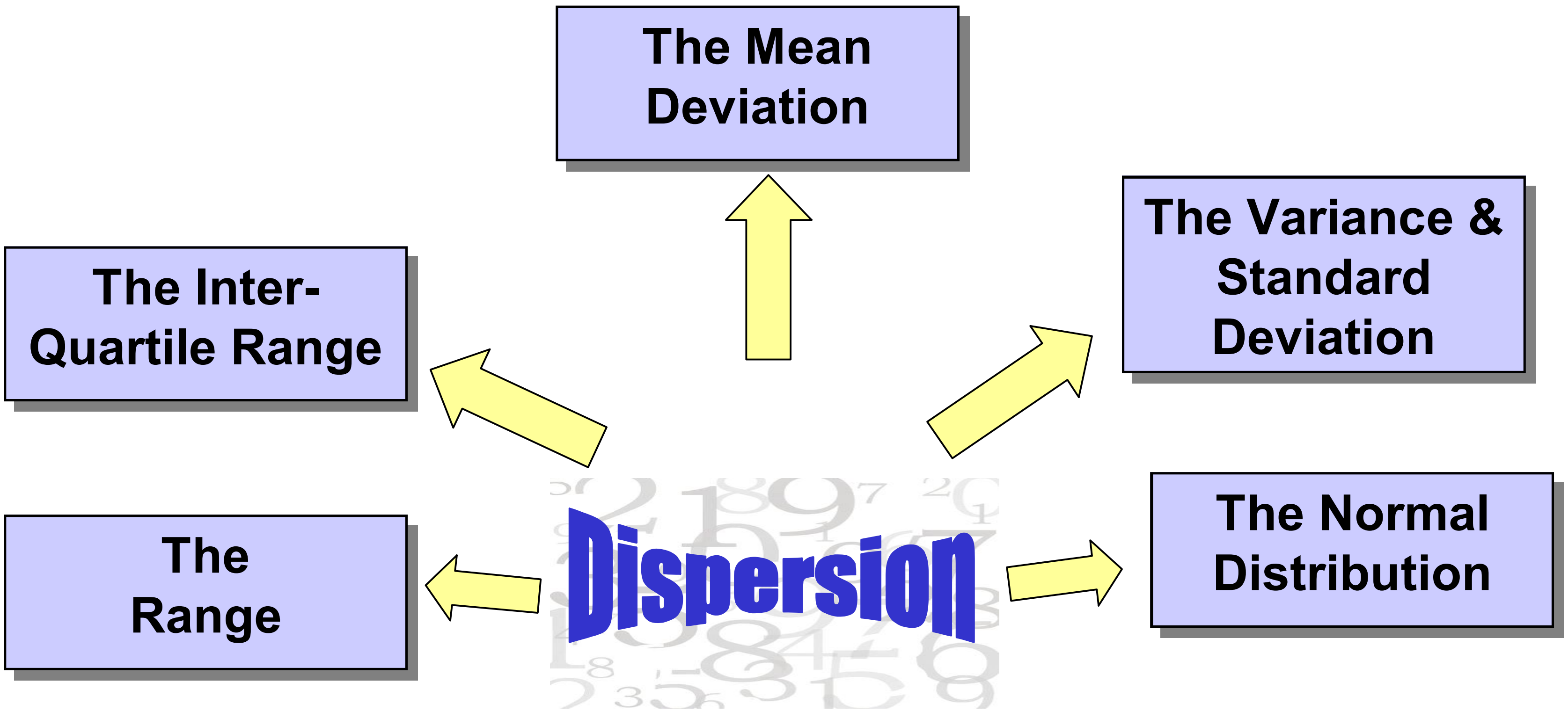
Dispersion

- Dispersion looks at the SPREAD of data
- It is possible to measure the spread of data in 5 ways:



The Range

- This simply measures the difference between the highest and lowest values in a set of data
  - E.g.
- Here the range would be:

Range = Highest Value – Lowest Value

Highest Value = 201,000

Lowest Value = 99,000

Range = 201,000 – 99,000

Range = £102,000

Month	Sales(£000s)
January	109
February	111
March	118
April	124
May	145
June	174
July	199
August	201
September	132
October	119
November	101
December	99

The Inter-Quartile Range (1)

- The range is affected by extreme values though
- To overcome this we can slice away the top and bottom quarters and calculate the inter-quartile range
- To do this we must first put the data in order:

Month	Sales(£000s)
January	109
February	111
March	118
April	124
May	145
June	174
July	199
August	201
September	132
October	119
November	101
December	99

Month	Sales(£000s)
December	99
November	101
January	109
February	111
March	118
October	119
April	124
September	132
May	145
June	174
July	199
August	201

The Inter-Quartile Range (2)

- Then we must determine the top and bottom quarters of the data so that they can be ignored before the range calculation is carried out

1st Quartile (Q1) = n/4

Q1 = 12/4 = 3rd piece of data = 109,000

2nd Quartile (Q2) = 3n/4

Q2 = 36/4 = 9th piece of data = 145,000

Inter-Quartile Range = 145-109 = £36,000

Month	Sales(£000s)
December	99
November	101
January	109
February	111
March	118
October	119
April	124
September	132
May	145
June	174
July	199
August	201

- Note that this is much narrower than the range

The Mean Deviation (1)

- The range and inter-quartile do not make use of all pieces of data
- The mean deviation, however does
- It measures how far, on average each piece of data is away from the mean
- As such the first task is to calculate the mean:

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

$$\bar{x} = \frac{1{,}632{,}000}{12} = £136{,}000$$

Month	Sales(£000s) (*x*)
January	109
February	111
March	118
April	124
May	145
June	174
July	199
August	201
September	132
October	119
November	101
December	99
TOTAL (Σ)	**1632**

The Mean Deviation (2)

- We can now calculate the how far away from this mean (£136,000) each value is:

- * Note that the sum of deviations IGNORES the negative signs
  - otherwise the value would be zero!

Month	Sales(£000s) (x)	Deviation $(x-\bar{x})$
January	109	-27
February	111	-25
March	118	-18
April	124	-12
May	145	9
June	174	38
July	199	63
August	201	65
September	132	- 4
October	119	-17
November	101	-35
December	99	-37
TOTAL ($\sum$)	**1628**	**350***

The Mean Deviation (3)

- We can now calculate the mean deviation using the formula:

$$\textbf{Mean Deviation} = \frac{\sum(x-\bar{x})}{n}$$

$$\text{Mean Deviation} = \frac{350{,}000}{12}$$

Mean Deviation = £29,166.67

This means that on average each piece of data is 29.17 away from the mean. The higher this number the wider the spread of the data

Month	Sales(£000s) (x)	Deviation $(x-\bar{x})$
January	109	**-27**
February	111	**-25**
March	118	**-18**
April	124	**-12**
May	145	**9**
June	174	**38**
July	199	**63**
August	201	**65**
September	132	**-4**
October	119	**-17**
November	101	**-35**
December	99	**-37**
TOTAL $(\sum)$	**1628**	**350**

The Variance

- The mean deviation is floored because it ignores the negative signs
- To avoid this we must calculate the **variance**
- It simply involves **squaring the deviations** since a negative number squared become positive:

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

$$\text{Variance} = 1{,}203{,}333.3$$

Variance = £1,203,333.3 sqrd

Month	Sales (£000s) (x)	Deviation ($x - \bar{x}$)	Deviation Squared ($x - \bar{x}$)^2
January	109	-27	729
February	111	-25	625
March	118	-18	324
April	124	-12	144
May	145	9	81
June	174	38	1444
July	199	63	3969
August	201	65	4225
September	132	- 4	16
October	119	-17	289
November	101	-35	1225
December	99	-37	1369
TOTAL	1628	350*	14440

The Standard Deviation

- The variance leaves us with a problem – the answer is in "squared units" e.g. squared pounds!
- This is obviously meaningless
- As such, we need to find the square root of the variance in order to return to meaningful units
- This is called the Standard Deviation
- So, using our previous example:

$$\text{Standard Deviation} = \sqrt{\frac{\sum (x-\bar{x})^2}{n}}$$

$$\text{Standard Deviation} = \sqrt{1{,}203{,}333.3}$$

Standard Deviation = £1,096.97