Solomon Islands Government

MINISTRY OF
FINANCE & TREASURY

Technical Assistance 8761 – Solomon Islands Economic Modeling for Policy Support

Lecture 1: Overview of Statistics

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Descriptive Statistics

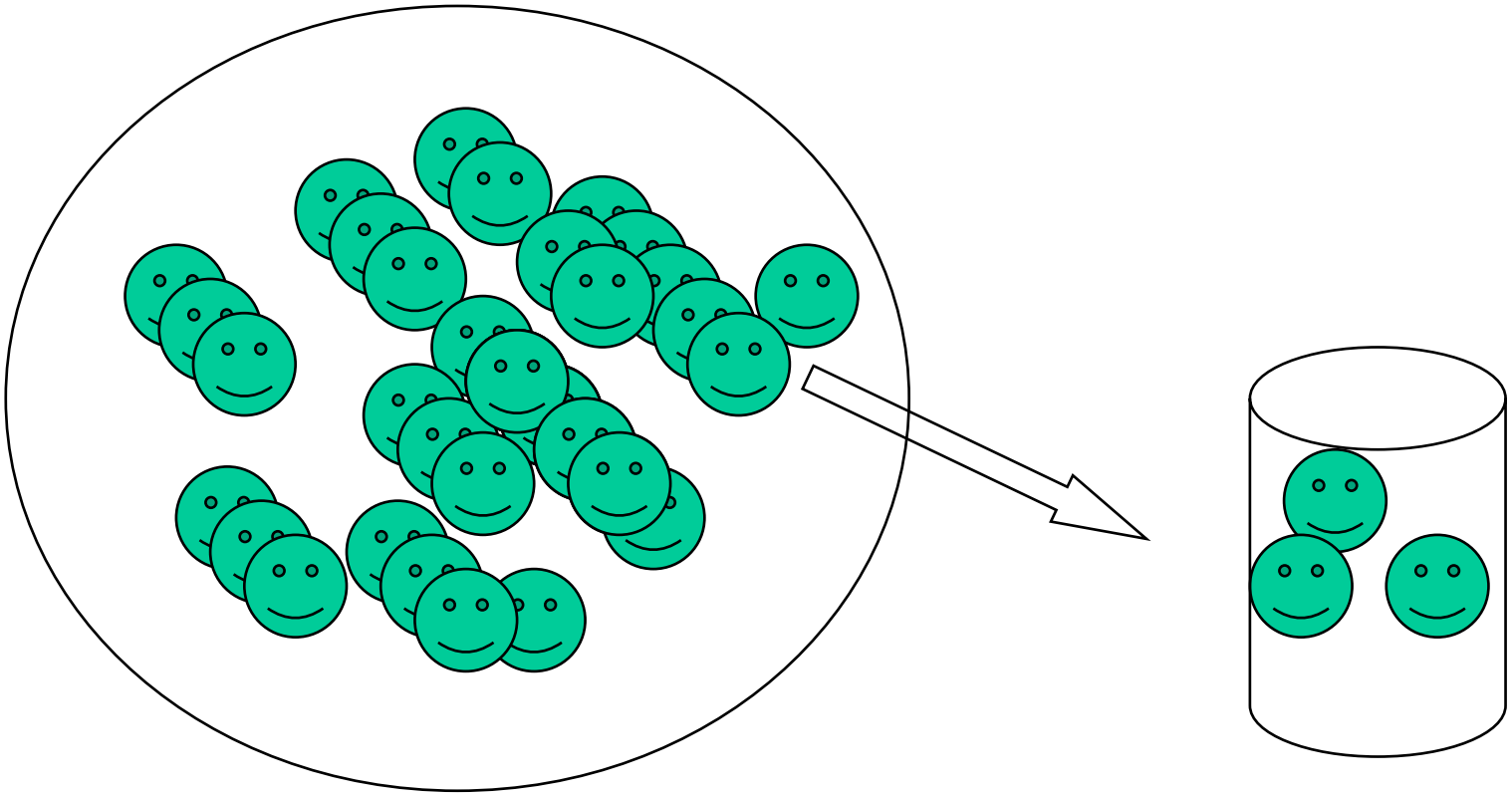
- Descriptive statistics are used by researchers to report on populations and samples

- In Economics and Finance:

  Summary descriptions of measurements (variables) taken about markets, microeconomic, and macroeconomic behavior, transactions, and flows

- By summarizing systematically, descriptive statistics reveal underlying relationships and trends

Sample vs. Population



Population

Sample

Descriptive Statistics

An Illustration:

Which Group is Smarter?

Class A--IQs of 13 Students		Class B--IQs of 13 Students	
102	115	127	162
128	109	131	103
131	89	96	111
98	106	80	109
140	119	93	87
93	97	120	105
110		109	

Each individual may be different. If you try to understand a group by remembering the qualities of each member, you become overwhelmed and fail to understand the group.

Descriptive Statistics

Which group is smarter now?

Class A--Average IQ	Class B--Average IQ
110.54	110.23

They're roughly the same!

With a summary descriptive statistic, it is much easier to answer our question.

Descriptive Statistics

Uses of descriptive statistics:

- Organize Data
  - Tables
  - Graphs

- Summarize Data
  - Central Tendency
  - Variation

Descriptive Statistics

Types of descriptive statistics:

- Organize Data
  - Tables
    - Frequency Distributions
    - Relative Frequency Distributions
  - Graphs
    - Bar Chart or Histogram
    - Stem and Leaf Plot
    - Frequency Polygon

SPSS Output for Frequency Distribution

IQ

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	82.00	1	4.2	4.2	4.2
	87.00	1	4.2	4.2	8.3
	89.00	1	4.2	4.2	12.5
	93.00	2	8.3	8.3	20.8
	96.00	1	4.2	4.2	25.0
	97.00	1	4.2	4.2	29.2
	98.00	1	4.2	4.2	33.3
	102.00	1	4.2	4.2	37.5
	103.00	1	4.2	4.2	41.7
	105.00	1	4.2	4.2	45.8
	106.00	1	4.2	4.2	50.0
	107.00	1	4.2	4.2	54.2
	109.00	1	4.2	4.2	58.3
	111.00	1	4.2	4.2	62.5
	115.00	1	4.2	4.2	66.7
	119.00	1	4.2	4.2	70.8
	120.00	1	4.2	4.2	75.0
	127.00	1	4.2	4.2	79.2
	128.00	1	4.2	4.2	83.3
	131.00	2	8.3	8.3	91.7
	140.00	1	4.2	4.2	95.8
	162.00	1	4.2	4.2	100.0
	Total	24	100.0	100.0	

Frequency Distribution

Frequency Distribution of IQ for Two Classes

IQ	Frequency
82.00	1
87.00	1
89.00	1
93.00	2
96.00	1
97.00	1
98.00	1
102.00	1
103.00	1
105.00	1
106.00	1
107.00	1
109.00	1
111.00	1
115.00	1
119.00	1
120.00	1
127.00	1
128.00	1
131.00	2
140.00	1
162.00	1
Total	24

Relative Frequency Distribution

Relative Frequency Distribution of IQ for Two Classes

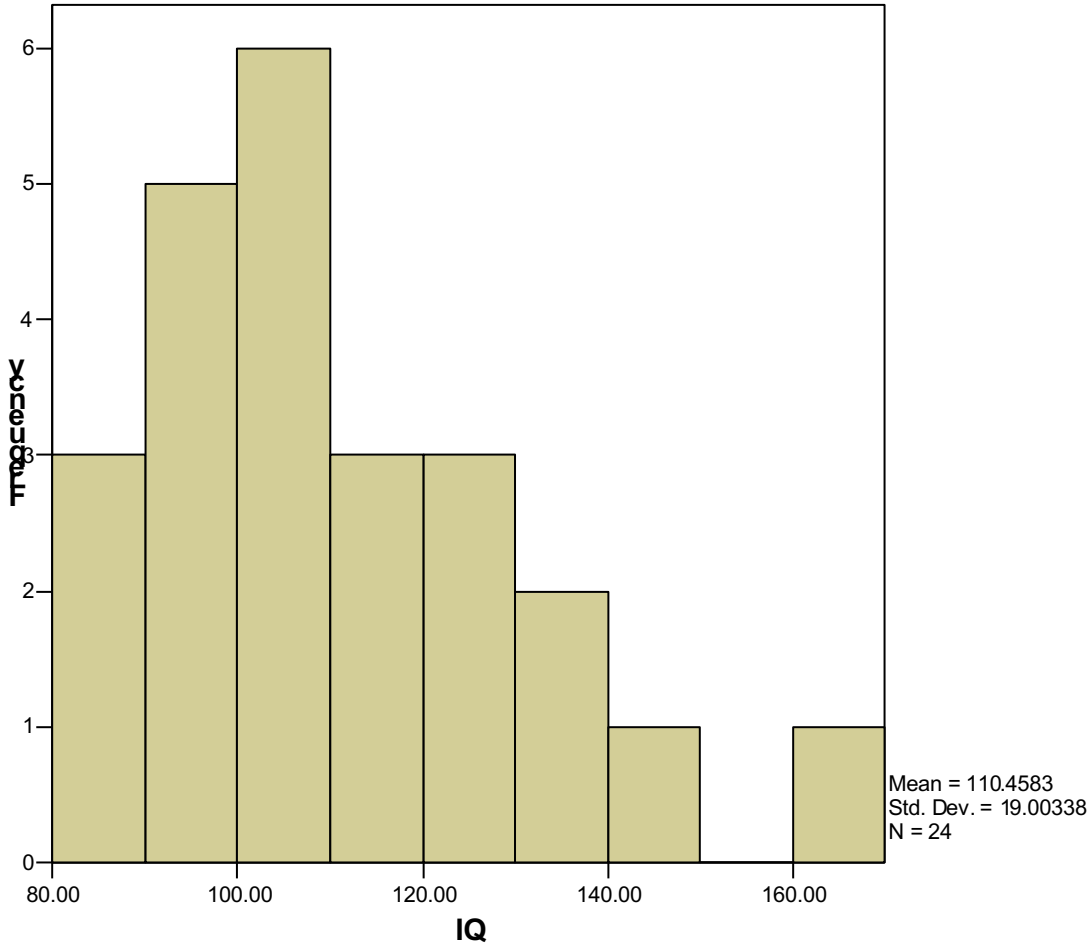
IQ	Frequency	Percent	Valid Percent	Cumulative Percent
82.00	1	4.2	4.2	4.2
87.00	1	4.2	4.2	8.3
89.00	1	4.2	4.2	12.5
93.00	2	8.3	8.3	20.8
96.00	1	4.2	4.2	25.0
97.00	1	4.2	4.2	29.2
98.00	1	4.2	4.2	33.3
102.00	1	4.2	4.2	37.5
103.00	1	4.2	4.2	41.7
105.00	1	4.2	4.2	45.8
106.00	1	4.2	4.2	50.0
107.00	1	4.2	4.2	54.2
109.00	1	4.2	4.2	58.3
111.00	1	4.2	4.2	62.5
115.00	1	4.2	4.2	66.7
119.00	1	4.2	4.2	70.8
120.00	1	4.2	4.2	75.0
127.00	1	4.2	4.2	79.2
128.00	1	4.2	4.2	83.3
131.00	2	8.3	8.3	91.7
140.00	1	4.2	4.2	95.8
162.00	1	4.2	4.2	100.0
Total	24	100.0	100.0	

Grouped Relative Frequency Distribution

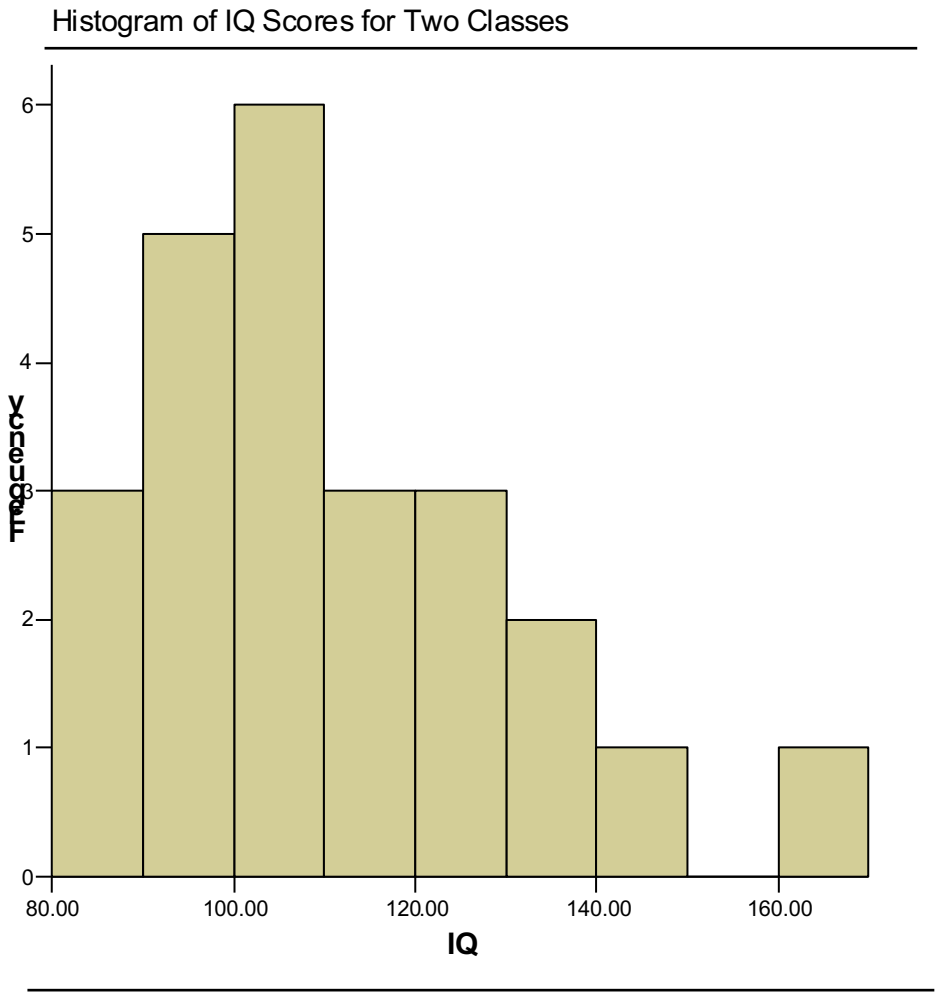
Relative Frequency Distribution of IQ for Two Classes

IQ	Frequency	Percent	Cumulative Percent
80 – 89	3	12.5	12.5
90 – 99	5	20.8	33.3
100 – 109	6	25.0	58.3
110 – 119	3	12.5	70.8
120 – 129	3	12.5	83.3
130 – 139	2	8.3	91.6
140 – 149	1	4.2	95.8
150 and over	1	4.2	100.0
Total	24	100.0	100.0

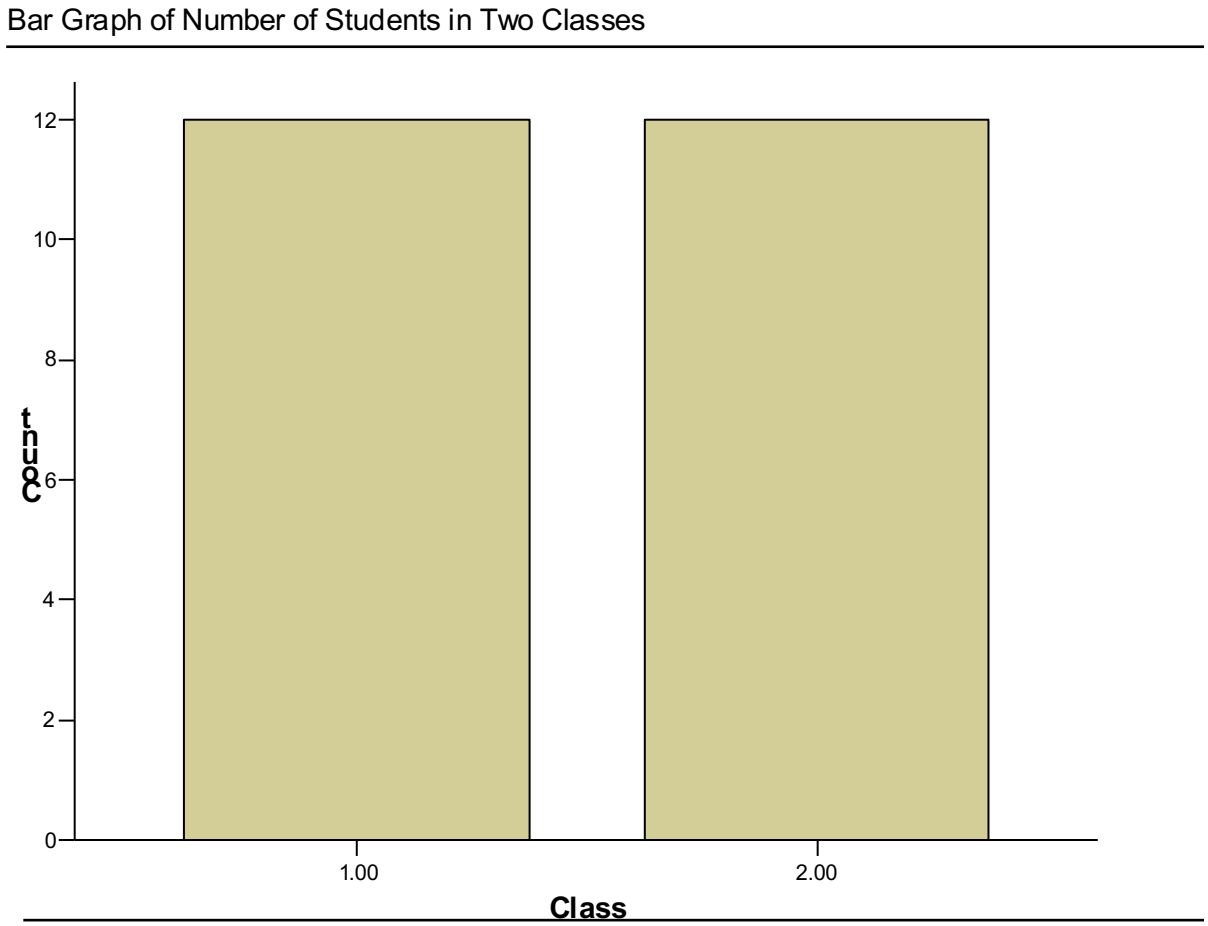
SPSS Output for Histogram



Histogram


Histogram of IQ Scores for Two Classes
6
5
4
3
2
1
0
80.00
100.00
120.00
140.00
160.00
IQ

Bar Graph


Bar Graph of Number of Students in Two Classes
12
10
8
6
4
2
0
1.00
2.00
Class

Stem and Leaf Plot

Stem and Leaf Plot of IQ for Two Classes

Stem	Leaf
8	2 7 9
9	3 6 7 8
10	2 3 5 6 7 9
11	1 5 9
12	0 7 8
13	1
14	0
15	
16	2

Note: Stata does a good job of producing these.

Descriptive Statistics

Summarizing Data:

- Central Tendency (or Groups' "Middle Values")
  - Mean
  - Median
  - Mode
- Variation (or Summary of Differences Within Groups)
  - Range
  - Interquartile Range
  - Variance
  - Standard Deviation

Mean

Not an attitude,

a measure of central tendency.

Most commonly called the “average.”

Nice kitty!

Add up the values for each case and divide by the total number of cases.

$$\bar{Y} = \frac{(Y1 + Y2 + \ldots + Yn)}{n}$$

$$\bar{Y} = \frac{\Sigma Yi}{n}$$

Mean

What's up with all those symbols, man?

$$\bar{Y} = \frac{(Y1 + Y2 + \ldots + Yn)}{n}$$

$$\bar{Y} = \frac{\Sigma Yi}{n}$$

Some Symbolic Conventions in this Class:

- Y = your variable (could be X or Q or ☺ or even "Glitter")
- "-bar" or line over symbol of your variable = mean of that variable
- Y1 = first case's value on variable Y
- ". . ." = ellipsis = continue sequentially
- Yn = last case's value on variable Y
- n = number of cases in your sample
- Σ = Greek letter "sigma" = sum or add up what follows
- *i* = a typical case or each case in the sample (1 through n)

Mean

Class A--IQs of 13 Students	
102	115
128	109
131	89
98	106
140	119
93	97
110	

$\Sigma Yi = 1437$

$\bar{Y}_A = \frac{\Sigma Yi}{n} = \frac{1437}{13} = 110.54$

Class B--IQs of 13 Students	
127	162
131	103
96	111
80	109
93	87
120	105
109	

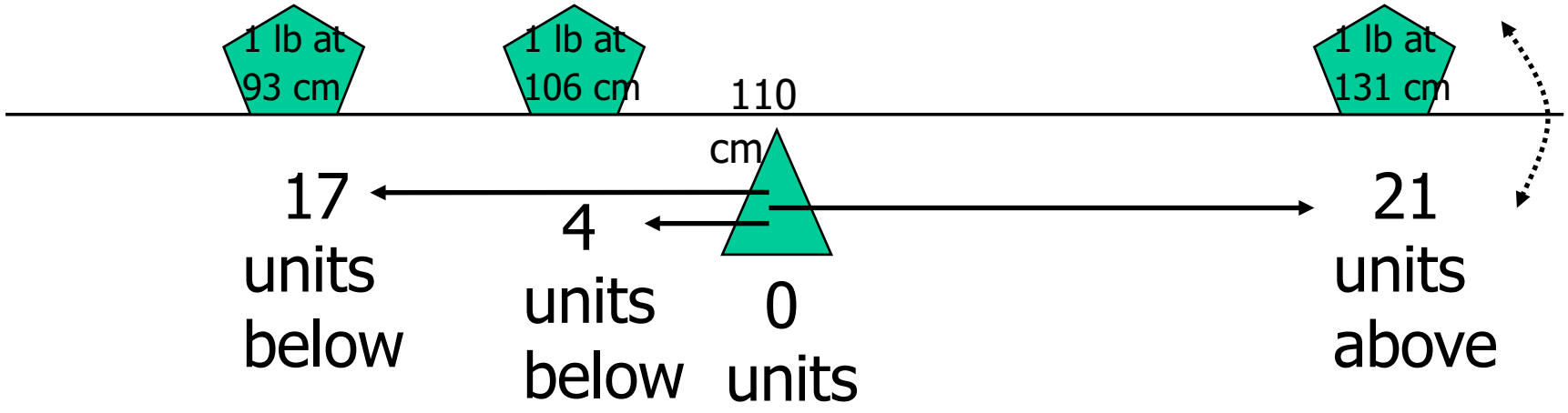
$\Sigma Yi = 1433$

$\bar{Y}_B = \frac{\Sigma Yi}{n} = \frac{1433}{13} = 110.23$

Mean

The mean is a "balance point" for the sample.

Each person's score is like 1 pound placed at the score's position on a see-saw. Below, on a 200 cm see-saw, the mean equals 110, the place on the see-saw where a fulcrum finds balance:

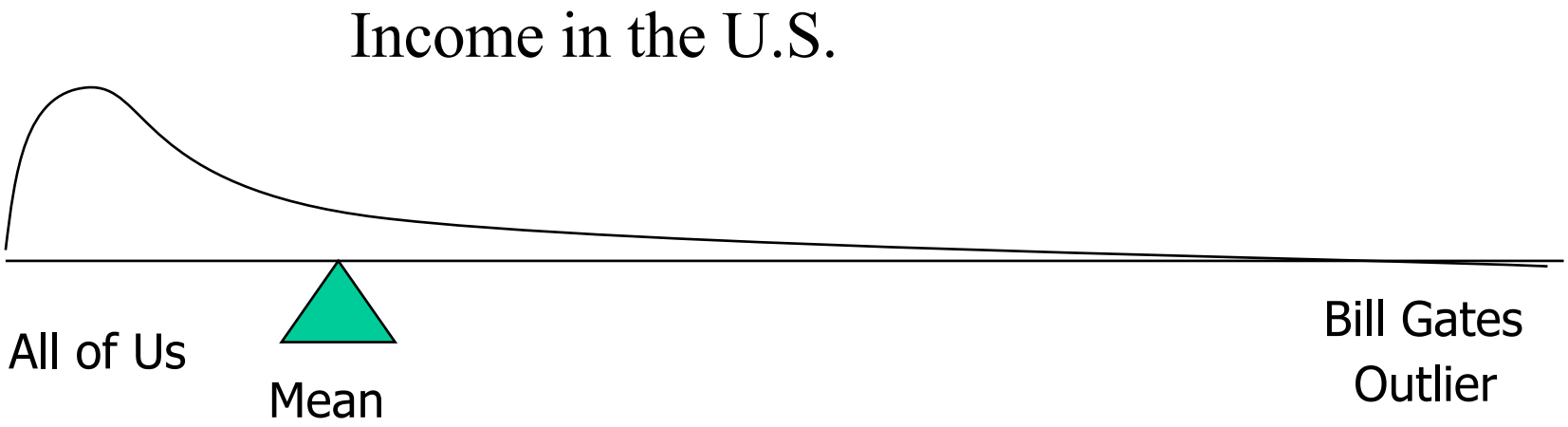


The scale is balanced because…

17 + 4 on the left = 21 on the right

Mean

1. Means can be badly affected by outliers (data points with extreme values unlike the rest)
2. Outliers can make the mean a bad measure of central tendency or common experience



Median

The middle value when a variable's values are ranked in order; the point that divides a sample into two equal size groups.

When data are listed in order, the median is the point at which 50% of the cases are above and 50% below it.

The 50th percentile.

Median

Class A--IQs of 13 Students

89
93
97
98
102
106
109
110
115
119
128
131
140

Median = 109

(six cases above, six below)

Median

If the first student were to drop out of Class A, there would be a new median:

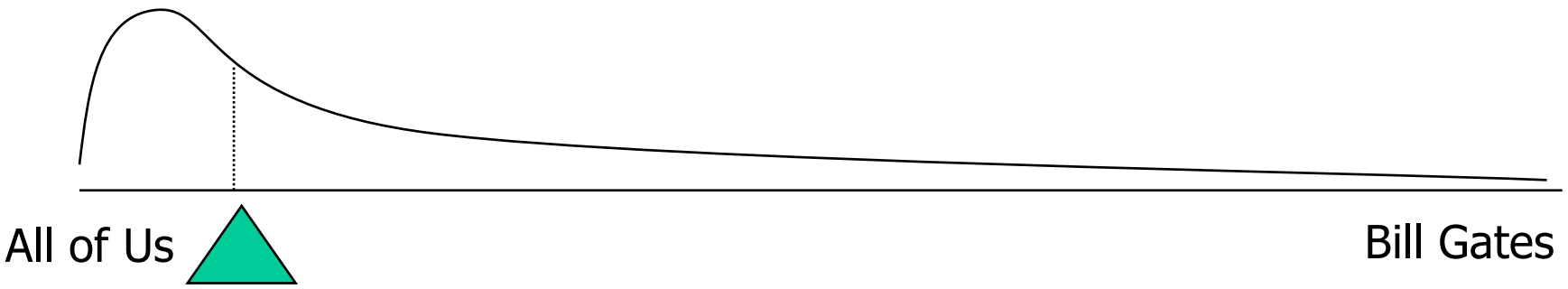
89
93
97
98
102
106
109
110 ← Median = 109.5
115
119
128
131
140

109 + 110 = 219/2 = 109.5

(six cases above, six below)

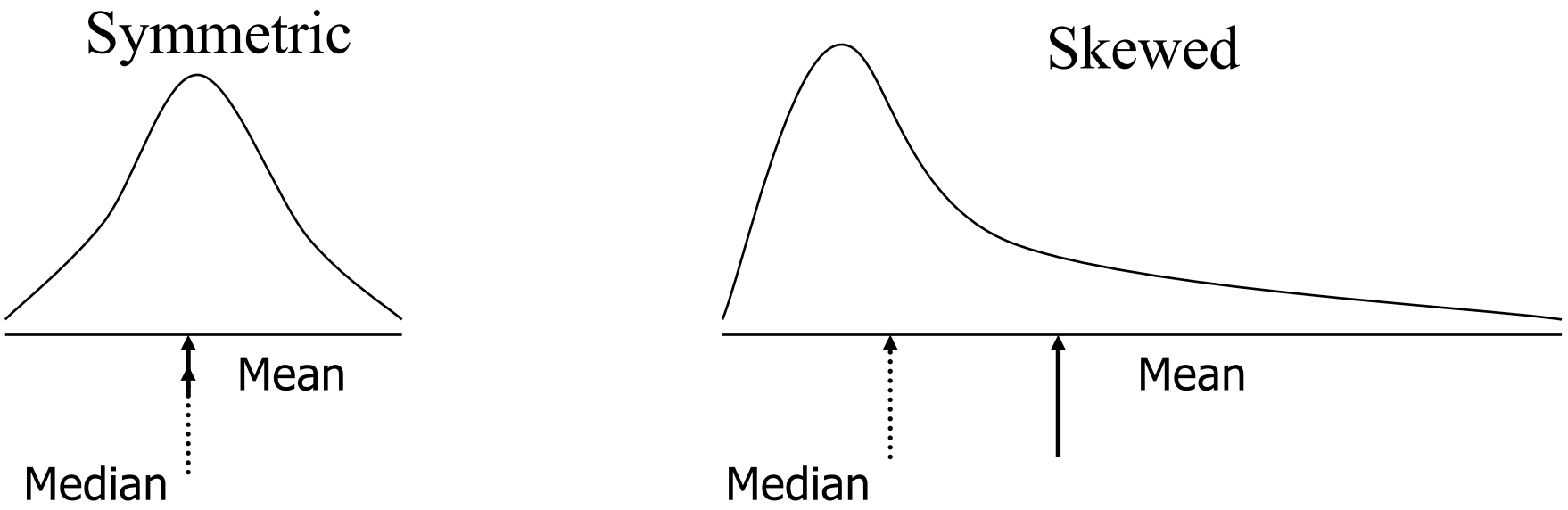
Median

1. The median is unaffected by outliers, making it a better measure of central tendency, better describing the "typical person" than the mean when data are skewed.



Median

2. If the recorded values for a variable form a symmetric distribution, the median and mean are identical.
3. In skewed data, the mean lies further toward the skew than the median.



Median

The middle score or measurement in a set of ranked scores or measurements; the point that divides a distribution into two equal halves.

Data are listed in order—the median is the point at which 50% of the cases are above and 50% below.

The 50th percentile.

Mode

The most common data point is called the mode.

The combined IQ scores for Classes A & B:

80 87 89 93 93 96 97 98 102 103 105 106 109 109 109 110 111 115 119 120
127 128 131 131 140 162

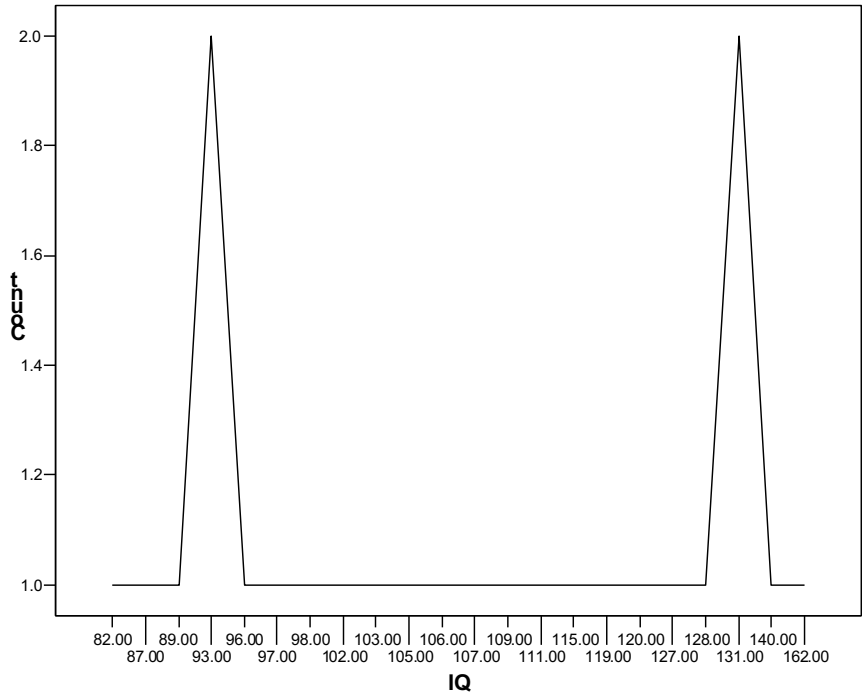
A la mode!!

It is possible to have more than one mode (in case of a tie).

Mode

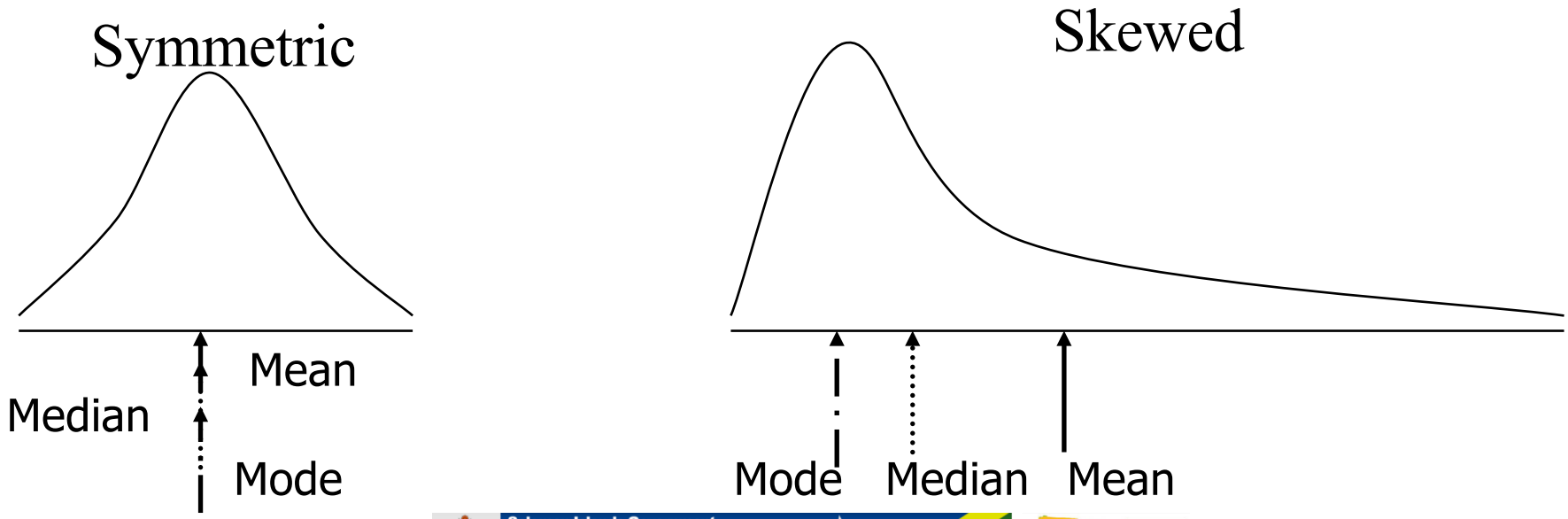
It may mot be at the center of a distribution.

Data distribution on the right is "bimodal"



Mode

1. It may give you the most likely experience rather than the "typical" or "central" experience.
2. In symmetric distributions, the mean, median, and mode are the same.
3. In skewed data, the mean and median lie further toward the skew than the mode.



Descriptive Statistics

Summarizing Data:

- ✓ Central Tendency (or Groups' "Middle Values")
  - ✓Mean
  - ✓Median
  - ✓Mode
- – Variation (or Summary of Differences Within Groups)
  - Range
  - Interquartile Range
  - Variance
  - Standard Deviation

Range

The spread, or the distance, between the lowest and highest values of a variable.

To get the range for a variable, you subtract its lowest value from its highest value.

Class A--IQs of 13 Students		Class B--IQs of 13 Students	
102	115	127	162
128	109	131	103
131	89	96	111
98	106	80	109
140	119	93	87
93	97	120	105
110		109	

Class A Range = 140 - 89 = 51 **Class B Range = 162 - 80 = 82**

Interquartile Range

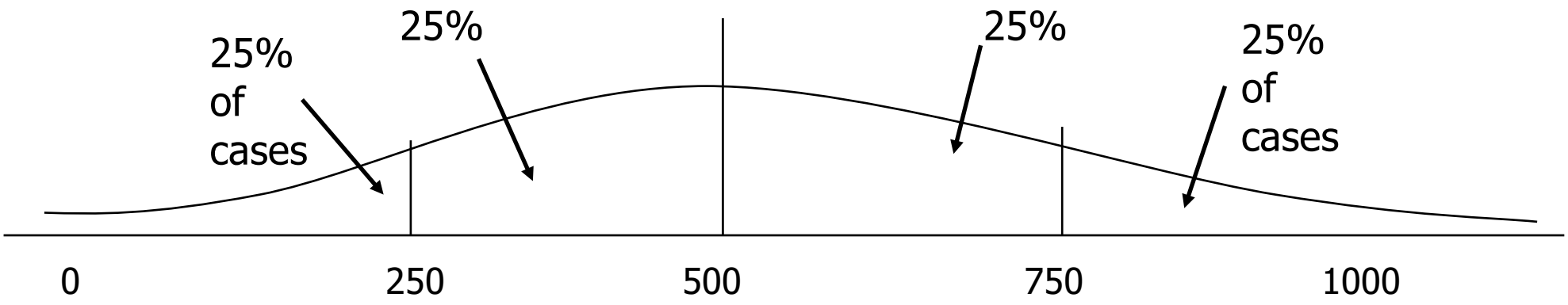
A quartile is the value that marks one of the divisions that breaks a series of values into four equal parts.

The median is a quartile and divides the cases in half.

25th percentile is a quartile that divides the first ¼ of cases from the latter ¾.

75th percentile is a quartile that divides the first ¾ of cases from the latter ¼.

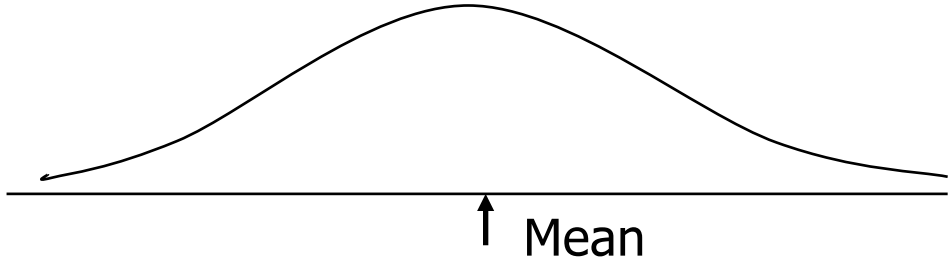
The interquartile range is the distance or range between the 25th percentile and the 75th percentile. Below, what is the interquartile range?



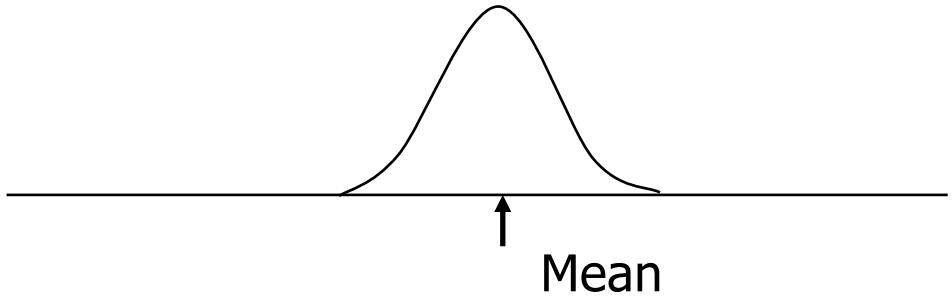
Variance

A measure of the spread of the recorded values on a variable. A measure of dispersion.

The larger the variance, the further the individual cases are from the mean.



The smaller the variance, the closer the individual scores are to the mean.



Variance

Variance is a number that at first seems complex to calculate = the average squared difference from the mean.

Calculating variance starts with a "deviation."

A deviation is the distance away from the mean of a case's score.

If the average person's car costs $20,000, my deviation from the mean is - $14,000!

6K - 20K = -14K

Variance

The deviation of 102 from 110.54 is? Deviation of 115?

Class A--IQs of 13 Students

102	115
128	109
131	89
98	106
140	119
93	97
110	

$\bar{Y}_A = 110.54$

Variance

The deviation of 102 from 110.54 is? Deviation of 115?

102 - 110.54 = -8.54 115 - 110.54 = 4.46

Class A--IQs of 13 Students

102	115
128	109
131	89
98	106
140	119
93	97
110	

$\bar{Y}_A = 110.54$

Variance

- We want to add these to get total deviations, but if we were to do that, we would get zero every time. Why?
- We need a way to eliminate negative signs.

Squaring the deviations will eliminate negative signs...

A Deviation Squared: $\sum(Y_i - \bar{Y})^2$

Back to the IQ example,

A deviation squared for 102 is: $(102 - 110.54)^2 = (-8.54)^2 = 72.93$

of 115: $(115 - 110.54)^2 = (4.46)^2 = 19.89$

Variance

If you were to add all the squared deviations together, you'd get what we call the "Sum of Squares."

Sum of Squares (SS) = $\sum(Y_i - \bar{Y})^2$

$\text{SS} = \sum(Y_1 - \bar{Y})^2 \sum(Y_2 - \bar{Y})^2 + \ldots + \sum(Y_n - \bar{Y})^2$

Variance

Class A, sum of squares:

$(102 - 110.54)^2 + (115 - 110.54)^2 +$
$(126 - 110.54)^2 + (109 - 110.54)^2 +$
$(131 - 110.54)^2 + (89 - 110.54)^2 +$
$(98 - 110.54)^2 + (106 - 110.54)^2 +$
$(140 - 110.54)^2 + (119 - 110.54)^2 +$
$(93 - 110.54)^2 + (97 - 110.54)^2 +$
$(110 - 110.54) = SS = 2825.39$

Class A--IQs of 13 Students

102	115
128	109
131	89
98	106
140	119
93	97
110	

$\bar{Y} = 110.54$

Variance

The last step…

The approximate average sum of squares is the sample variance.

SS/N = Variance for a population.

SS/n-1 = Variance for a sample.

$$\text{Variance} = \frac{\sum(Y_I - \bar{Y})^2}{n-1}$$

Variance

For Class A, Variance = 2825.39 / n - 1

= 2825.39 / 12 = 235.45

How helpful is that???

Standard Deviation

To convert variance into something meaningful, we need to return to the original units, creating the standard deviation.

The square root of the variance reveals the average deviation of the observations from the mean.

$$\text{s.d.} = \sqrt{\frac{\sum(Y_I - \bar{Y})^2}{n-1}}$$

Standard Deviation

For Class A, the standard deviation is:

$$\sqrt{235.45} = 15.34$$

The average of persons' deviation from the mean IQ of

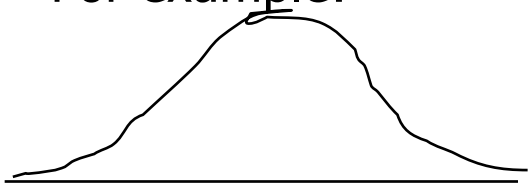
110.54 is 15.34 IQ points.

Review:
1. Deviation
2. Deviation squared
3. Sum of squares
4. Variance
5. Standard deviation

Standard Deviation

1. Larger s.d. = greater amounts of variation around the mean.

   For example:



19 25 31

$\bar{Y} = 25$

s.d. = 3

13 25 37

$\bar{Y} = 25$

s.d. = 6

2. s.d. = 0 only when all values are the same (only when you have a constant and not a "variable")
3. If you were to "rescale" a variable, the s.d. would change by the same magnitude—if we changed units above so the mean equaled 250, the s.d. on the left would be 30, and on the right, 60
4. Like the mean, the s.d. will be inflated by an outlier case value.

Descriptive Statistics

Summarizing Data:

- ✓ Central Tendency (or Groups' "Middle Values")
  - ✓ Mean
  - ✓ Median
  - ✓ Mode
- ✓ Variation (or Summary of Differences Within Groups)
  - ✓ Range
  - ✓ Interquartile Range
  - ✓ Variance
  - ✓ Standard Deviation
- – …Wait! There's more

Box-Plots

A way to graphically portray almost all the descriptive statistics at once is the box-plot.

A box-plot shows: Upper and lower quartiles

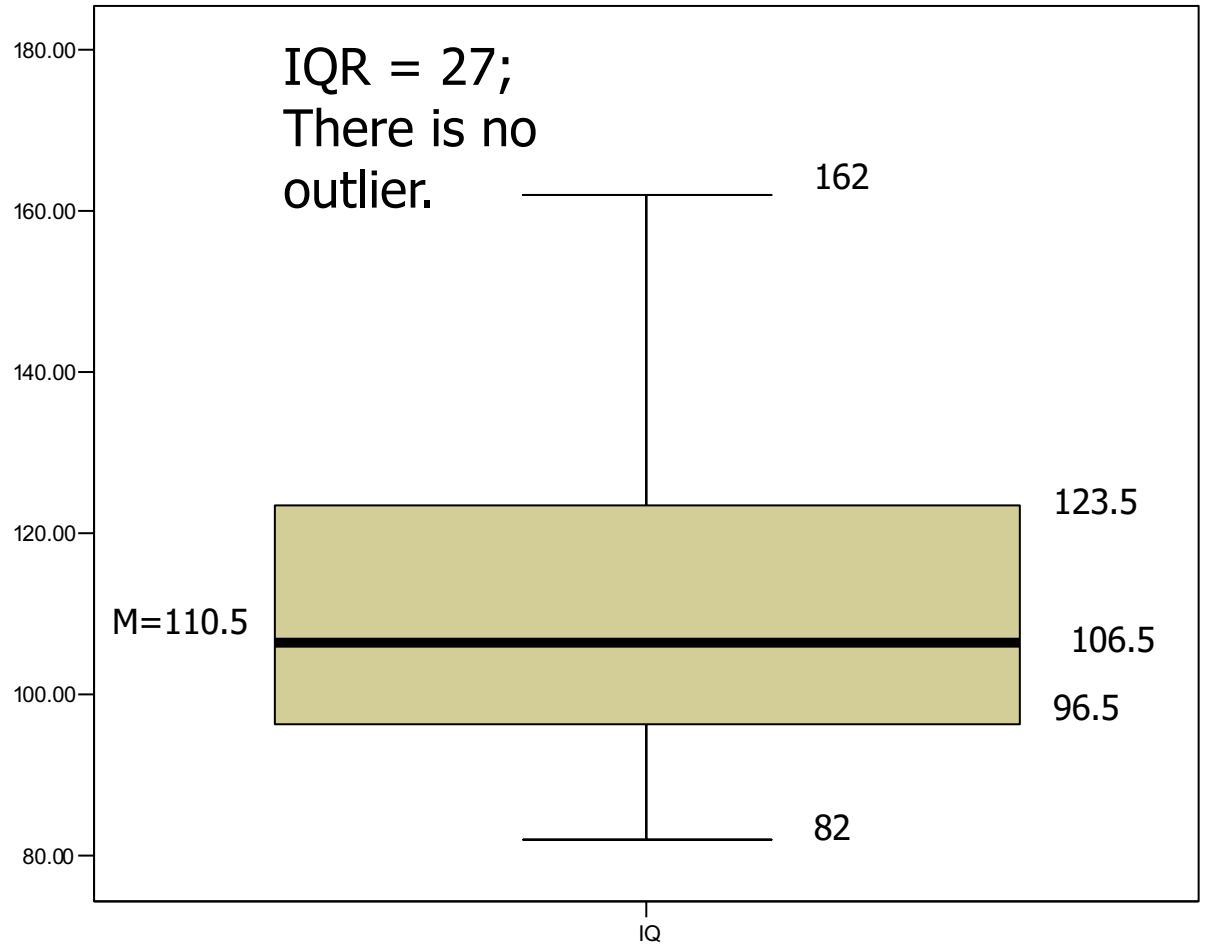
Mean

Median

Range

Outliers (1.5 IQR)

Box-Plots


IQR = 27;
There is no outlier.
180.00
160.00
140.00
120.00
100.00
80.00
162
123.5
M=110.5
106.5
96.5
82
IQ

Sample Cases

1. *California Income Data*
2. *Solomon Islands 2015 Enterprise Survey*
3. *Solomon Islands Opinion Poll on World Bank Services*