

Basic Statistics

Describing Data – Measures of Central Tendency

Learning, Teaching
and Student Engagement

Describing Data

Learning Intentions

Today we will understand:

- ▶ Measures of Central Tendency
 - * Mean
 - * Median
 - * Mode



Describing Data

Two descriptions of data:

- ▶ Measures of Central Tendency
- ▶ Measures of Dispersion



Measures of Central Tendency

- ▶ Mean
- ▶ Median
- ▶ Mode

The Average Bears



Mr. Mean



Mr. Median



Mr. Mode

Mean

- ▶ Arithmetic average

$$\text{Mean} = \frac{\text{Sum of all data values}}{\text{Number of data values}}$$

Symbolically,

$$\bar{x} = \frac{\sum x}{n}$$

where:

\bar{x} (read as 'x bar') is the mean of the set of x values

$\sum x$ is the sum of all the x values

n is the number of x values



Mean

- ▶ Calculate the mean height of JCU students

$$\bar{x} = \frac{\sum x}{n}$$

$$= \frac{(175 + 163 + 155 + 149 + 180 + 165)}{6}$$

$$= \frac{987}{6}$$

$$= 164.5 \text{ cm}$$

Height (cm)
175
163
155
149
180
165

You try.....

1)

Weight (g)
23
50
16
44
36
29
47
52
35
42
41
28
26
24
38

2)

Time (s)
90
63
87
56
71
38
42
52
86
79
67
83
69
82
64

3)

Length (m)
5.3
2.8
3.6
3.9
2.7
4.8
4.2
6.2
5.9
5.1
4.6
5.3
6.9

Answers

$$1) \quad \bar{x} = \frac{\sum x}{n}$$

$$= \frac{(23 + 50 + 16 + 44 + 36 + 29 + 47 + 52 + 35 + 42 + 41 + 28 + 26 + 24 + 38)}{15}$$

$$= 531$$

$$= 34.5 \text{ g}$$

$$2) \quad \bar{x} = \frac{\sum x}{n}$$

$$= \frac{(90 + 63 + 87 + 56 + 71 + 38 + 42 + 52 + 86 + 79 + 67 + 83 + 69 + 82 + 64)}{15}$$

$$= 1029$$

$$= 68.6 \text{ s}$$

Answers

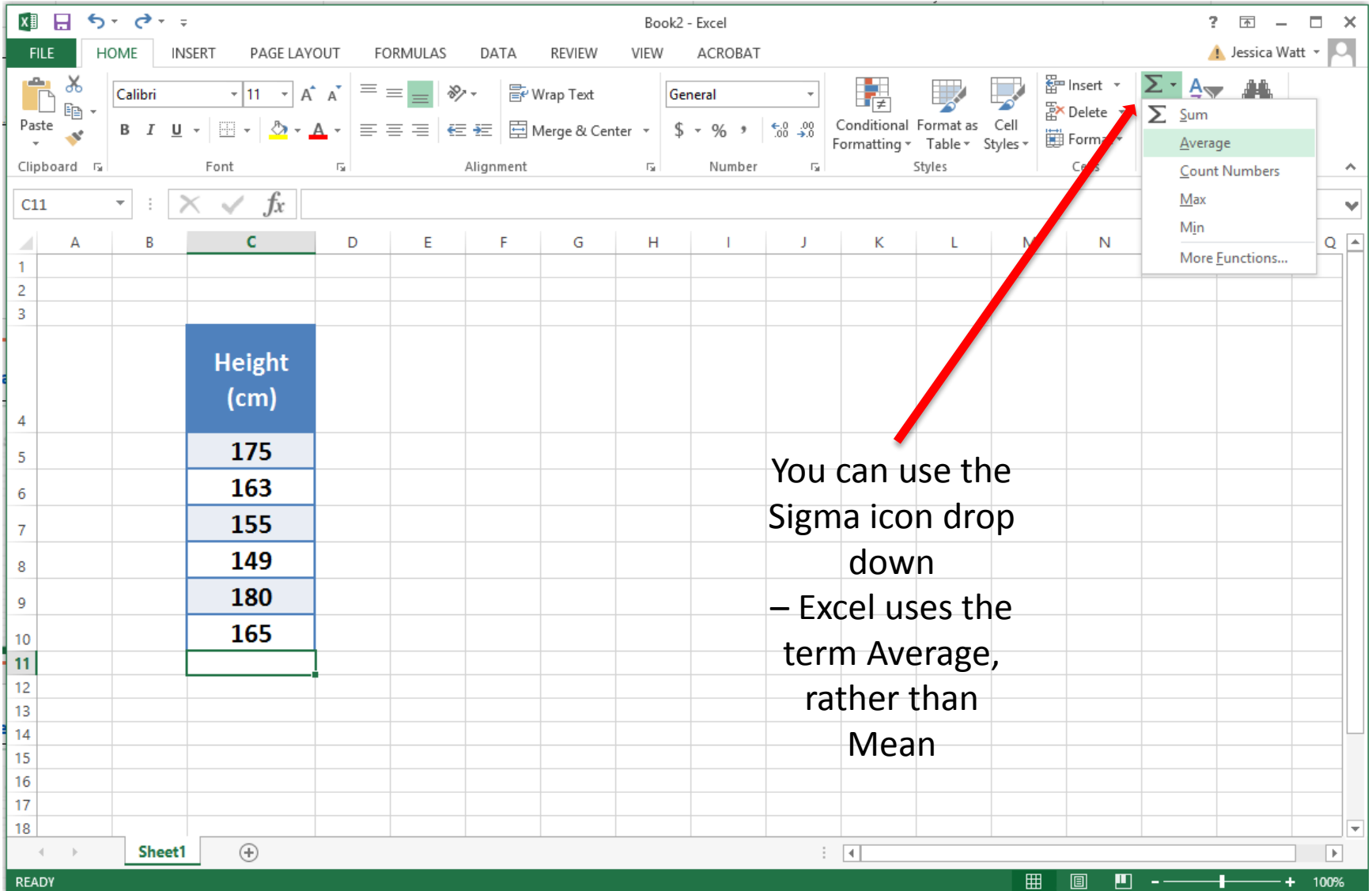
$$3) \quad \bar{x} = \frac{\sum x}{n}$$

$$= \frac{(5.3 + 2.8 + 3.6 + 3.9 + 2.7 + 4.8 + 4.2 + 6.2 + 5.9 + 5.1 + 4.6 + 5.3 + 6.9)}{13}$$

$$= 613$$

$$= 4.7 \text{ m}$$

Using Excel to Find the Mean



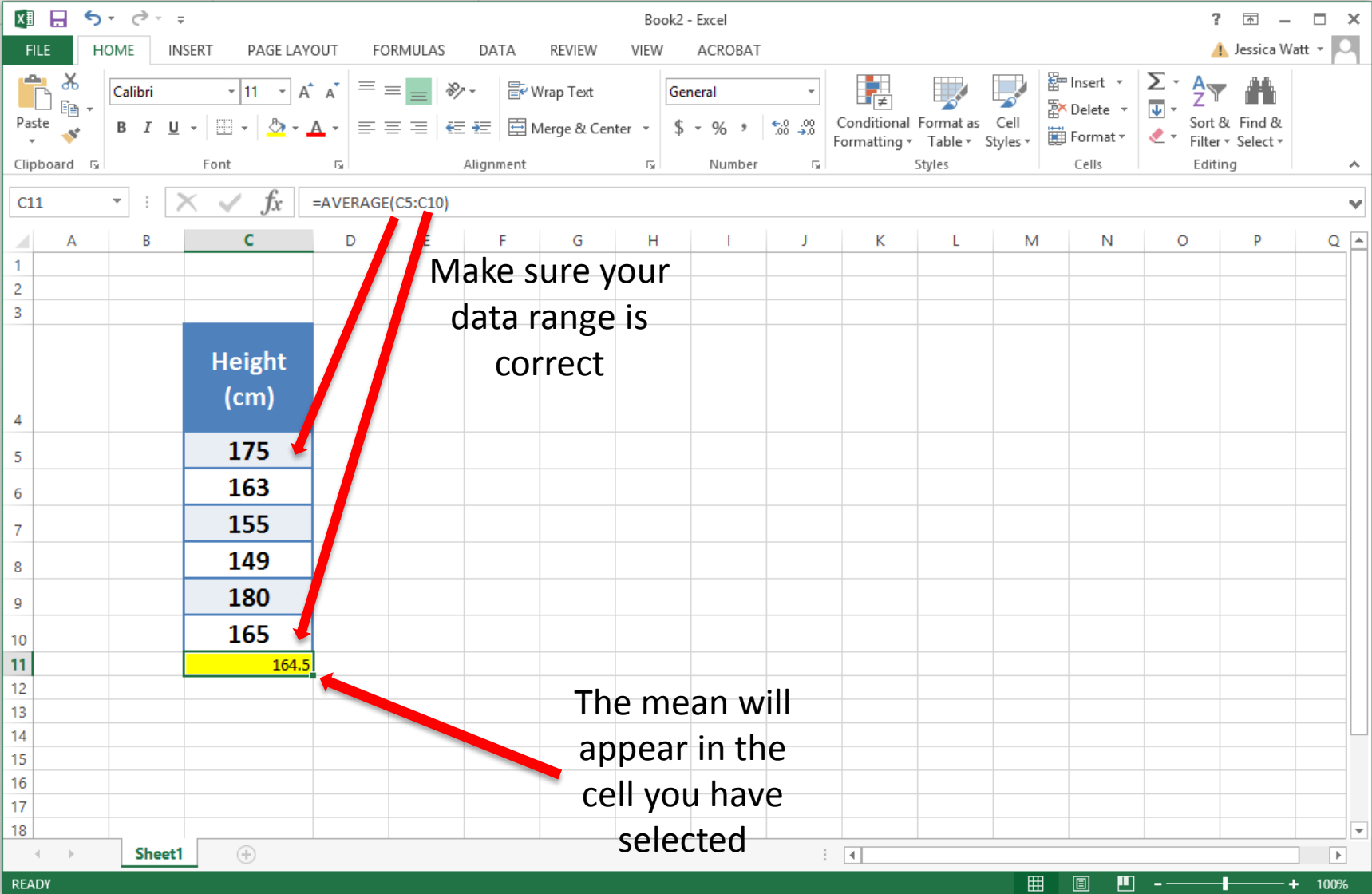
The screenshot shows the Microsoft Excel interface. The ribbon is set to 'HOME'. The 'FUNCTIONS' group in the ribbon is expanded, showing the 'Sigma' icon (Σ) with a dropdown menu. A red arrow points from the text below to the 'Average' option in the dropdown menu. The spreadsheet contains a table with the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1														
2														
3														
4			Height (cm)											
5			175											
6			163											
7			155											
8			149											
9			180											
10			165											
11														
12														
13														
14														
15														
16														
17														
18														

The status bar at the bottom shows 'Sheet1' and 'READY'.

You can use the
Sigma icon drop
down
– Excel uses the
term Average,
rather than
Mean

Using Excel to Find the Mean



The screenshot shows the Microsoft Excel interface with a spreadsheet titled "Book2 - Excel". The ribbon is set to "HOME". The active cell is C11, and the formula bar shows the formula `=AVERAGE(C5:C10)`. The spreadsheet data is as follows:

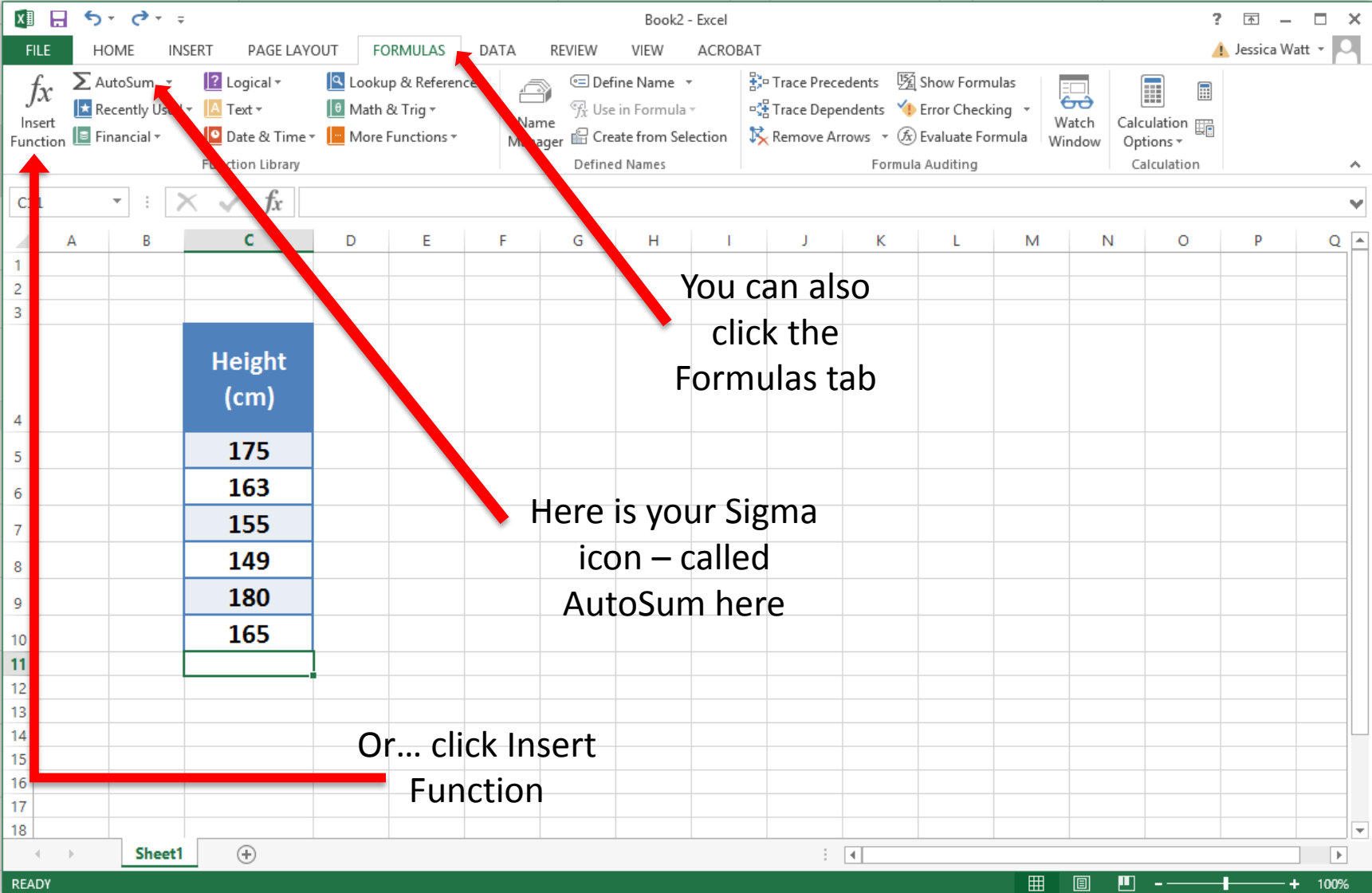
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1																	
2																	
3																	
4			Height (cm)														
5			175														
6			163														
7			155														
8			149														
9			180														
10			165														
11			164.5														
12																	
13																	
14																	
15																	
16																	
17																	
18																	

Annotations:

- Two red arrows point from the text "Make sure your data range is correct" to the data range C5:C10.
- A red arrow points from the text "The mean will appear in the cell you have selected" to cell C11.

READY 100%

Using Excel to Find the Mean



The screenshot shows the Microsoft Excel interface with the 'FORMULAS' tab selected. The ribbon includes 'Function Library' with the 'AutoSum' icon (a sigma symbol) highlighted. The spreadsheet contains a table of height measurements in centimeters. Red arrows point from the 'AutoSum' icon to the 'FORMULAS' tab and from the 'FORMULAS' tab to the 'AutoSum' icon. Another red arrow points from the 'FORMULAS' tab to the 'Insert Function' button. A third red arrow points from the 'Insert Function' button to the 'AutoSum' icon.

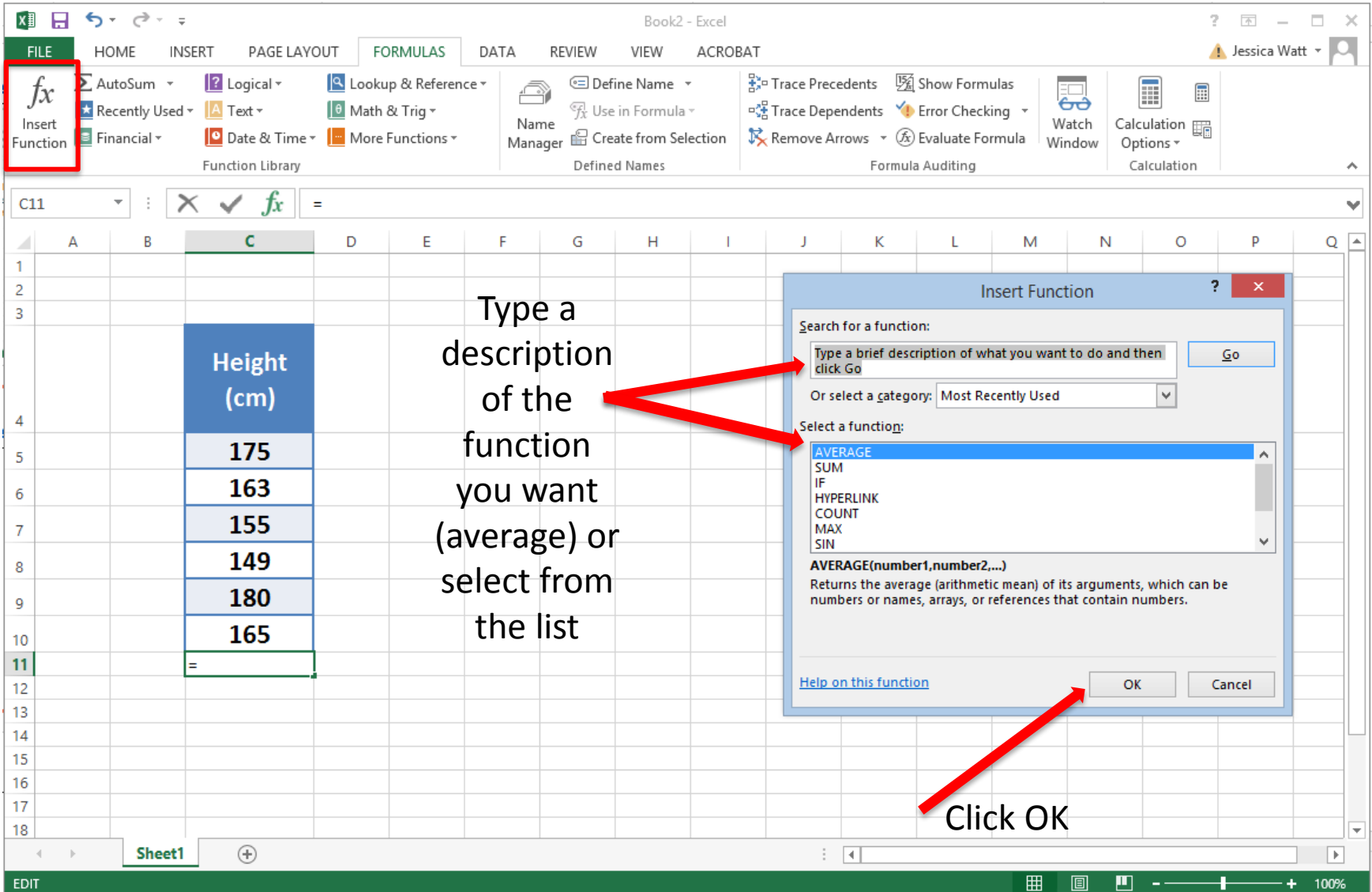
Height (cm)
175
163
155
149
180
165

You can also click the Formulas tab

Here is your Sigma icon – called AutoSum here

Or... click Insert Function

Using Excel to Find the Mean



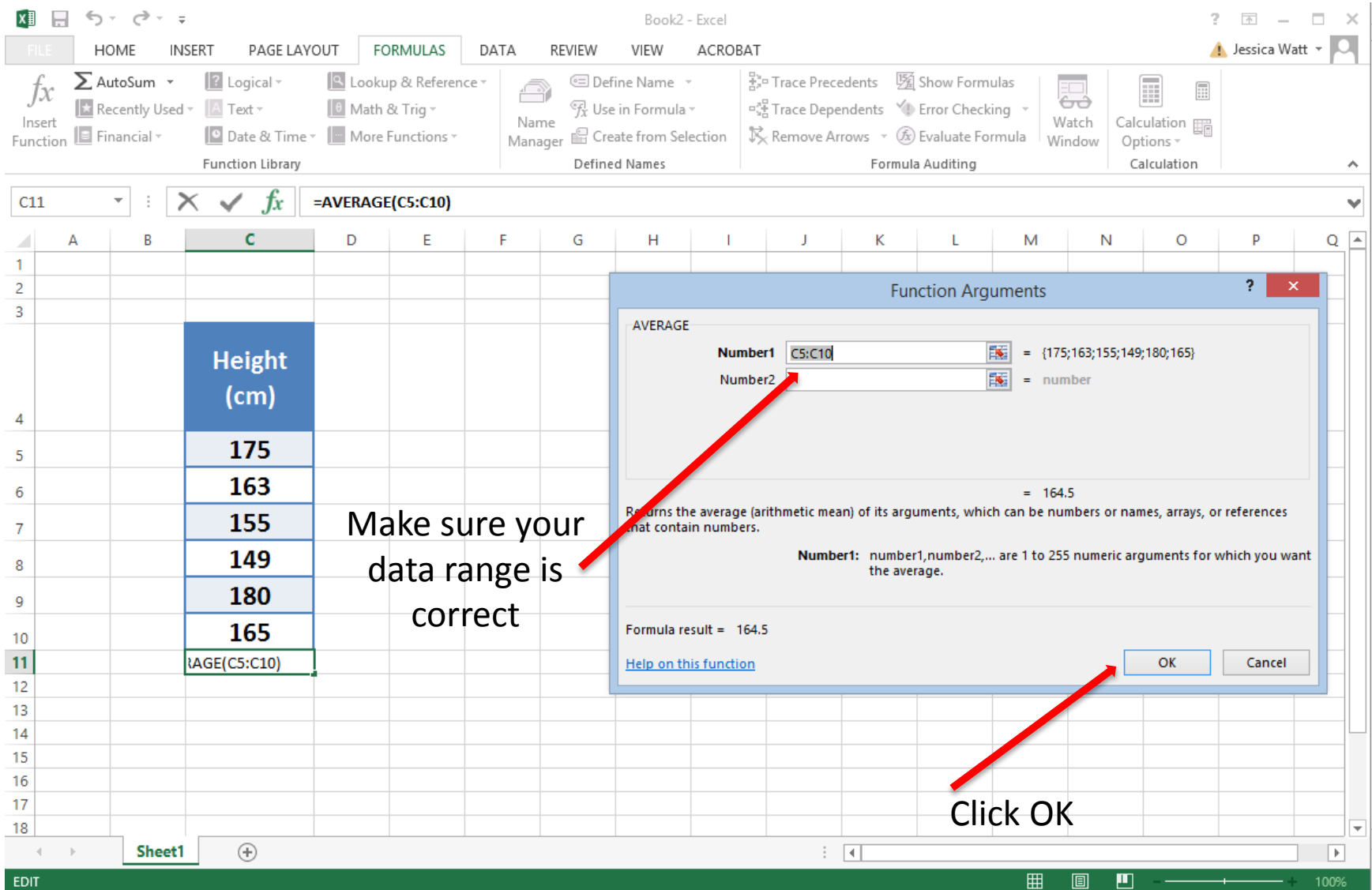
The screenshot shows the Microsoft Excel interface. The 'FORMULAS' ribbon is active, and the 'Insert Function' button (fx) is highlighted with a red box. The spreadsheet contains a table of heights in centimeters. The 'Insert Function' dialog box is open, showing the 'AVERAGE' function selected. A red arrow points from the text 'Type a description of the function you want (average) or select from the list' to the search box in the dialog. Another red arrow points from the text 'Click OK' to the 'OK' button in the dialog.

Height (cm)
175
163
155
149
180
165

Type a description of the function you want (average) or select from the list

Click OK

Using Excel to Find the Mean



The screenshot shows the Microsoft Excel interface with the **FORMULAS** tab selected. The formula bar displays `=AVERAGE(C5:C10)`. The spreadsheet contains a table of heights in centimeters:

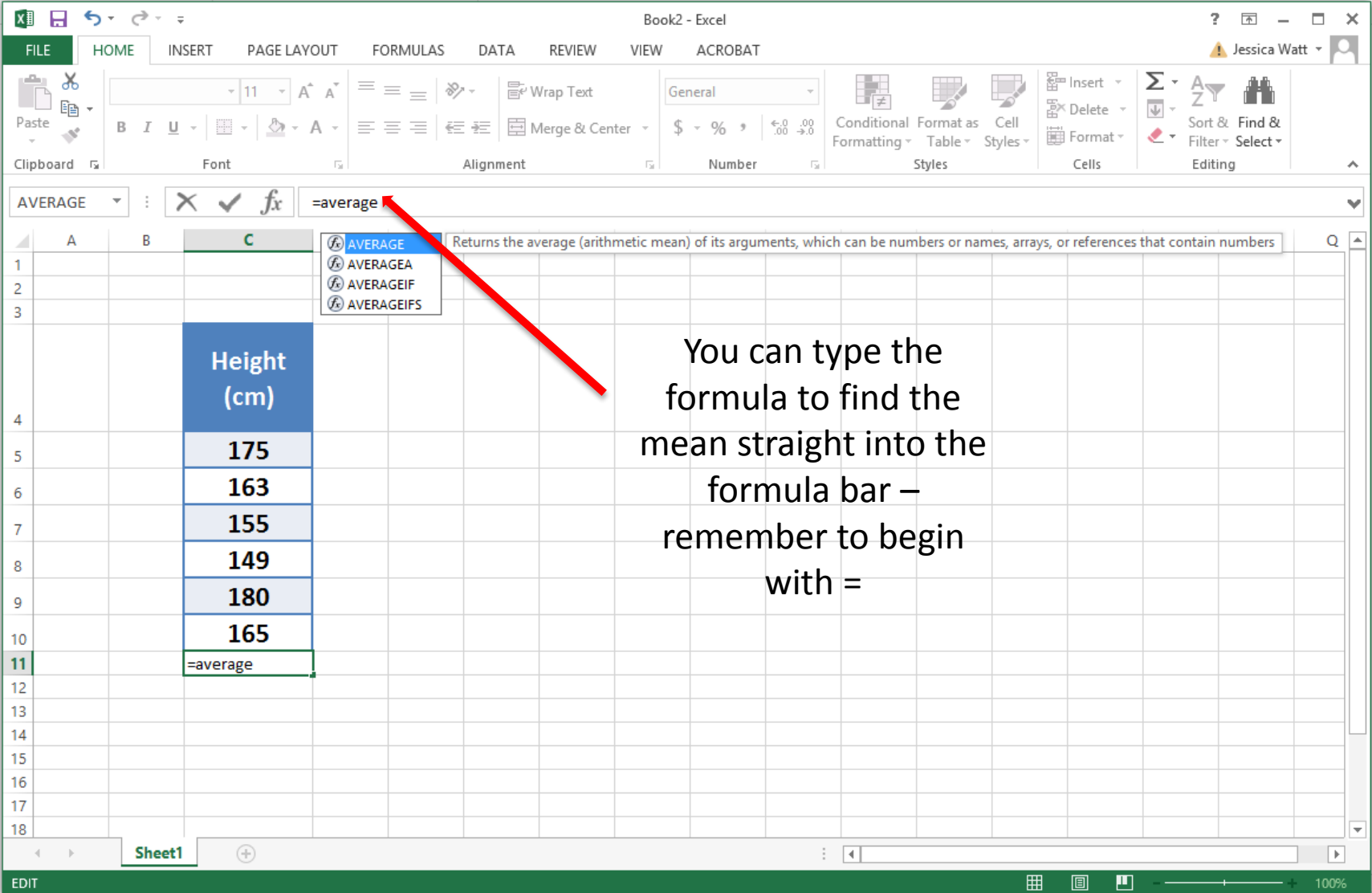
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1																	
2																	
3																	
4			Height (cm)														
5			175														
6			163														
7			155														
8			149														
9			180														
10			165														
11			AVERAGE(C5:C10)														

The **Function Arguments** dialog box is open, showing the **AVERAGE** function with the **Number1** argument set to `C5:C10`. The dialog box displays the calculation: `= {175;163;155;149;180;165}` and the result `= 164.5`. A red arrow points from the text "Make sure your data range is correct" to the `C5:C10` input field. Another red arrow points from the text "Click OK" to the **OK** button.

Make sure your data range is correct

Click OK

Using Excel to Find the Mean



The screenshot shows the Microsoft Excel interface. The formula bar at the top contains the text `=average`. A dropdown menu is open below the formula bar, listing the following functions: `AVERAGE`, `AVERAGEA`, `AVERAGEIF`, and `AVERAGEIFS`. A red arrow points from the text in the dropdown menu to the formula bar. The spreadsheet below shows a column of height data in centimeters.

	A	B	C
1			
2			
3			
4			Height (cm)
5			175
6			163
7			155
8			149
9			180
10			165
11			=average
12			
13			
14			
15			
16			
17			
18			

Returns the average (arithmetic mean) of its arguments, which can be numbers or names, arrays, or references that contain numbers

You can type the formula to find the mean straight into the formula bar – remember to begin with =

Measures of Central Tendency

- ▶ Mean
- ▶ Median
- ▶ Mode

The Average Bears



Mr. Mean



Mr. Median



Mr. Mode

Median

- ▶ Middle value of rank ordered data
- ▶ Value that separates the higher half of a data set from the lower half
- ▶ Can be found by arranging all values from lowest to highest and determining the value in the middle



Median

- ▶ If there is an odd number of values in the data set, then the median is the middle value

For the data set:

6, 9, 1, 2, 6, 5, 1

Arrange from lowest to highest:

1, 1, 2, **5**, 6, 6, 9



The median is **5**



The middle value

Median

- ▶ If there is an even number of values in the data set, then the median is the mean of the two middle values

For the data set:

6, 9, 1, 2, 6, 5, 1

Arrange from lowest to highest:

1, 1, 2, 6, 6, 9

Two middle values

The median is the mean of 2 and 6:

$$\frac{2 + 6}{2} = 4$$



The median
is 4

You try.....

▶ Determine the median for the following data sets

1) 132, 139, 131, 138, 132, 139, 133, 137, 139

2) 25, 10, 16, 25, 12, 22, 20, 23, 13, 10

3) 56, 23, 48, 78, 94, 35, 88, 69, 44, 53, 27

Answers

1) 132, 139, 131, 138, 132, 139, 133, 137, 139

Rearrange from lowest to highest:

131, 132, 132, 133, 137, 138, 139, 139, 139

Middle value - 137

Median = 137

Answers

2) 25, 10, 16, 25, 12, 22, 20, 23, 13, 10

Rearrange from lowest to highest:

10, 10, 12, 13, 16, 20, 22, 23, 25, 25

Middle values - 16 and 20

$$\text{Median} = \frac{16 + 20}{2} = 18$$

Median = 18

Answers

3) 56, 23, 48, 78, 94, 35, 88, 69, 44, 53, 27

Rearrange from lowest to highest:

23, 27, 35, 44, 48, 53, 56, 69, 78, 88, 94

Middle value - 53

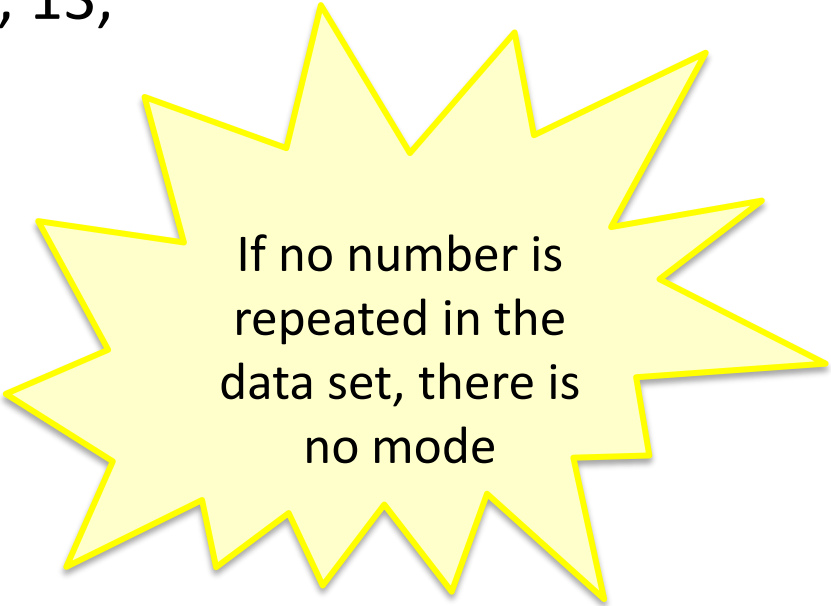
Median = 53

Mode

- ▶ The most frequent measurement

12, 11, 15, 12, 12, 11, 14, 17, 15, 12, 13,

Number of Cars Sold	Frequency
11	2
12	4
13	1
14	1
15	2
17	1



If no number is repeated in the data set, there is no mode

You try.....

▶ Determine the mode for the following data sets

1) 132, 139, 131, 138, 132, 139, 133, 137, 139

2) 3, 3, 3, 5, 5, 5, 3, 6, 4, 8, 5, 4, 2, 4, 3, 5

3) 56, 23, 48, 78, 94, 35, 88, 69, 44, 53, 27

Answers

1) 132, 139, 131, 138, 132, 139, 133, 137, 139

= 139

2) 3, 3, 3, 5, 5, 5, 3, 6, 4, 8, 5, 4, 2, 4, 3, 5

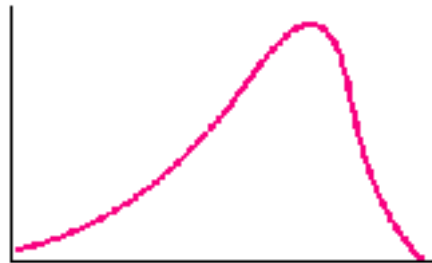
= 3 and 5 = bimodal

3) 56, 23, 48, 78, 94, 35, 88, 69, 44, 53, 27

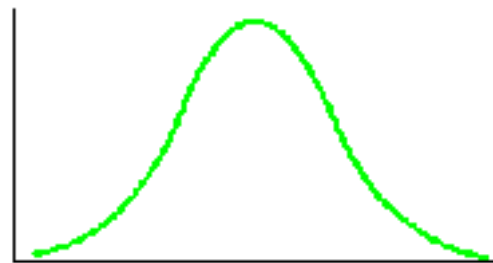
= no mode

Considerations

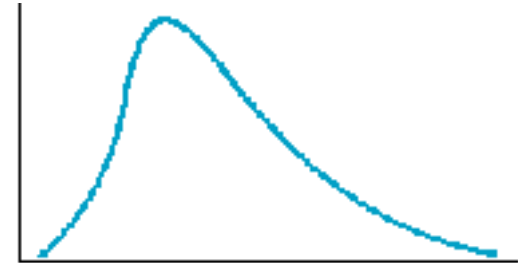
- ▶ Your data will determine which measure of central tendency is appropriate
- ▶ PLOT DATA FIRST



**Negatively (left)
skewed
distribution**



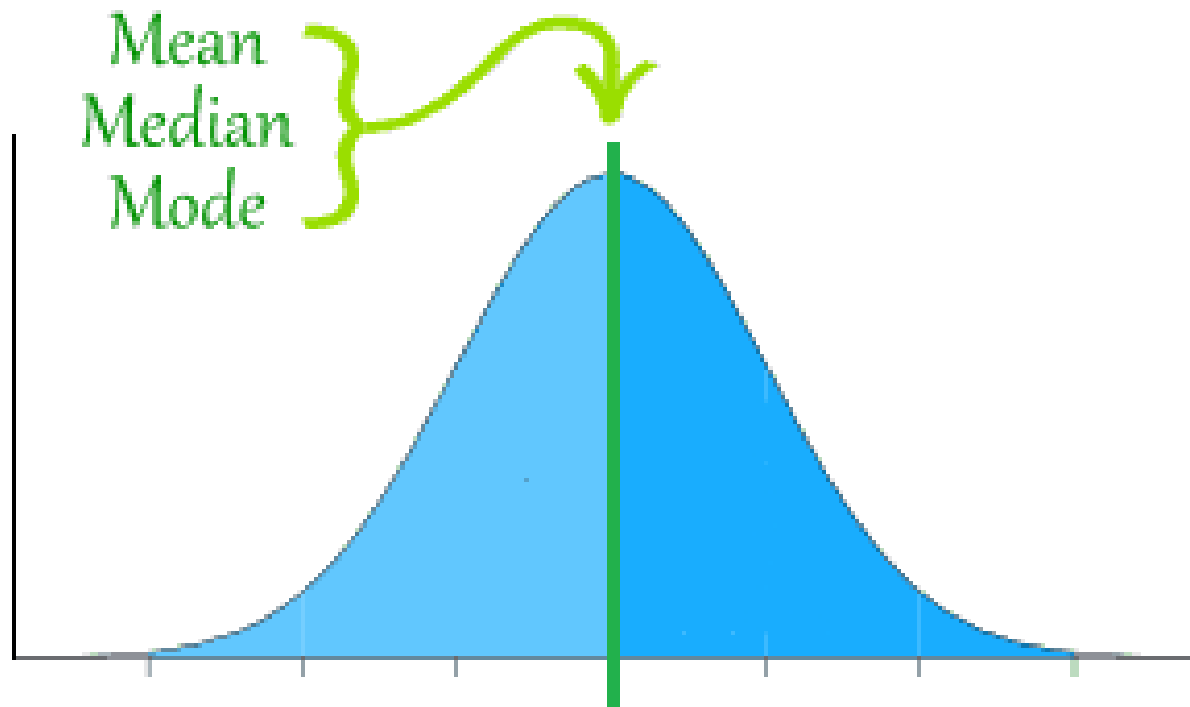
**Normal
skewed
distribution**



**Positively (right)
skewed
distribution**

Considerations

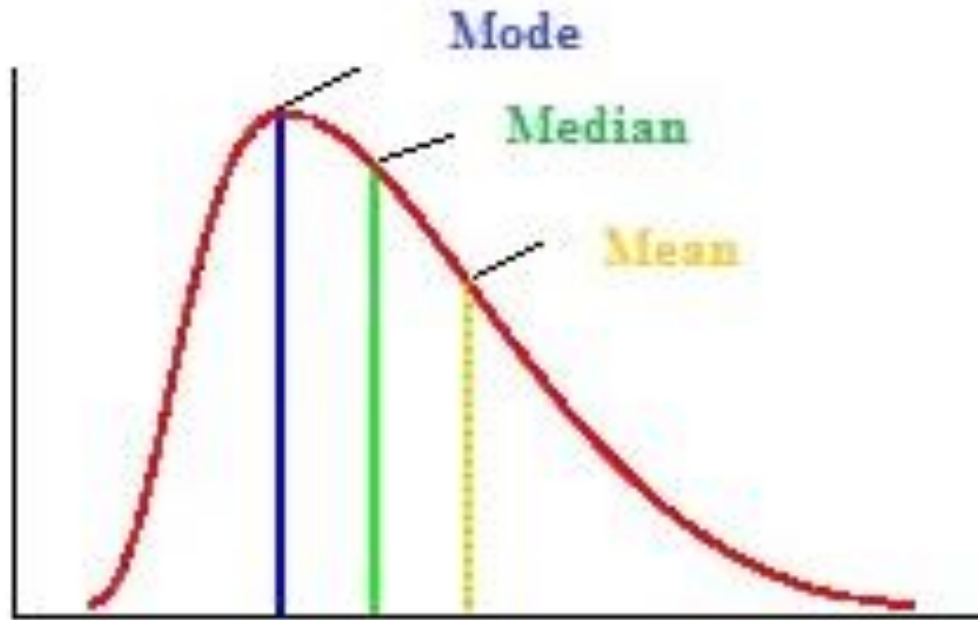
- ▶ Normally distributed data



Normally Distributed Data: MEAN = MEDIAN = MODE

Considerations

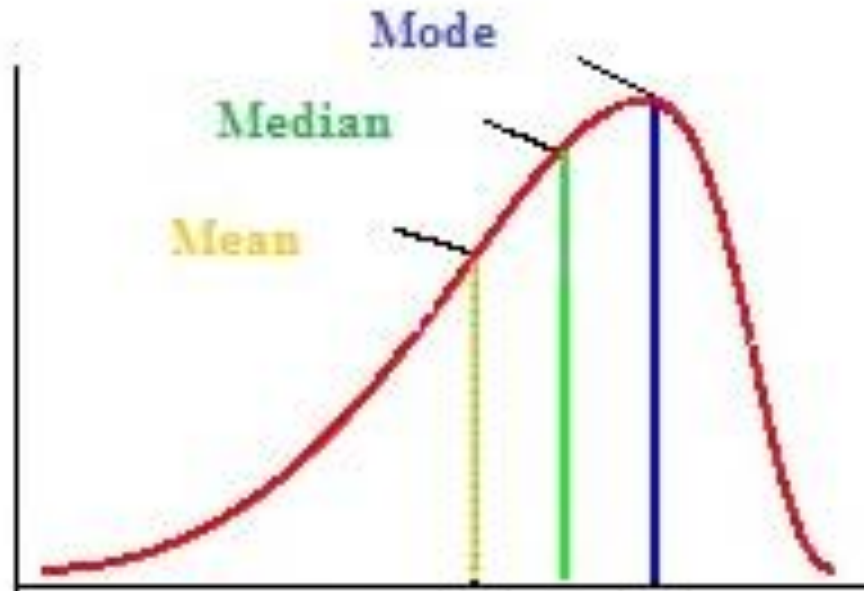
- ▶ Positively skewed (right) distribution



Skewed Right: MODE < MEDIAN < MEAN

Considerations

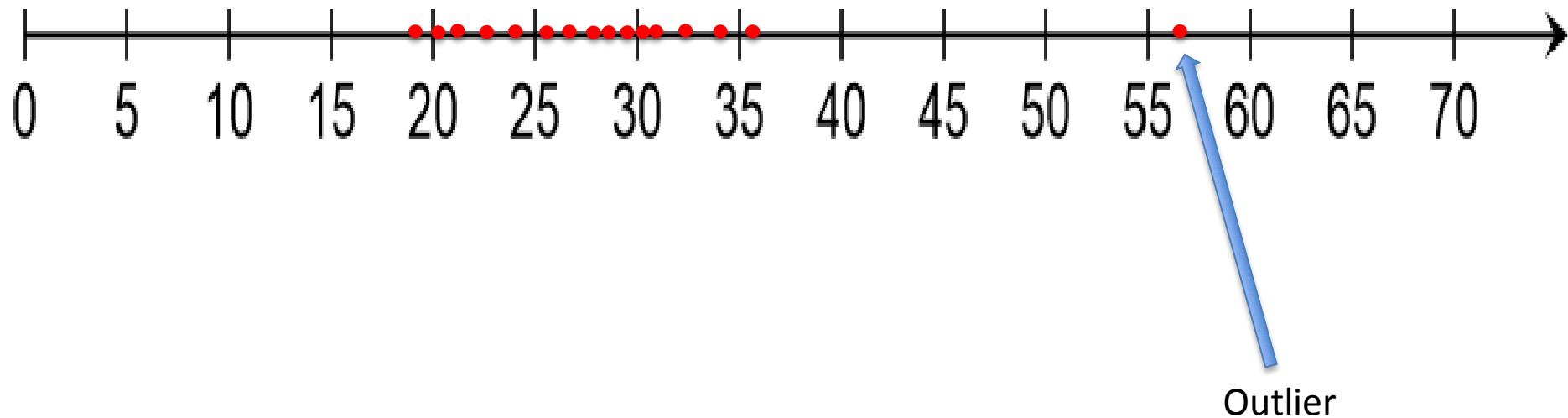
- ▶ Negatively skewed (left) distribution



Skewed Left: MEAN < MEDIAN < MODE

Outliers

- ▶ Data values that are 'far away' from the main group of data
- ▶ **Outliers** are the values that **lie outside** the other values



Outliers

- ▶ Outliers have **extreme effects** on the **mean**

Consider:

5, 6, 4, 7, 6, 19

$$\bar{x} = \frac{\sum x}{n}$$

$$= \frac{5 + 6 + 4 + 7 + 6 + 19}{6}$$

Mean = 9

5, 6, 4, 7, 6

$$\bar{x} = \frac{\sum x}{n}$$

$$= \frac{5 + 6 + 4 + 7 + 6}{5}$$

Mean = 5.6

Outliers

- ▶ Outliers **do not** have **extreme effects** on the **median**

Consider:

5, 6, 4, 7, 6, 19

5, 6, 4, 7, 6

Arrange from lowest to highest:

4, 5, 6, 6, 7, 19

4, 5, 6, 6, 7

= 6

= 6

Questions

