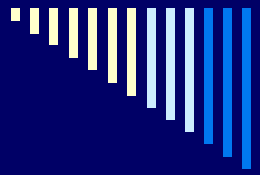
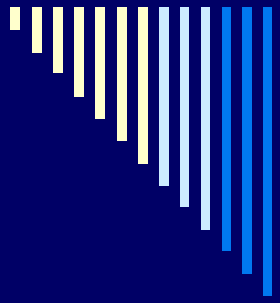


Experimental strategies: An Introduction

From a descriptive view up to study questions

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



What an experiment can prove

No amount of experimentation can ever prove me right; a single experiment can prove me wrong.

Albert Einstein

Letter to Max Born, *December 4, 1926*

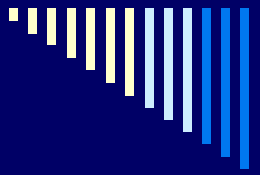
Cases without human subjects

We want to show some cases where Exp. Eng. Techniques are applied [quite] without human subjects (only MD experiments should have human objects).

Valutare, al fine di ottenere, a parità di tutto il resto:

- +10% della durezza da tempera di alluminio in bagni {B1, B2, B3} e con temperature {T1, T2}

- - 3% scarti da saldatura componenti elettronici su circuito stampato con tecniche {S1, S2}



A case with human subjects

We want to show a case where Exp. Sw. Eng. Techniques are applied with human subjects (but, of course, without human objects).

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

- Tecnica I1 e tecnica I2 di ispezione di requisiti software (o codice, etc.)

A case of MD experiment with human objects (and subjects)

We as want to show a case where MD subjects apply Exp. Med. Treatments (or Levels) of a given Exp. Factor to human (as exp. objects).

Valutare impatto su ore/giorno di mal di testa in persone predisposte:

- Somministrazione del principio attivo Xxx in dose di 10 mg, 5 mg 1 o, rispettivamente, 0 mg una volta al giorno.

An ESE example

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

Input Variables

- Sw. Design (MVC, Ad hoc)
- Others: as usual

– Levels: 1 factor, 2 treatments.

One more ESE example

We would want to understand if it improves in the average the extensive maintenance time of software applications in a given domain using a structured approach to software design, and J2EE, Java, RSA and people with different levels of experience and expertise.

Input Variables

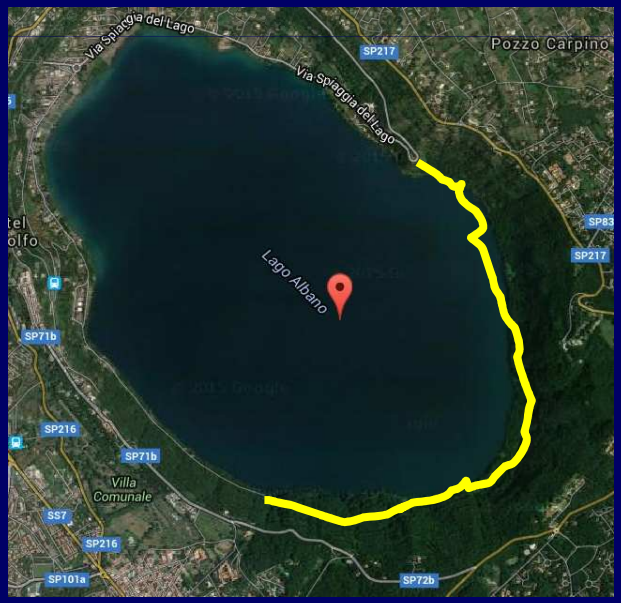
- Sw. Design (MVC, Ad hoc)
- Development technology (J2EE, .NET)
- Programming Languages (Java 2.6, C# 1.5)
- Documentation tools (*UML, RSA)
- Experience of subjects (Junior, Average, Senior)
- Expertise of subjects (Low, Medium, High)
- …

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

A simple hybrid example

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

Input Variables ?



A simple hybrid example

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

Input Variables

- Bike type (C, MB)
- Rocket rate (S, L)
- Wheel diameter (24, 26)
- Wheel type (L, C)
- Weather (D, W)
- Expertise of subjects (Medium, High)
- …

Levels: 1 out of 2 for each input variable.

Experimental strategy

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

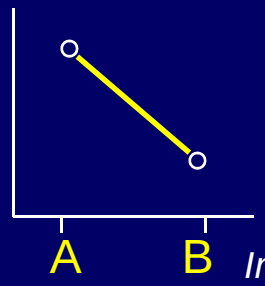
Experimental strategy

1 factor, 2 treatments {A, B}

Number of factors

Number of treatments

Dependent variable



Independent variable

1x2 elementary experiments.

Experimental strategy

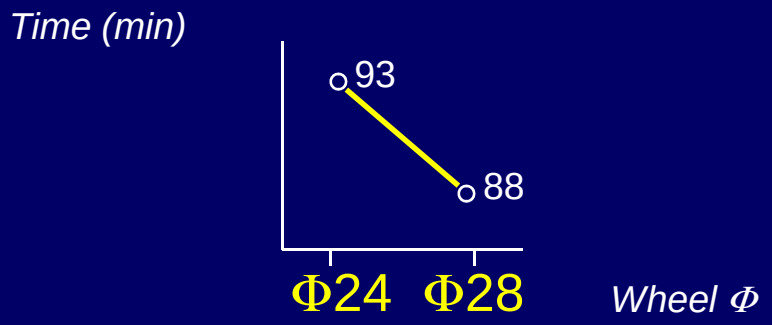
1 factor, 2 treatments {A, B}

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 other about people involved as experimental subjects?

Experimental strategy

1 factor, 2 treatments {A, B}

Style Σ: {ΣMVC, ΣAdHoc}

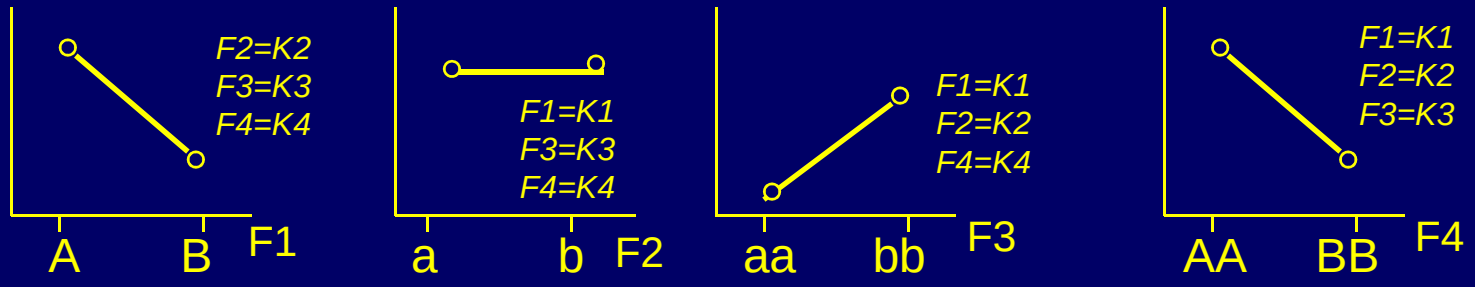
Parameters

INPUT VARIABLES
CONTROLLED AT
CONSTANT LEVELS:
Dev. Tech. = J2EE
Prg. Lang.= Java
Doc. Tools= {starUML, …}
Env.= {SQL, Apache, ..}
Experience= J
Expertise= M

Q: What other about people involved as experimental subjects?

Experimental strategy

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



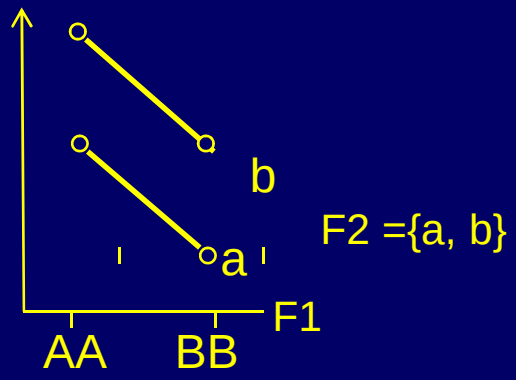
Four factors (F1..F4), each with two treatments

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.*

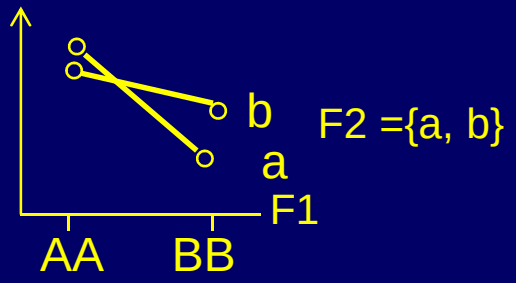
Experimental strategy

Interaction between two factors



Not interacting factors

Best result: (AA, b) , ascending Y scale



Interacting factors

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

Two factors, each with two treatments

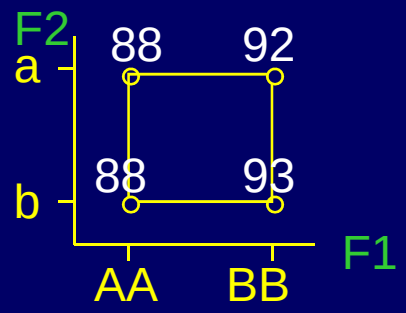
Factors interact when variation in the combinations of treatments do affect outcome variations (Δ)

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

Experimental strategy

Factorial

Number of factors



Number of treatments (or levels)

2 factors, each with 2 treatments (2x2)

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

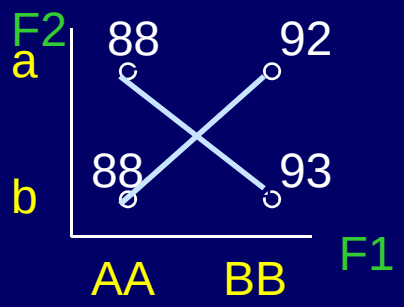
Effect of F2 = (88+93)/2 – (88+92)/2= 0.5

2x2 elementary experiments.

Experimental strategy

Factorial 2x2

Interactions



Effect of interaction btw. F1 and F2

= (93+88)/2 – (88+92)/2= 0,5

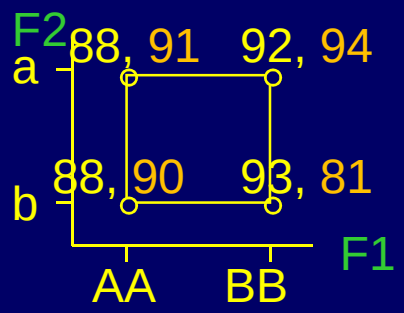
Q: Concerning outcomes, in what % do they depend on F1, F2, F1 and F2 interaction, respectively?

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

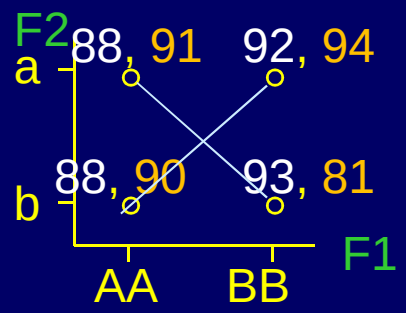
(*) = (92+94+93+81)/4 – (88+91+88+90)/4

Q: Does replication impact on variance?

Experimental strategy

Factorial 2x2 + 1 replication

Interaction & Replications



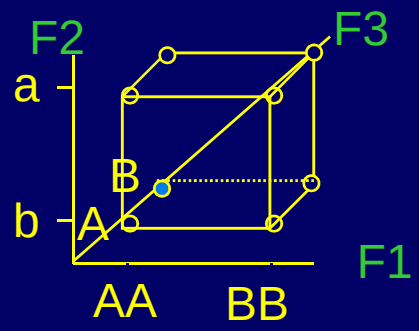
Effect of interaction btw. F1 and F2

= (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?

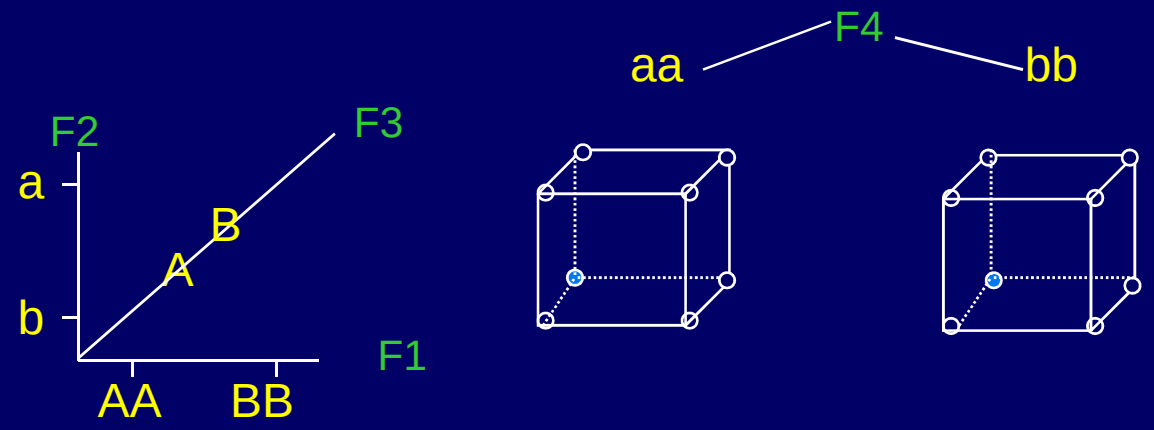
Experimental strategy

Factorial design with 3 factors, each with 2 treatments.



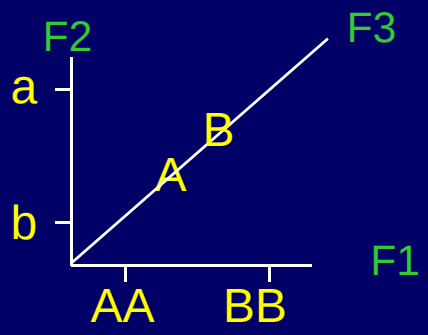
Experimental strategy

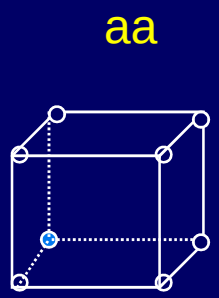
Factorial design with 4 factors, each with 2 treatments.

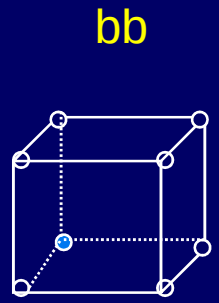


Experimental strategy

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







F4

½ Fraction