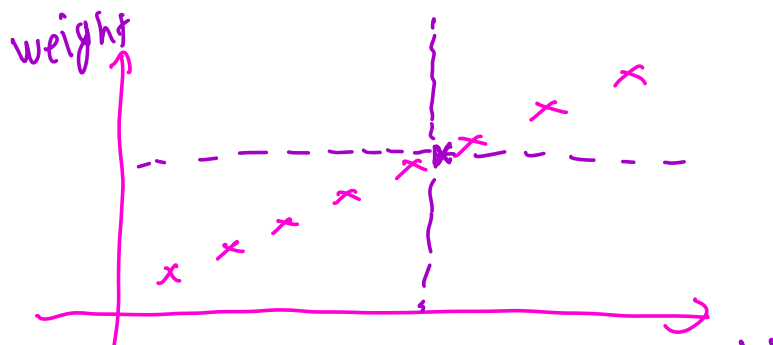
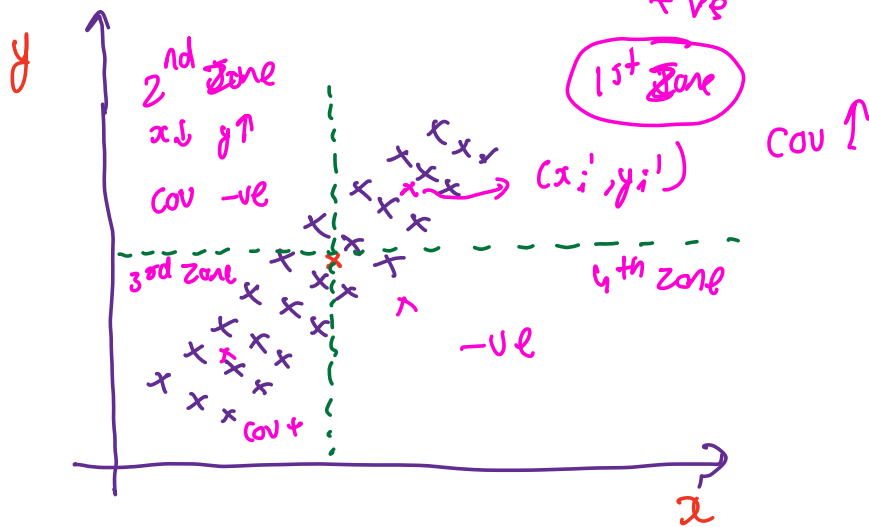




variance $\Rightarrow \frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})(x_i - \bar{x})$

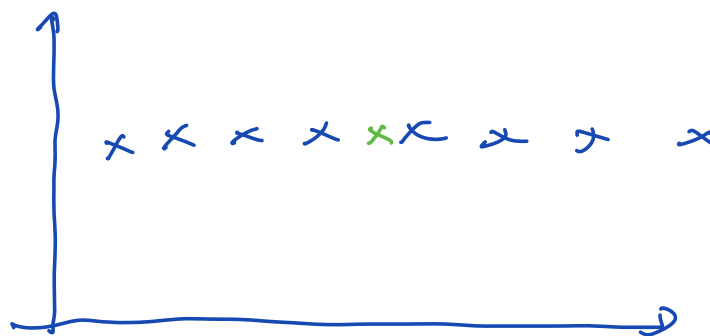
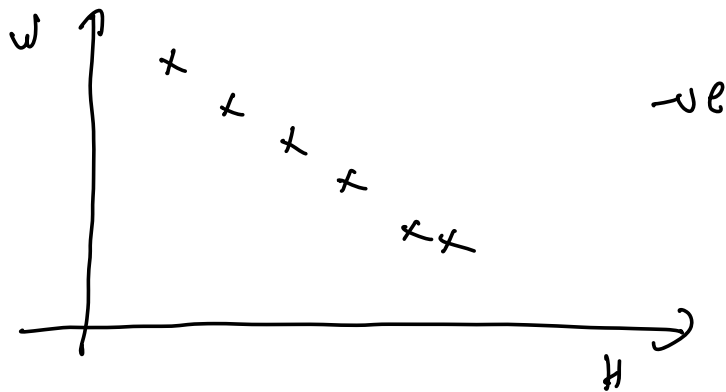
Cov - variance \Rightarrow

$$\text{Cov}(x, y) = \frac{1}{N} \sum_{i=1}^N \underbrace{(x_i - \bar{x})}_{\text{+ve}} \underbrace{(y_i - \bar{y})}_{\text{+ve}}$$



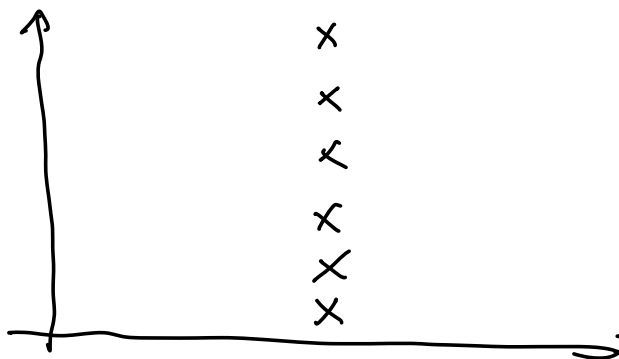
v

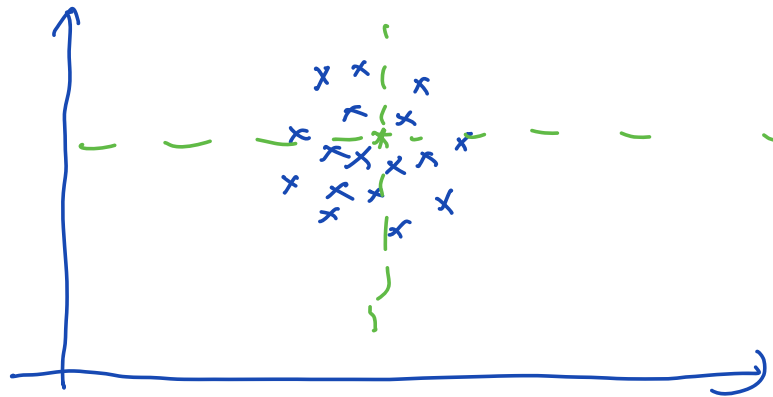
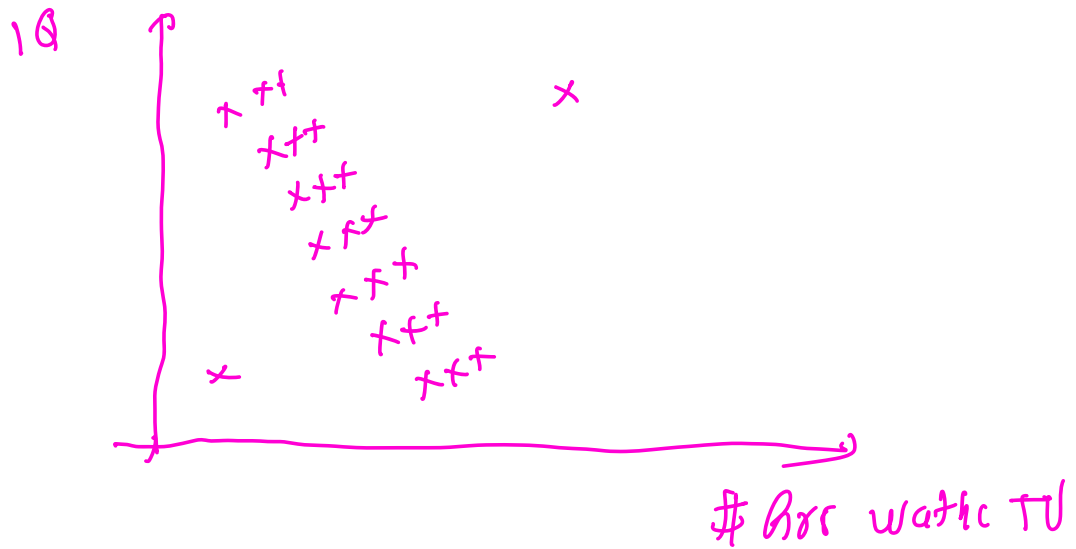
Height



$$\frac{1}{n} \sum (x_i - \bar{x})(y_i - \bar{y})$$

$\frac{\sum}{n}$





$x, x \rightarrow$ independent event
 $\text{cov}(x, x) = 0$

$$y = x^2$$

\Rightarrow If $\text{cov}(x, y) = 0$
 then x, y may not be independent event
 $x = x^2$

⇒

cm Height	gm weight
170	70000

$\text{cov}(H_1, w_1)$

ft Height	kg weight
5'10"	70

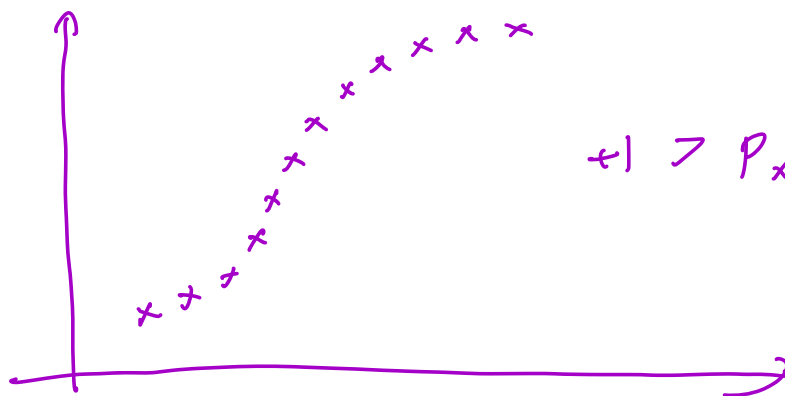
$\text{cov}(H_2, w_2)$

PCC
Pearson Correlation

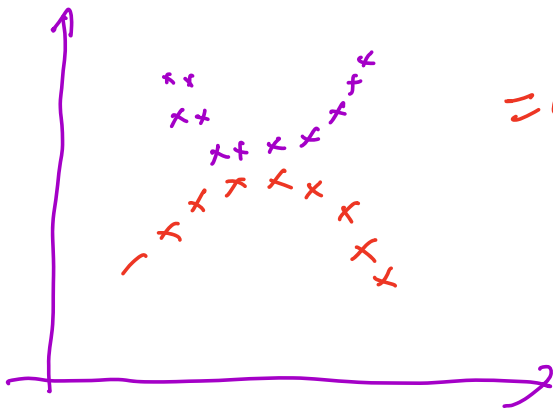
$$\Rightarrow \frac{\text{cov}(H_1, w_1)}{\sigma_{H_1} \cdot \sigma_{w_1}} = \frac{\text{cov}(H_2, w_2)}{\sigma_{H_2} \cdot \sigma_{w_2}}$$

⇓

[-1 to +1]



$$+1 > \rho_{x,y} > 0$$



= 0



Coffee	IQ

$$P_{x,y} \rightarrow 0$$

① correlation is 0

② Coffee \nearrow my IQ
 \nearrow
 Causation

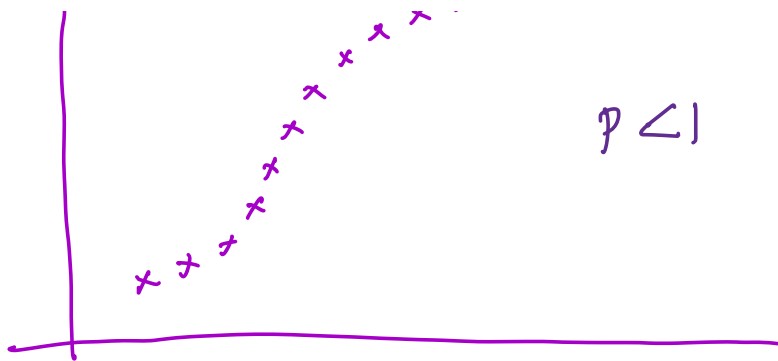
measure Causation

Alg test

→ Causation Analysis

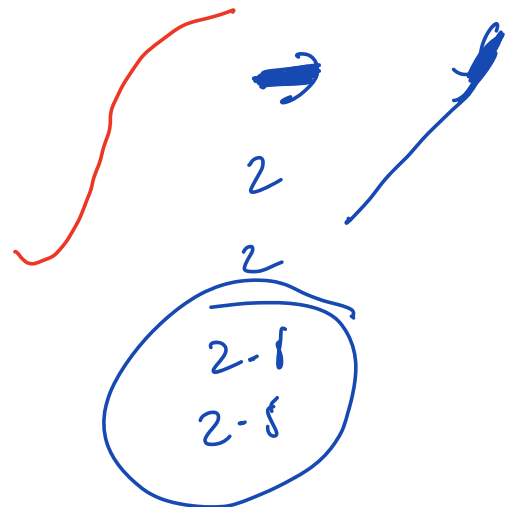
\nearrow

... x x



x_i ΣQ	y_i Tv	$\text{rank } x_i$	$\text{rank } y_i$
86	2	1	1
97	20	2	6
99	20	3	8
100	27	4	7
101	50	5	10
103	29	6	9
106	7	7	3
110	17	8	5
112	6	9	2
113	12	10	4

$P_{\text{rank } x_i, \text{rank } y_i}$



$P_{\Sigma Q, Tv}$

$$P_{IQ,TV} = \frac{1}{n} (1 - \bar{x}) (2 - \bar{y}) + \dots$$

$$SP_{R_{IQ} R_{TV}} = \frac{1}{n} (1 - \bar{x}) (1 - \bar{y})$$

$$Spearman(x, y) = PCC(R_x, R_y)$$