STATISTICS FOR DATA SCIENCE

Power Test &
Simple Linear Regression

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STATISTICS FOR DATA SCIENCE

Unit 5 : Power Test & Simple Linear Regression

Session : 4

Sub Topic : Correlation

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- Classification of Data
- What is Correlation ?
- Pearson’s Correlation Coefficient

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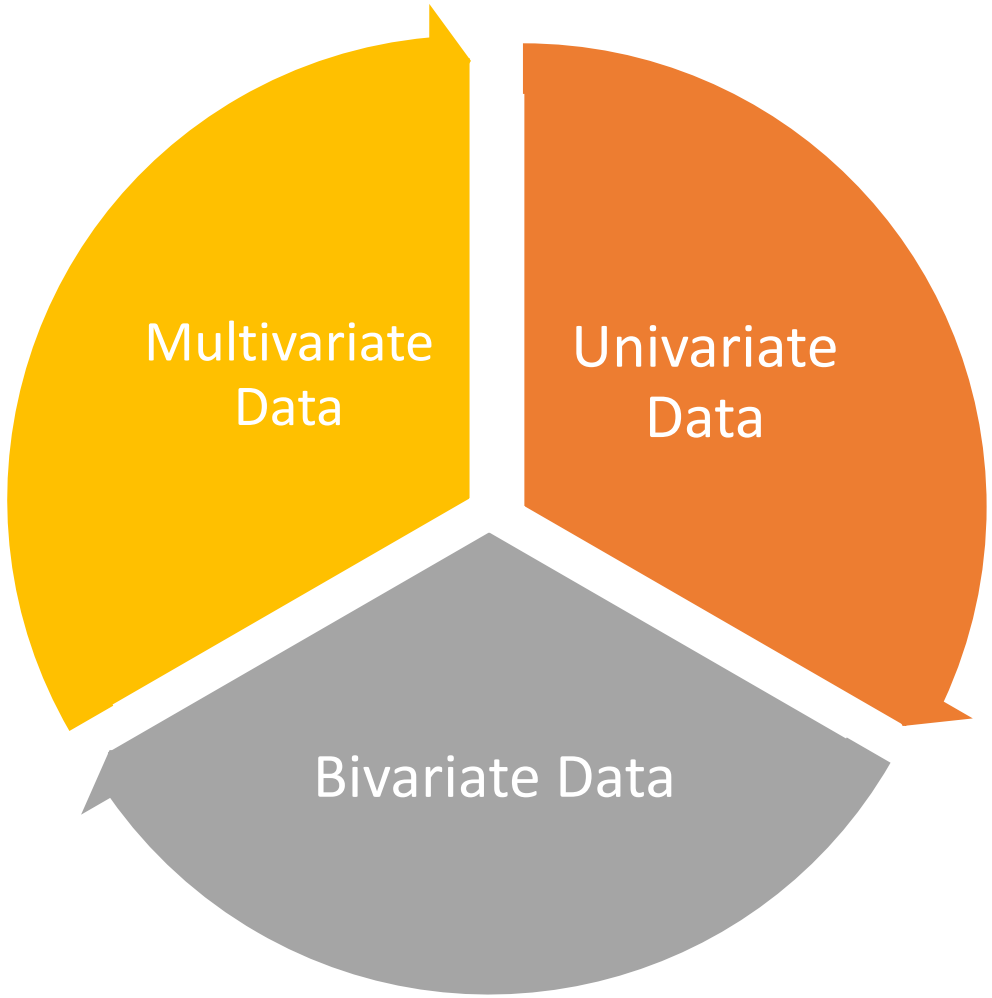
Types of Data



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Types of Data

Sl No.	SRN	10th Marks	12th Marks	PESSAT Ranking	CGPA	Annual Pay Compensation
1.	PESXX001	82%	79%	1228	8.3	8 Lakhs
2.	PESXX002	85%	86%	1119	9.4	10 Lakhs
3.	PESXX003	76%	77%	1302	8.3	7 Lakhs
4.	PESXX004	69%	75%	1356	8.2	6 Lakhs
5.	PESXX005	95%	94%	567	9.8	19 Lakhs
6.	PESXX006	84%	82%	1287	9.1	9 Lakhs
7.	PESXX007	89%	86%	1006	9.4	12 Lakhs
8.	PESXX008	86%	88%	1011	9.3	10 Lakhs
9.	PESXX009	79%	81%	1286	8.7	8 Lakhs
10.	PESXX010	92%	90%	822	9.5	15 Lakhs
11.	PESXX011	90%	91%	799	9.6	16 Lakhs
12.	PESXX012	80%	83%	1021	8.6	8 Lakhs

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Univariate Data

❖The analysis of Univariate data can be done using :

1. Analytical Techniques :
    - Central tendency measures (mean, median and mode)
    - Dispersion or Spread of data (range, minimum, maximum quartiles, variance and standard deviation)
    - Frequency distribution tables
2. Visualization techniques :
    - Histograms
    - Pie Charts
    - Frequency Polygon
    - Bar Charts.

Bi - Variate Data

❖The analysis of Bivariate data can be done using :

1. Analytical Technique :
    - Correlation Co-efficient
    - Regression Analysis
2. Visualization Technique :
    - Scatter Plot

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Bi - Variate Analysis

- Bivariate analysis means the analysis of bivariate data; used to find out if there is a relationship between two sets of values.

- It usually involves the variables X and Y and is represented as an ordered pair $(X,\ Y)$.

- X represents the independent variable and Y represents the dependent variable.

Alternate terminology for Independent / Dependent variables

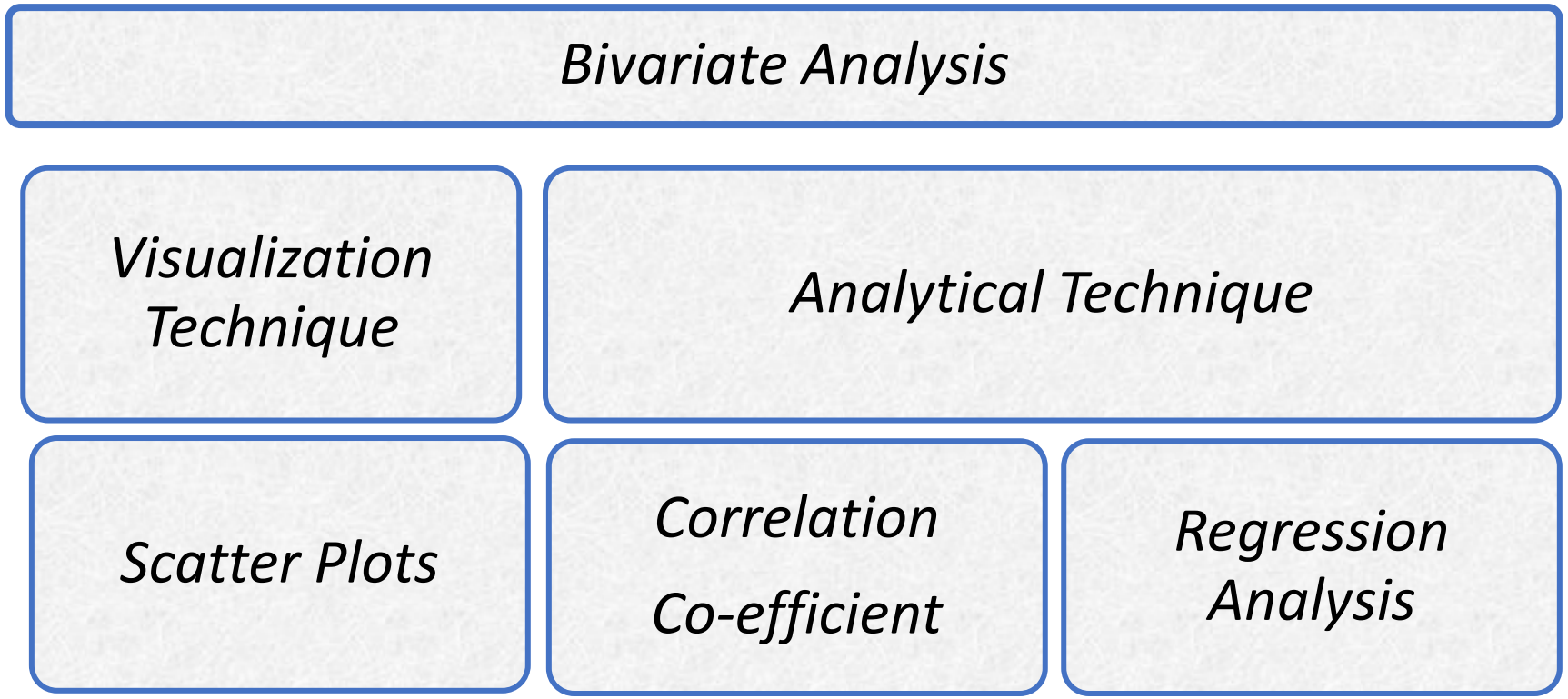
Independent Variable

- Input variable
- Predictor variable
- Controlled variable
- Explanatory variable
- Regressor
- Manipulated variable

Dependent Variable

- Output/ Response variable
- **Predicted variable**
- **Measured variable**
- **Explained variable**
- **Regresand**
- **Experimental variable**

Bivariate Analysis

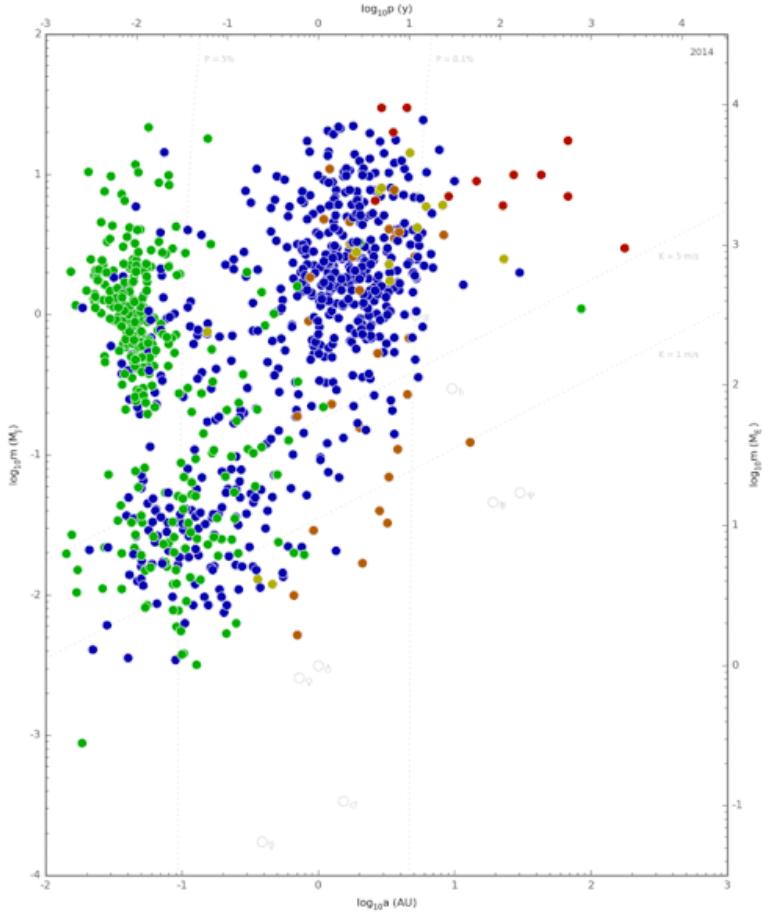


Scatter Plots

❖The Scatter Plot is a mathematical diagram that plots pairs of data on an X-Y graph in order to reveal the relationship between the data sets.

❖ Scatter plots give you a visual idea of the pattern that your variables follow.

❖Scatterplots can show you visually the strength of the relationship between the variables, the direction of the relationship between the variables and whether any outliers exist.



Source : commons.Wikimedia.org

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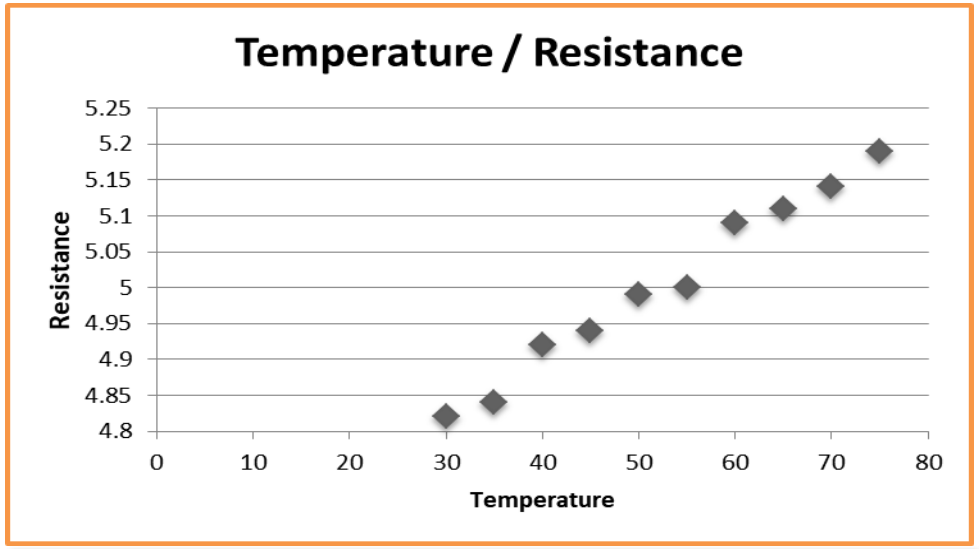
Example for Physics Lab :

❖ Variation of resistance with change in temperature of a Semiconductor/ Conductor.

Temperature	Resistance
55	5
45	4.94
35	4.84
65	5.11
75	5.19
70	5.14
60	5.09
50	4.99
40	4.92
30	4.82



The resistance decreases with increase in temperature in a Semiconductor whereas in a Conductor, the resistance increases with an increase in the temperature.

Source :semiconductor.org

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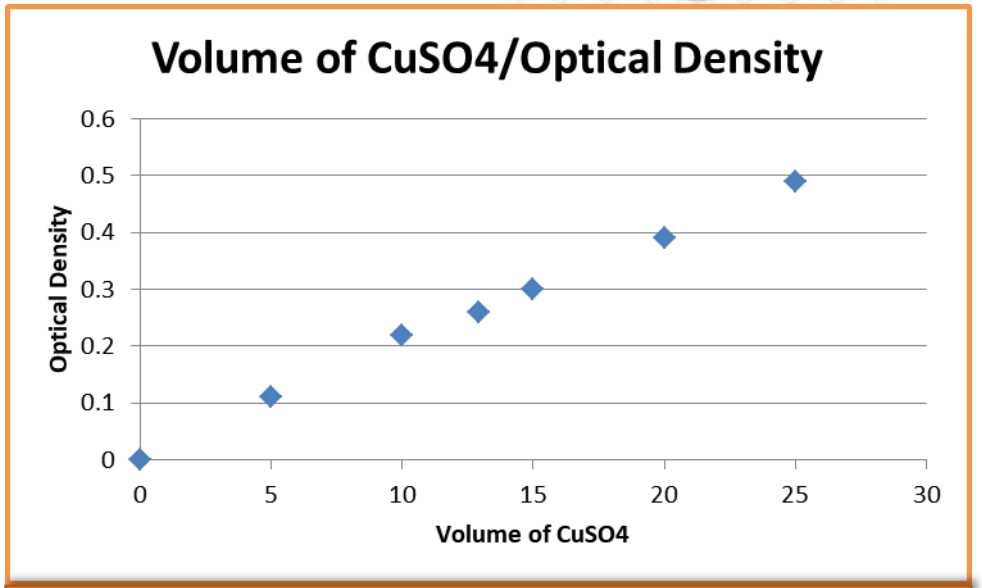
Example from Chemistry Lab :

❖ Estimation of copper in copper sulphate solution by means of Calorimetry

Copper Sulphate	Optical Density
0	0
5	0.11
10	0.22
15	0.3
20	0.39
25	0.49
12.94	0.26



The optical density increases with an increase in the volue of CuSO4.

Source :iconscout.com

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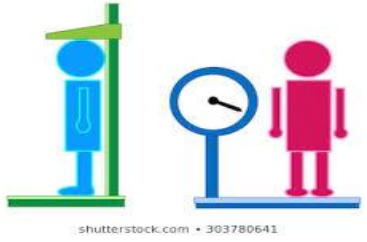
Correlation

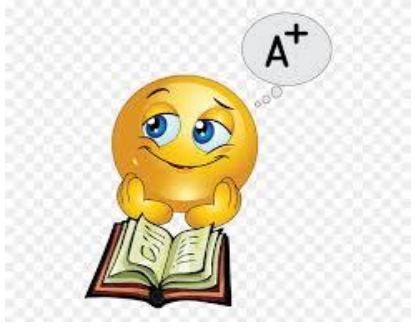
- Does height have an impact on the performance of a player in a Basket ball match?

- Is there a relationship between internet bandwidth and time taken for data transfer?

- Are Height and Weight of an individual related?



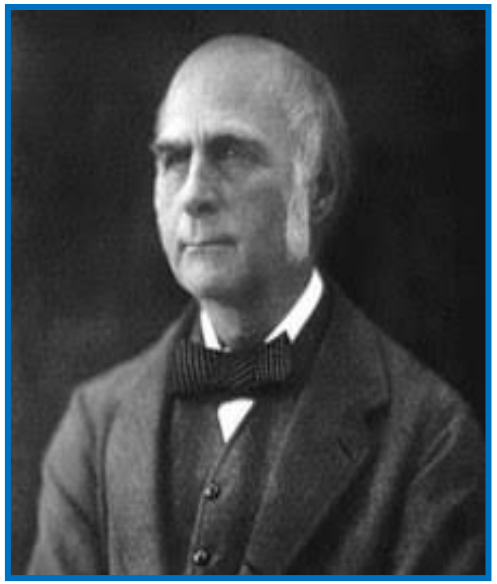
- Does no. of hours effort have an impact on CGPA scored?

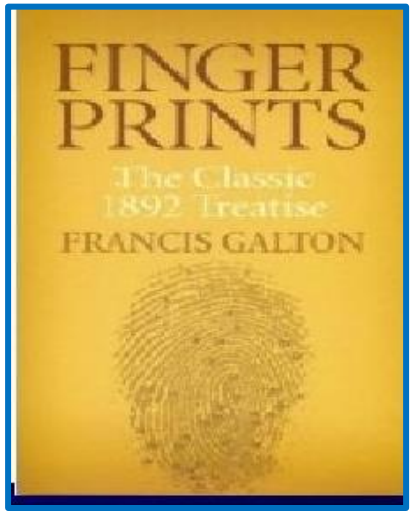


Sources :shutterstock.com, hdsmileys.com, internet sources

Brief history of Correlation

- Sir Francis Galton, (16 February 1822 – 17 January 1911).
- He was an English Victorian era statistician and a Fellow of the Royal Society.
- Galton produced over 340 papers and books.
- In 1892, he published the book "Finger Prints" and proposed the use of fingerprints as a means of personal identification.





Sources : en.wikipedia.org, amazon.in

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Galton's case study!!

Is there any relation between the *height of an individual* and the *length of his forearm*???

Sir Francis Galton introduced the concept of 'Correlation' in 1888 with a paper discussing how to measure the relationship between two variables.

Sources :aliexpress.com, freepik.com

Case Study : Galtons

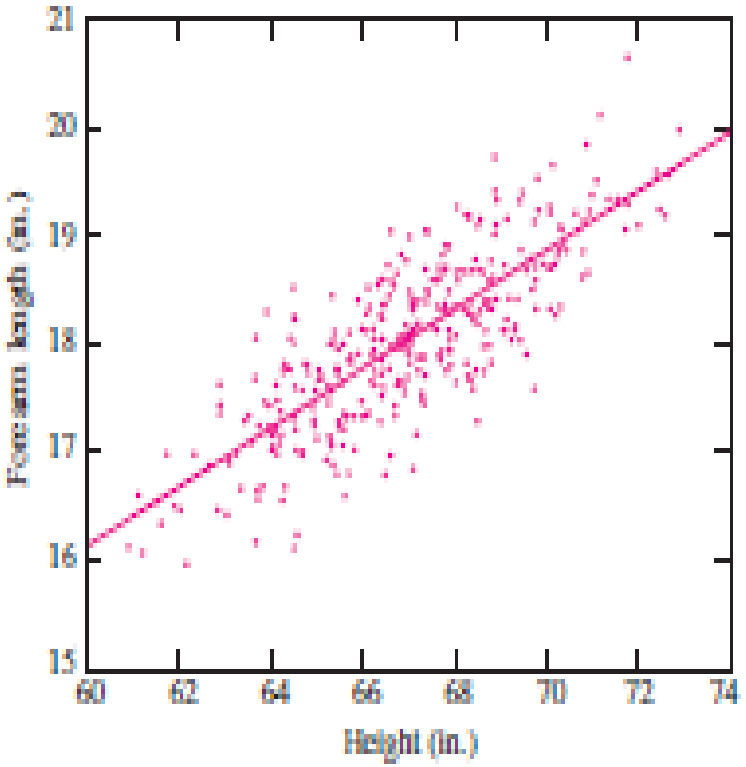
- The data set that he considered consisted of the *heights and forearm lengths of 348 adult men*.

  (He measured the distance from the elbow to the tip of the middle finger which is called as a cubit)

- Let the *height of the ith man* be = x_i

- Let the *length of the forearm of the ith man* be = y_i

- Then Galton's data consists of *348 ordered pairs* (x_i, y_i)



Source : Statistics for Engineers and Scientists, William Navidi

Correlation Coefficient

- Let (x_i, y_i) = ordered pairs that represent points on a scatter plot.
- $\bar{x}$ = mean of the 'x' values
- $\bar{y}$ = mean of the 'y' values
- S_x = standard deviation of 'x' values
- S_y = standard deviation of 'y' values
- Correlation Co-efficient is given by

$$r = \frac{1}{n-1}\sum_{i=1}^{n}\left(\frac{x_i-\bar{x}}{S_x}\right)\left(\frac{y_i-\bar{y}}{S_y}\right)$$

$$\Rightarrow r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\overline{y})^2}}$$

The Correlation Coefficient is the average of the product of z-scores

Pearson's Correlation Coefficient

Example Problem :

The Psychological tests of intelligence and of engineering ability were applied to 10 students. Here is a record of ungrouped data showing intelligence ratio (I.R) and engineering ratio (E.R). Calculate the Correlation Coefficient?

Student	A	B	C	D	E	F	G	H	I	J
I.R	105	104	102	101	100	99	98	96	93	92
E.R	101	103	100	98	95	96	104	92	97	94

Solution :

Students	IR (x)	ER (y)	$X = x - \bar{x}$	$Y = y - \bar{y}$	X^2	Y^2	XY
1	105	101	6	6	36	9	18
2	104	103	5	5	25	25	25
3	102	100	3	3	9	4	6
4	101	98	2	2	4	0	0
5	100	95	1	1	1	9	-3
6	99	96	0	0	0	4	0
7	98	104	-1	-1	1	36	6
8	96	92	-3	-3	9	36	18
9	93	97	-6	-6	36	1	6
10	92	94	-7	-7	49	16	28
	990	980	0	0	170	140	92

$$r = \frac{\sum XY}{\sqrt{\sum X^2}\sqrt{\sum Y^2}}$$

$$= \frac{92}{\sqrt{170}\sqrt{140}}$$

$$= 0.59$$

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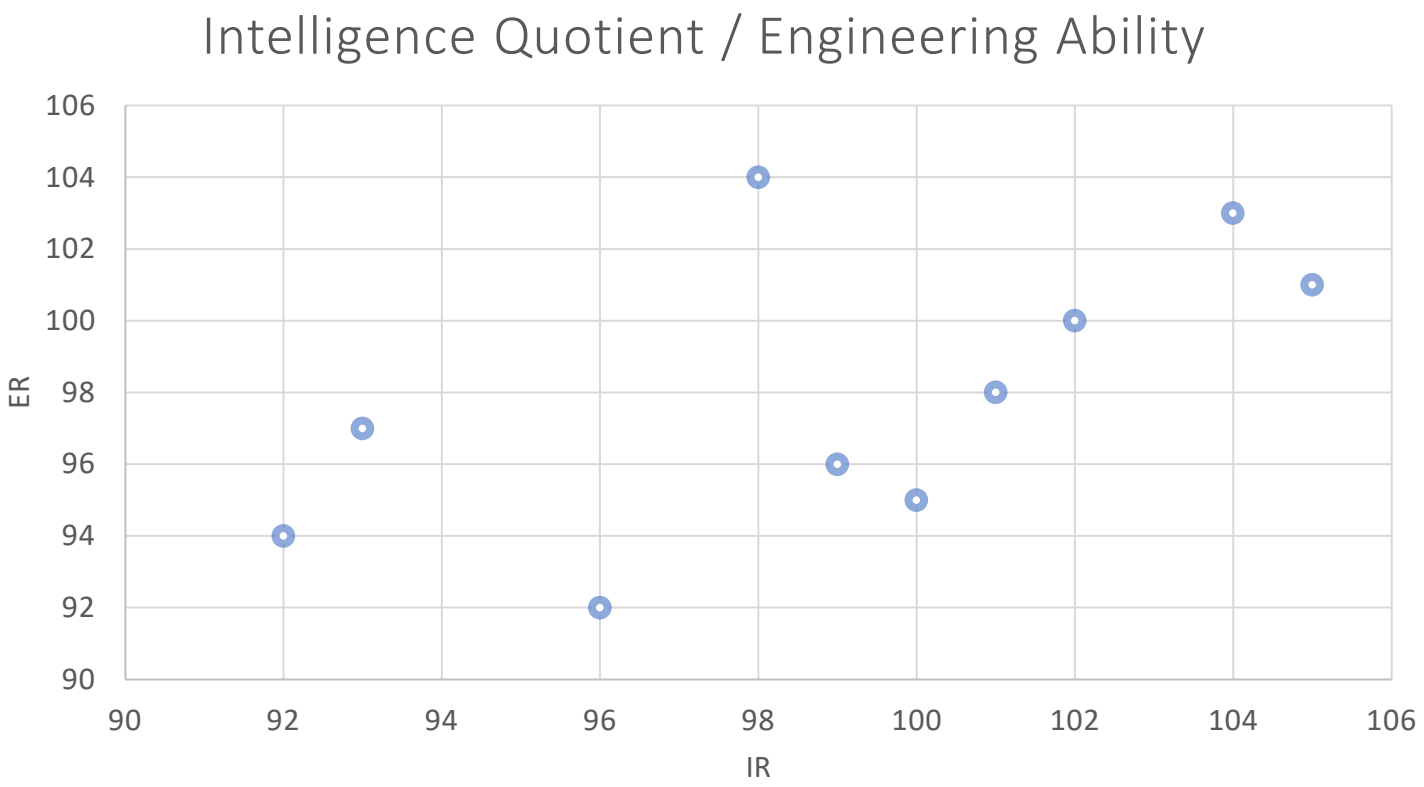
Scatter Plot



Correlation Co-efficient, $r = 0.59$

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THANK YOU

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