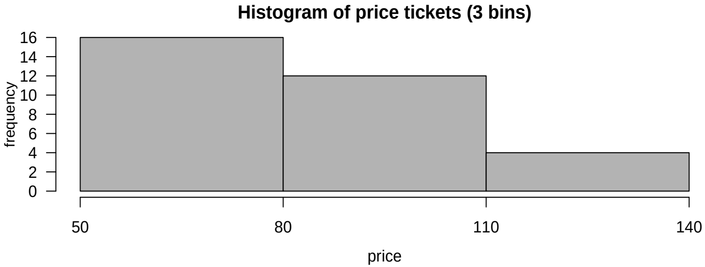
Histogram with 4 bins

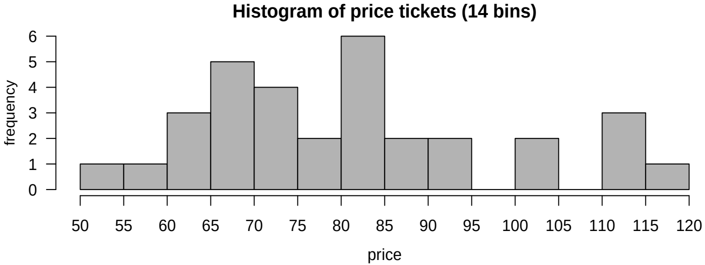


Histograms with different bins



Avoid too few and too many bins

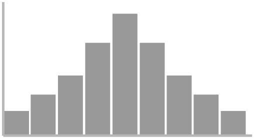




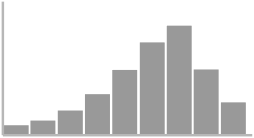
About Histograms

- The shape of a histogram depends on the chosen bins
- This suggests that there is a fundamental instability at the heart of its construction
- The bars are adjacent (not discontinuous)
- The areas of the bars are meaningful

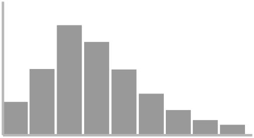
Histogram patterns



Symmetrical

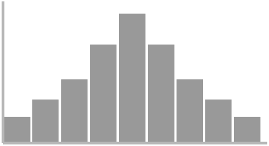


Skewed to the left

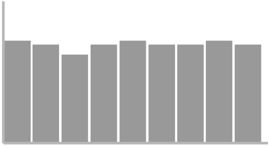


Skewed to the right

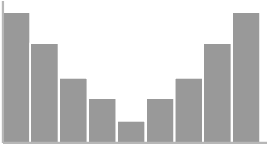
Histogram patterns



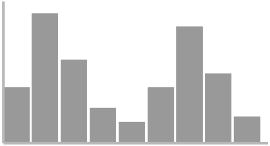
Curved



Flat or Uniform

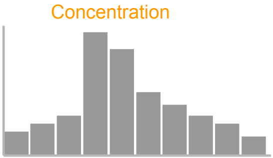


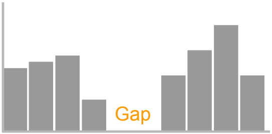
Curved Downward

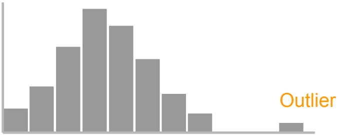


Multiple peaks
(e.g. bimodal, trimodal. etc)

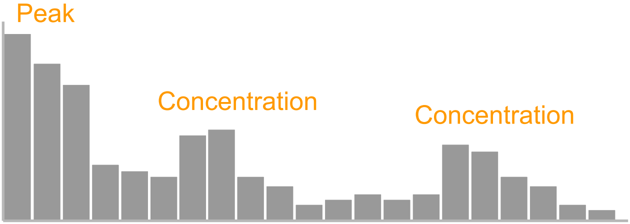
Histogram patterns







Histogram patterns



Box plots

Building a Histogram

1. **Box-and-whisker plots**, most commonly known as “box plots”
2. created by John Tukey
3. simple and effective way to display the distribution of values
4. relies on the so-called **5-summary indicators**

Box plots based on 5-number summary

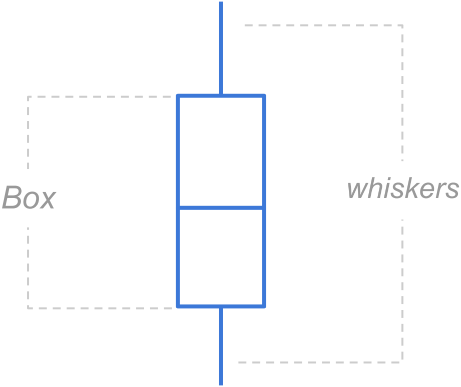
5 summary indicators

Box plots based on 5-number summary

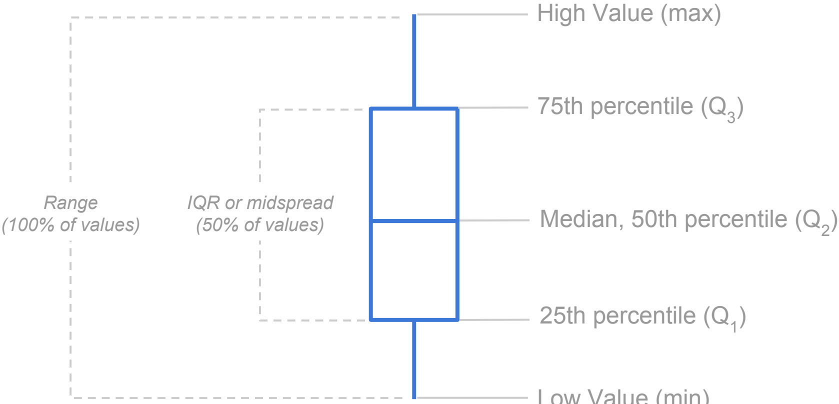
5 summary indicators

1. minimum
2. 25th percentile (1st quartile)
3. 50th percentile (2nd quartile, or median)
4. 75th percentile (3rd quartile)
5. maximum

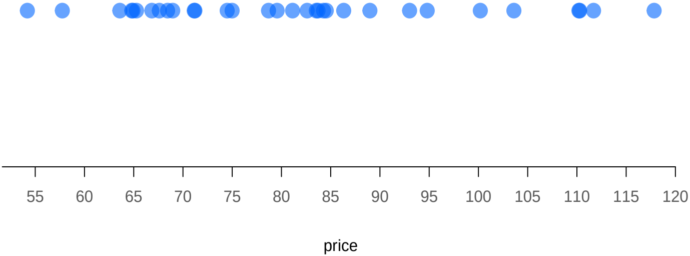
Box plot basics



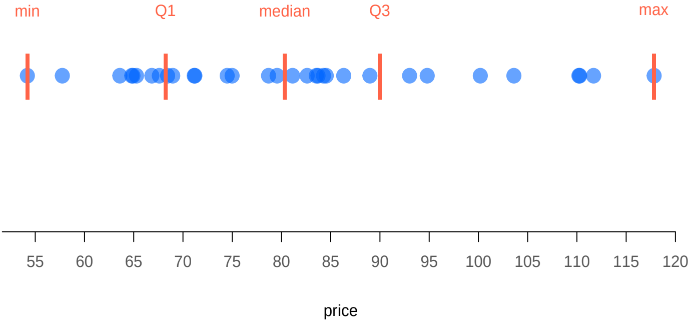
Box plot basics



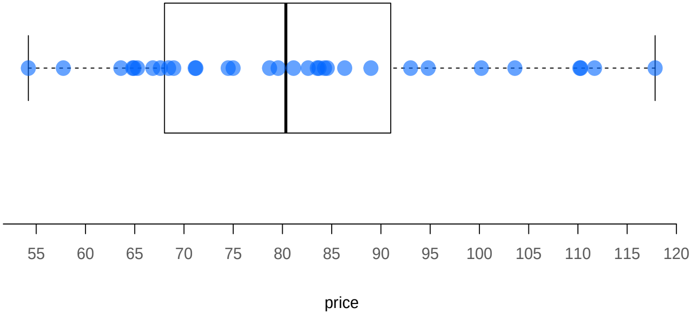
NFL Ticket Prices



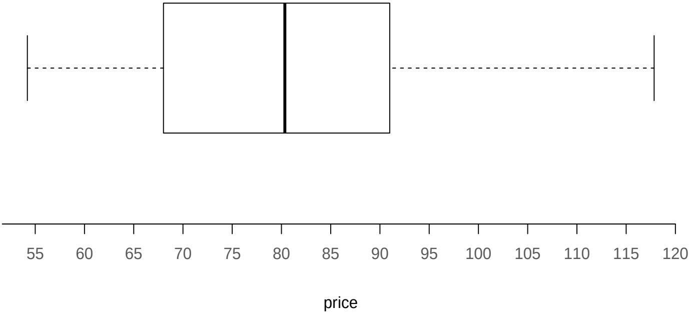
5 number summary



Box plot



Box plot

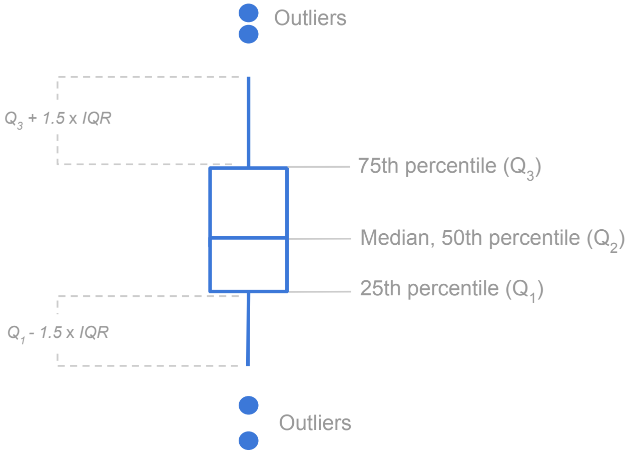


Box plot and outliers

The 1.5 x IQR rule for outliers

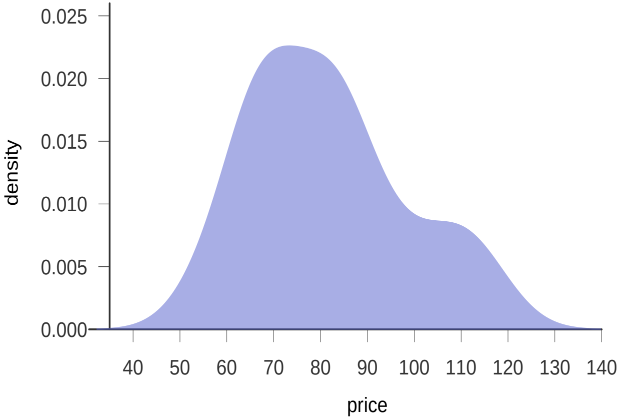
Call an observation a suspected outlier if it falls more than 1.5 x IQR above the third quartile or below the first quartile

Modified Box plot



Density Curves

Density Curve



Density Curve

A Density Curve

- Describes the distribution of values by a smooth curve
- Is always on or above the horizontal axis
- Has area equal to 1 underneath it
- Is an idealized distribution

Density Curve

About Density Curve

- The **mode** is the peak point of the curve (could be more than one or none)
- The **median** is the equal-areas point
- The **mean** is the balance point
- The median and the mean are always equal on a symmetric density curve

Ogives

Ogives

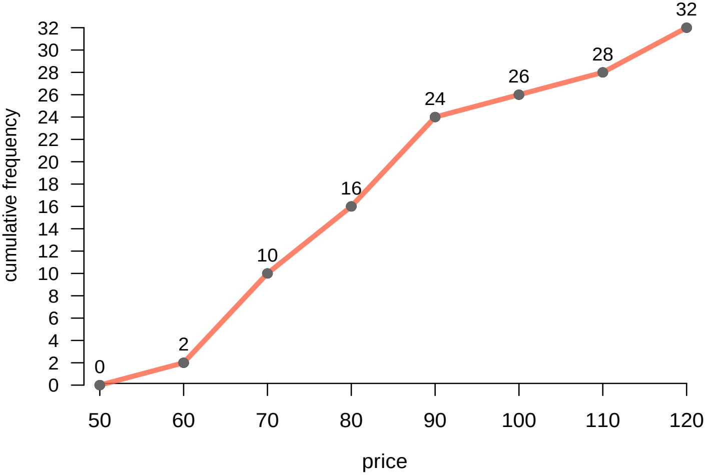
About Ogives

- Ogives help us examine the cumulative distribution of values in a quantitative variable
- An ogive tells us how many data are less than the indicated value on the horizontal axis
- An ogive shows how slowly or rapidly the data values accumulate over the range of the data

Frequency Table NFL Price Tickets

Bin	Interval	Mid-point	Frequency	Cum Freq
1	[50-60)	55	2	2
2	[60-70)	65	8	10
3	[70-80)	75	6	16
4	[80-90)	85	8	24
5	[90-100)	95	2	26
6	[100-110)	105	2	28
7	[110-120)	115	4	32

Ogive



cumulative frequency
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
2
10
16
24
26
28
32
50
60
70
80
90
100
110
120
price

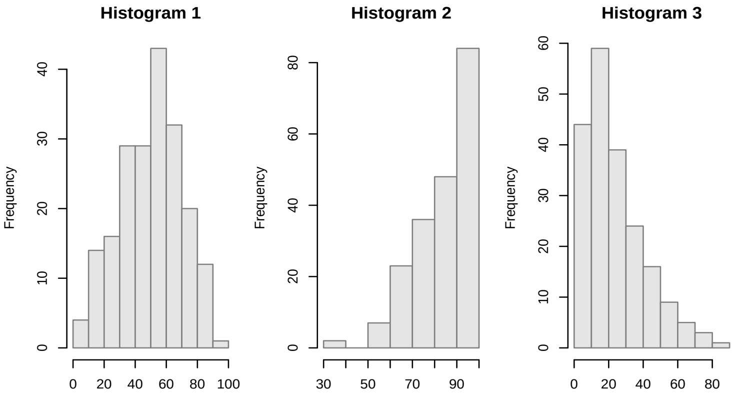
Ogives

Building an Ogive

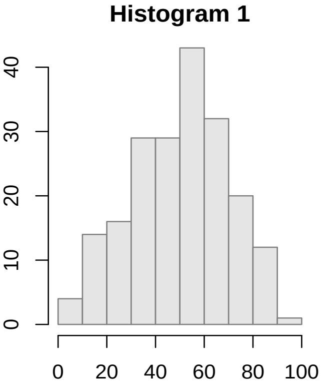
- Make a frequency table showing bin intervals and cumulative frequencies.
- An ogive begins on the horizontal axis at the lower boundary of the first bin.
- For each bin, make a dot over the upper interval limit at the height of the cumulative frequency.
- Connect the dots with line segments.

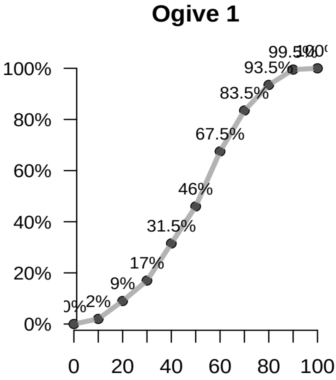
Distributions and Ogives

Three histograms

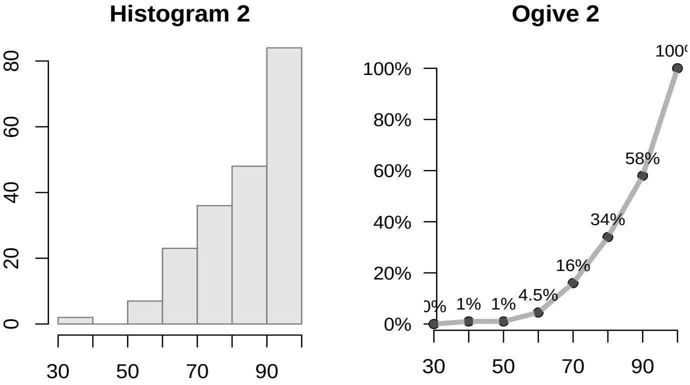


Symmetric Distribution

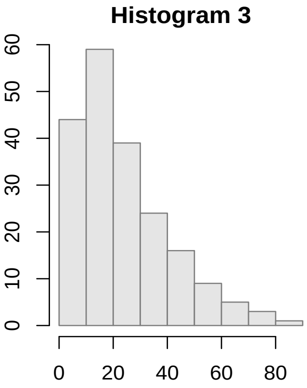


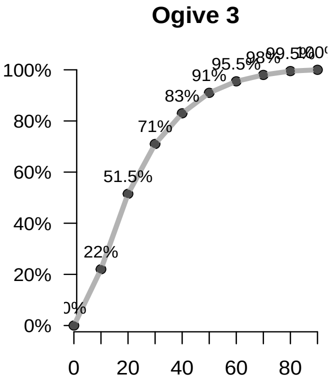


Skewed to the left Distribution



Skewed to the right Distribution


Histogram 3


Ogive 3