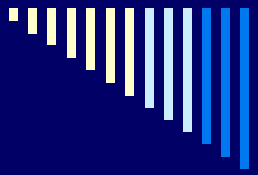


Experimental strategies: An Introduction

From a descriptive view to study questions

Based on *D. C. Montgomery*, *Design and Analysis of Experiments*, McGraw-Hill.

Cases without human subjects

We want to show some case where Exp. Eng. Techniques are applied without human subjects.

Valutare, al fine di ottenere +10% della durezza:

- Tempera di alluminio in diversi bagni e con diverse temperature

Valutare, a fini di riduzione scarti del 3%:

- Processo chimico produzione vernici
- Saldatura componenti elettronici su circuito stampato: riduzione scarti
- …

Cases with human subjects

We want to show some cases where Exp. Eng. Techniques are applied with human subjects.

Valutare impatto su ore/giorno di mal di testa in soggetti predisposti:

- Somministrazione di principio attivo X al 10% e, rispettivamente, 5% 1 volta al giorno

Valutare, al fine di ridurre del 10% i difetti al rilascio:

- Tecnica X e tecnica Y di ispezione di requisiti software | codice

A simple hybrid example

We want to improve the (average) time that a certain team (person) need(s) to bike two ways the Albano lake's wood path.

Input Variables

(when impact of subjectivity is not taken into consideration)

- Bike type (C, MB)
- Rocket rate (S, L)
- Wheel diameter (24, 26)
- Wheel type (L, C)
- Weather (D, W)
- Experience about the path (S, H)

Levels: 1 out of 2 for each input variable.

One more example

We want to understand if it improves the (average) extensive maintenance time of software applications in a given domain using a structured approach to software design.

Input Variables

- Sw. Design (MVC, Ad hoc)
- Development technology (J2EE, .NET)
- Programming Languages (Java 2.6, C# 1.5)
- Documentation tools (starUML, ..)
- Experience of subjects (Junior, Average, Senior)
- Expertise of subjects (Low, Medium, High)
- …

- Levels: 1 out of 2 or 3 for each input variable.

Experimental strategy

- None
- Attempt
- One variable does change per time
- Factorial (complete, incomplete)
- ….

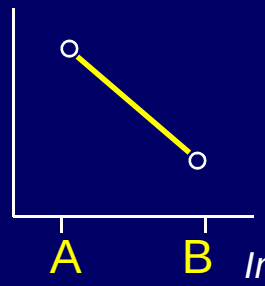
Experimental strategy

1 factor, 2 treatments {A, B}

Number of factors

Number of treatments

Dependent variable



Independent variable

1x2 elementary experiments.

Experimental strategy

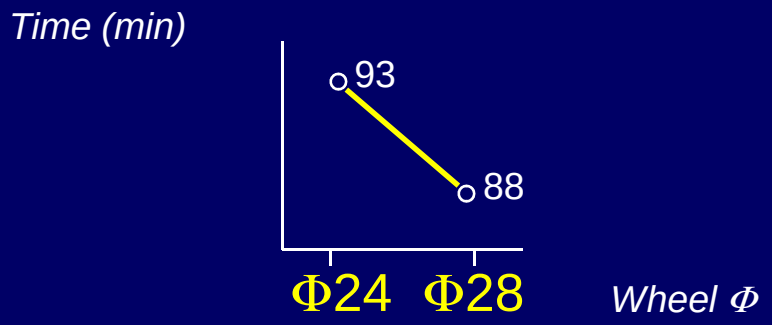
1 factor, 2 treatments {A, B}

Wheel Φ: {Φ24, Φ28}

Parameters

INPUT VARIABLES CONTROLLED AT CONSTANT LEVELS:

Bike type = MB
Rocket= S
Wheel type= L
Weather= Dry
Path experience= H



Q: What about people involved as experimental subjects?

Experimental strategy

1 factor, 2 treatments {A, B}

Style Σ: {ΣMVC, ΣAdHoc}

Parameters

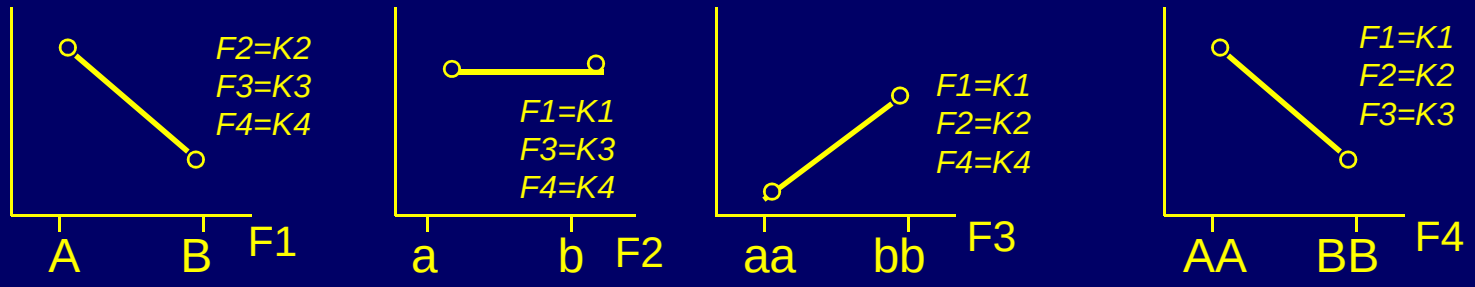
INPUT VARIABLES CONTROLLED AT CONSTANT LEVELS:

Dev. Tech. = J2EE
Prg. Lang.= Java
Doc. Tools= {starUML, …}
Env.= {SQL, Apache, ..}
Experience= J
Expertise= M

Q: What about people involved as experimental subjects?

Experimental strategy

More than one factors (F1, F2, … F_n).
1 factor does change per time



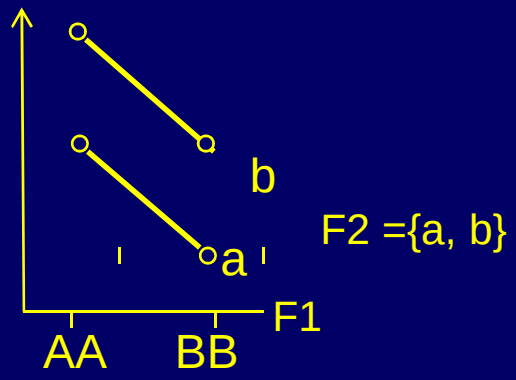
Four factors (F1..F4), each with two treatments

Descriptive result

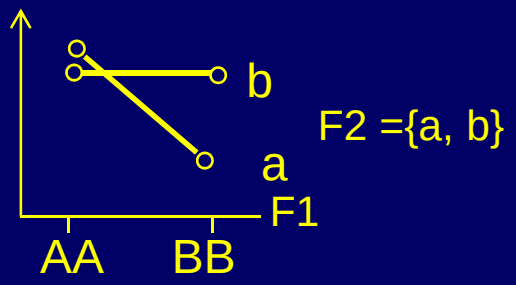
- *If the scale of ordinate is ascending (resp. descending) then the best choice for (F1, F3, F4) is (A, bb, AA) (resp. (B, aa, BB)).*
- *F2 does not affect outcomes for the given constant levels.*

Experimental strategy

Interaction between two factors



Not interacting factors, ascending Y scale
Best result: (AA, b)



Interacting factors, ascending Y scale
Best result: (AA, a)

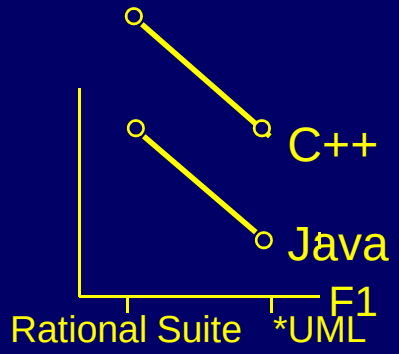
Two factors, each with two treatments

Factors interact when variation in the combinations of treatments do affect outcome variations (Δ)

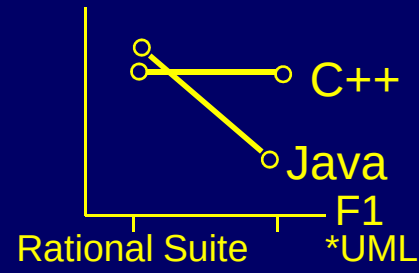
Q: What tools to use to understand whether there is interaction between input variables?

Experimental strategy

Interaction between two factors



Not interacting factors
Best result: (Rationale Suite, C++)



Interacting factors
Best result: (Rational Suite, Java)

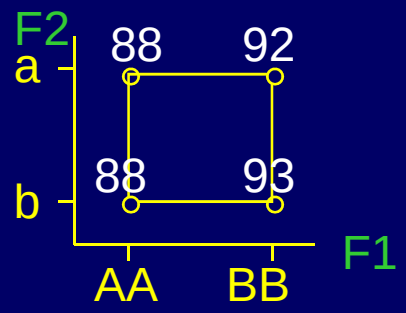
Two factors, each with two treatments

Factors interact when variation in the combinations of treatments do affect outcome variations (Δ)

Experimental strategy

Factorial

Number of factors



Number of treatments

2 factors, each with 2 treatments (2x2)

Effect of F1 = (92+93)/2 – (88+88)/2= 4.5

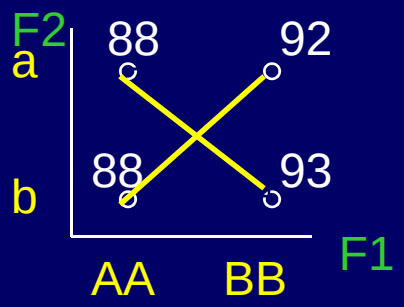
Effect of F2 = (88+93)/2 – (88+92)/2= 0.5

2x2 elementary experiments.

Experimental strategy

Factorial 2x2

Interactions



Effect of interaction btw. F1 and F2

= (93+88)/2 – (88+92)/2= 0,5

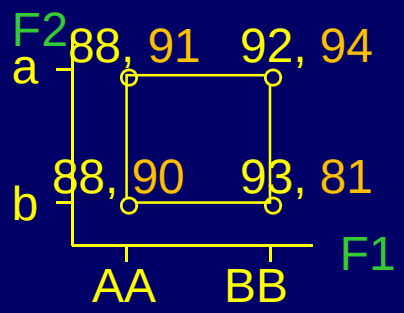
Q: Concerning outcomes, in what % do they depend on F1, F2, F1 and F2 interaction, respectively?

Q: What tools to evaluate the effect of interaction between input variables?

Experimental strategy

Factorial 2x2 + 1 replication

Replications



Effect of F1 = 3,25 (*)

Effect of F2 = 0.75

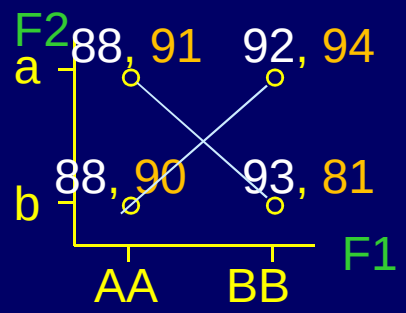
(*) = (92+94+93+81)/4 – (88+91+88+90)/4

Q: Does replication impact on variance?

Experimental strategy

Factorial 2x2 + 1 replication

Interaction & Replications



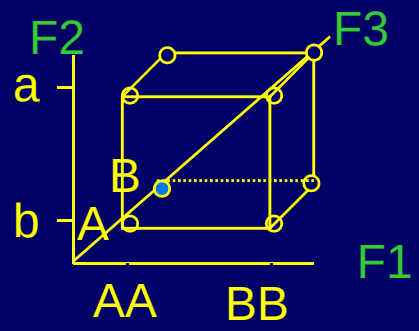
Effect of interaction btw. F1 and F2

= (92+94+88+90)/4 – (88+91+93+81)/4= 0,25

Q: concerning outcomes, in what % do they depend on F1, F2, F1 and F2 interaction, respectively?
Is there an impact on mean and variance?

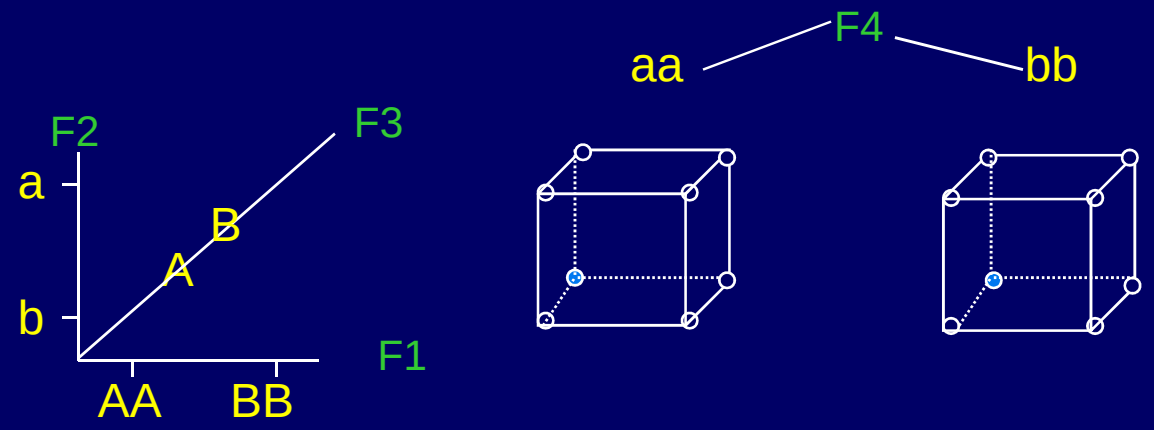
Experimental strategy

Factorial design with 3 factors, each with 2 treatments.



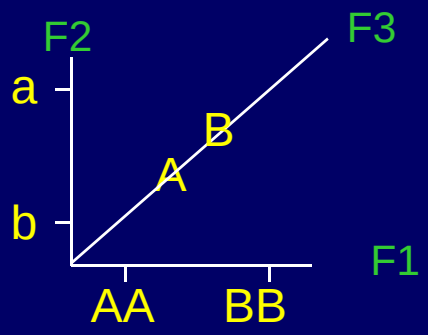
Experimental strategy

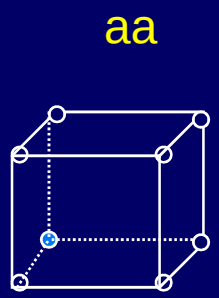
Factorial design with 4 factors, each with 2 treatments.

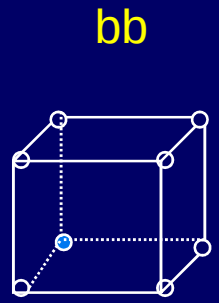


Experimental strategy

Fractional Factorial design with 4 factors, each with 2 treatments.







F4

½ Fraction