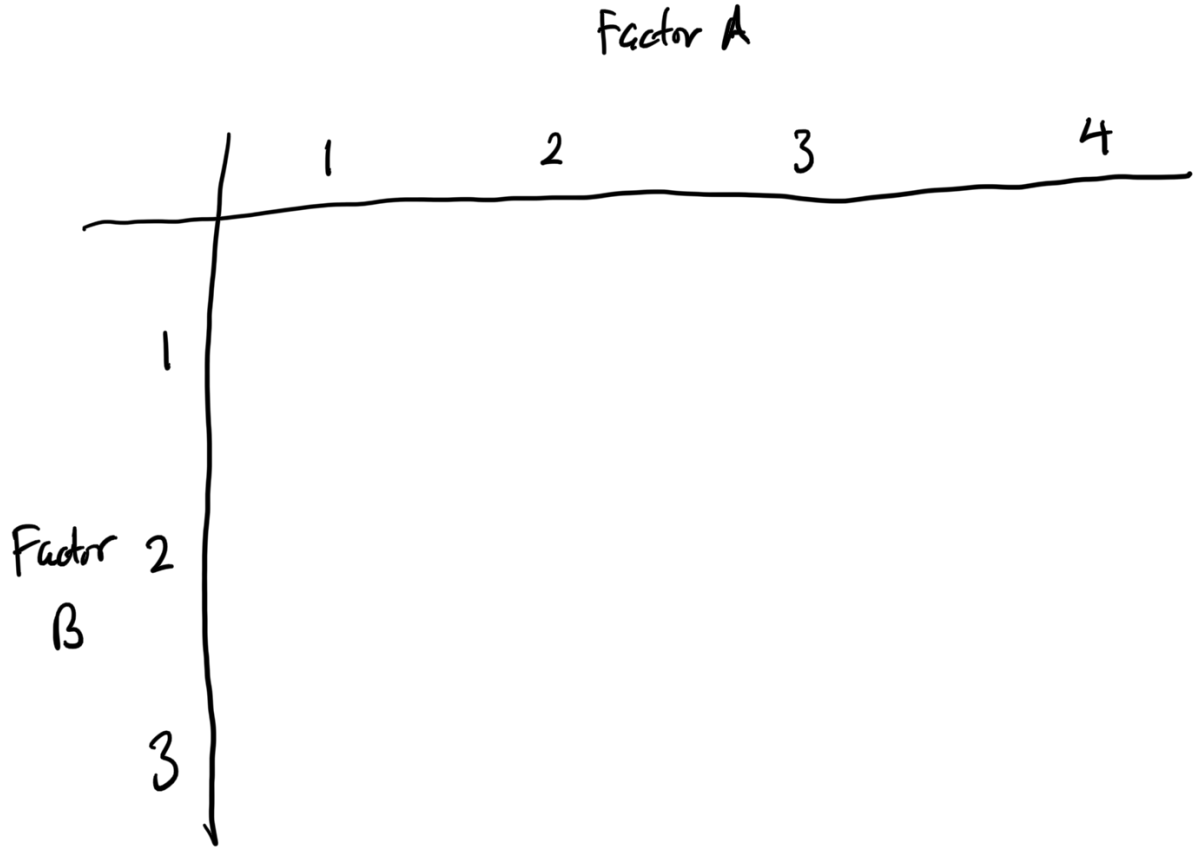
Physics 341 - Lecture 25

→ A few comments about assignment

→ Multi-Factor ANOVA



Tukey's HSD

(i) std_error = $\sqrt{\frac{MS_{error}}{n}}$ ✓

(ii) q (k, dof_error, α) ✓

k → 2, 3, ... * means.

dof_error ↑

α ↑

q_tukey (k, dof_error, α)

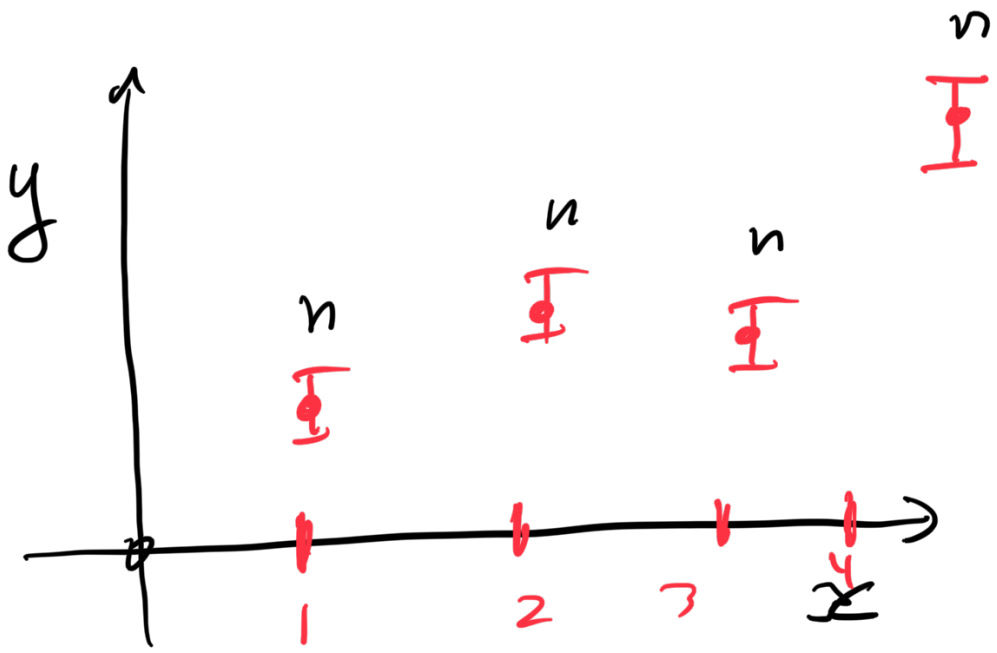
Jupyter Notebooks

from q_tukey import q_tukey

→ website ANOVA.ipynb

q = np.array([-, -, -])

Multi-Factor ANOVA



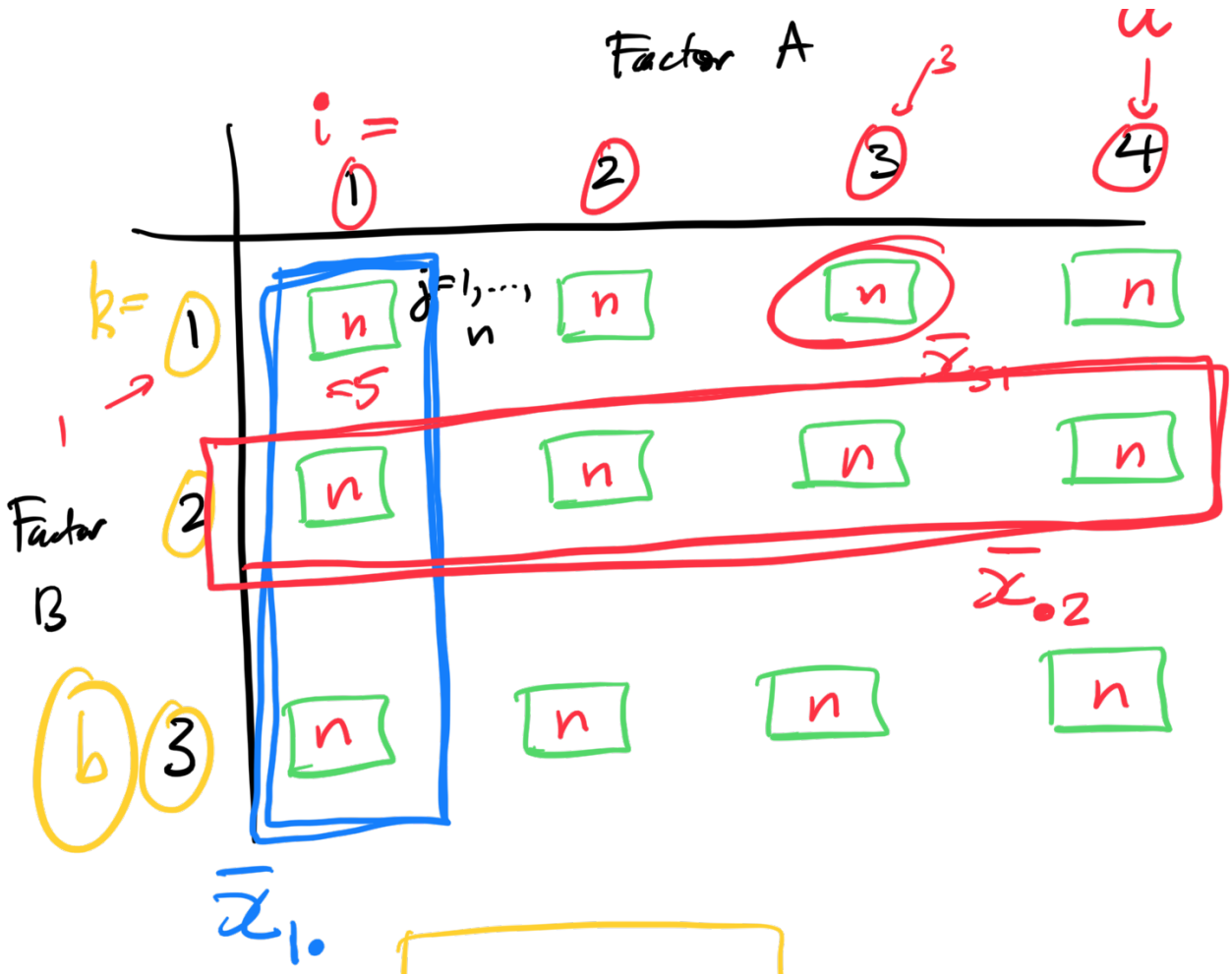
"life is bitch, then you die."

→ $y(x, t, r, s, m, \text{gurman})$

① how do we analyze?

② how do we design the experi

Two-Factor Experiment



$$x_{ijk}$$

Degrees of freedom. $(a=4,\ b=3,\ n=5)$

Total: $N = nab$ (60)

$$\nu_{total} = 59 = nab - 1$$

Treatment: $\nu_{treatment} \equiv$ "setting of explanatory" $- 1$

$= ab - 1 = 11$

Error: $\nu_{error} = \nu_{total} - \nu_{treatment}$

$= nab - 1 - (ab - 1)$

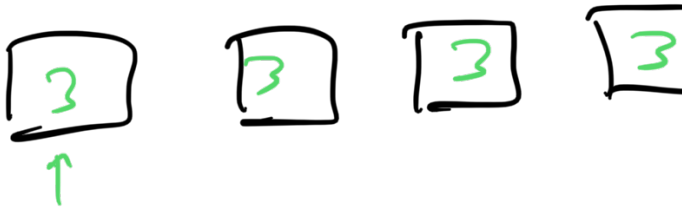
$= nab - ab$

$= (n-1)ab$

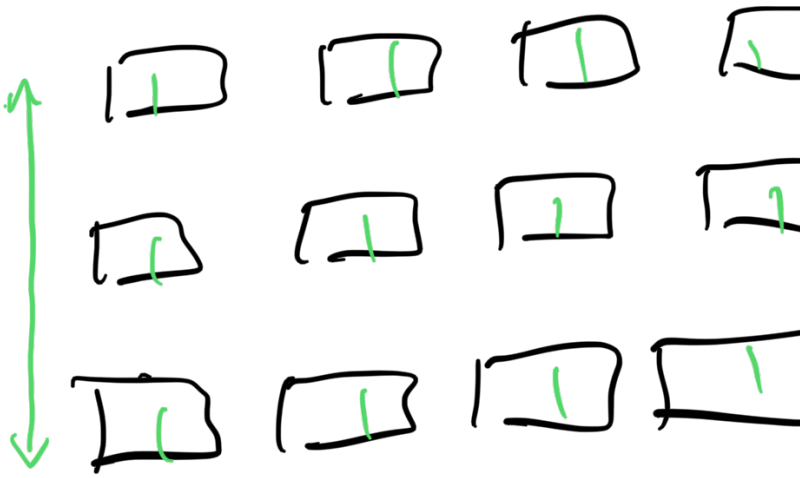
$= 4 \cdot 4 \cdot 3 = 48$

$n \geq 2$

Single Factor



Two Factor



Treatment:

$$\nu_{treat} = ab - 1$$

$$= (a-1) + (b-1) + (a-1)(b-1)$$

$$3 + 2 + 6$$

$\nu_A = a - 1$

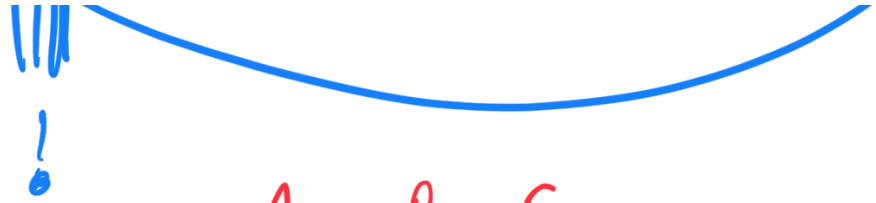
$\nu_B = b - 1$

Correlations !!!!!!

$\nu_{AB} = (a-1)(b-1)$

3×2

not the same? $\rightarrow a+b-?$



A B C

3: (a), (b), (c)

$$\nu_{TREATMENT} = abc - 1$$

$$+ \quad \nu_A = a - 1$$

$$+ \quad \nu_B = b - 1$$

$$+ \quad \nu_C = c - 1$$

$$+ \quad \nu_{AB} = (a-1)(b-1)$$

$$+ \quad \nu_{AC} = (a-1)(c-1)$$

$$+ \quad \nu_{BC} = (b-1)(c-1)$$

$$+ \quad \nu_{ABC} = (a-1)(b-1)(c-1)$$

2-Factor

$$\nu_{TOTAL} = nab - 1$$

$$\nu_{TREATMENT} = ab - 1$$

$$\nu_A = a - 1$$

$$\nu_B = b - 1$$

$$\nu_{AB} = (a-1)(b-1)$$

$$\nu_{ERROR} = (n-1)ab$$

Sums of Squares.

$$\bar{\bar{x}} = \frac{1}{N} \sum_i \sum_j \sum_k x_{ijk}$$

~~Single Factor.~~ $\bar{x}_i$ At each setting.

n

$$\bar{x}_{ik} = \frac{1}{n}\sum_{j=1} x_{ijk}$$

A B

column

$\bar{x}_{i\cdot}$

4 columns

row

$\bar{x}_{\cdot k}$

3 rows

$$SS_{TOTAL} = \sum_{i}\sum_{j}\sum_{k}\left(x_{ijk} - \bar{\bar{x}}\right)^2$$

$$SS_A = \sum_{i=1}^{a}\left(\bar{x}_{i\cdot} - \bar{\bar{x}}\right)^2 nb$$

$$SS_B = \sum_{k=1}^{b} (\bar{x}_{\cdot k} - \bar{\bar{x}})^2 na$$

$$SS_{TREATMENT} = \sum_{i=1}^{a} \sum_{k=1}^{b} (\bar{x}_{ik} - \bar{\bar{x}})^2 r$$

$$SS_{ERROR} = SS_{TOTAL} - SS_{TREATMENT}$$

$$SS_{AB} = SS_{TREATMENT} - SS_A - SS_B$$

$a = 3$

$b = 4$

$n = 2$

$N = 24$

$df_{TOTAL} = 23$

$$\nu_A = 2$$

$$\nu_B = 3$$

$$\nu_{AB} = 6$$

$$\nu_{TOT} = 11$$

$$\nu_{ERROR} = 23 - 11 = 12$$

$$\left[\begin{matrix} \text{data} \\ \text{pt.} \end{matrix} , i , k \right]$$