STA 674

Regression Analysis And Design Of Experiments

Blocking and Precision – Lecture 2

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Blocking and Precision

- Last time, we talked about a method of controlling local error, blocking.
- This time, want to emphasize a couple of key points about using blocking and talk about the most frequently used design with blocking, the randomized complete block design.

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Example – fertilizer effect

- An agricultural researcher wants to test the effects of four different fertilizers on the growth of corn. The test field (depicted below) is long and narrow and is divided into 16 plots of equal size, each of which will be treated with one fertilizer.
- A tall stand of trees along one side of the field shades 8 of the plots, and past experiments have shown that corn grows slower in these plots.
- How should we allot the four fertilizers to the plots?

Randomly assign four fertilizers in shady plots,
randomly assign four fertilizers in sunny plots

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16

randomized complete block design

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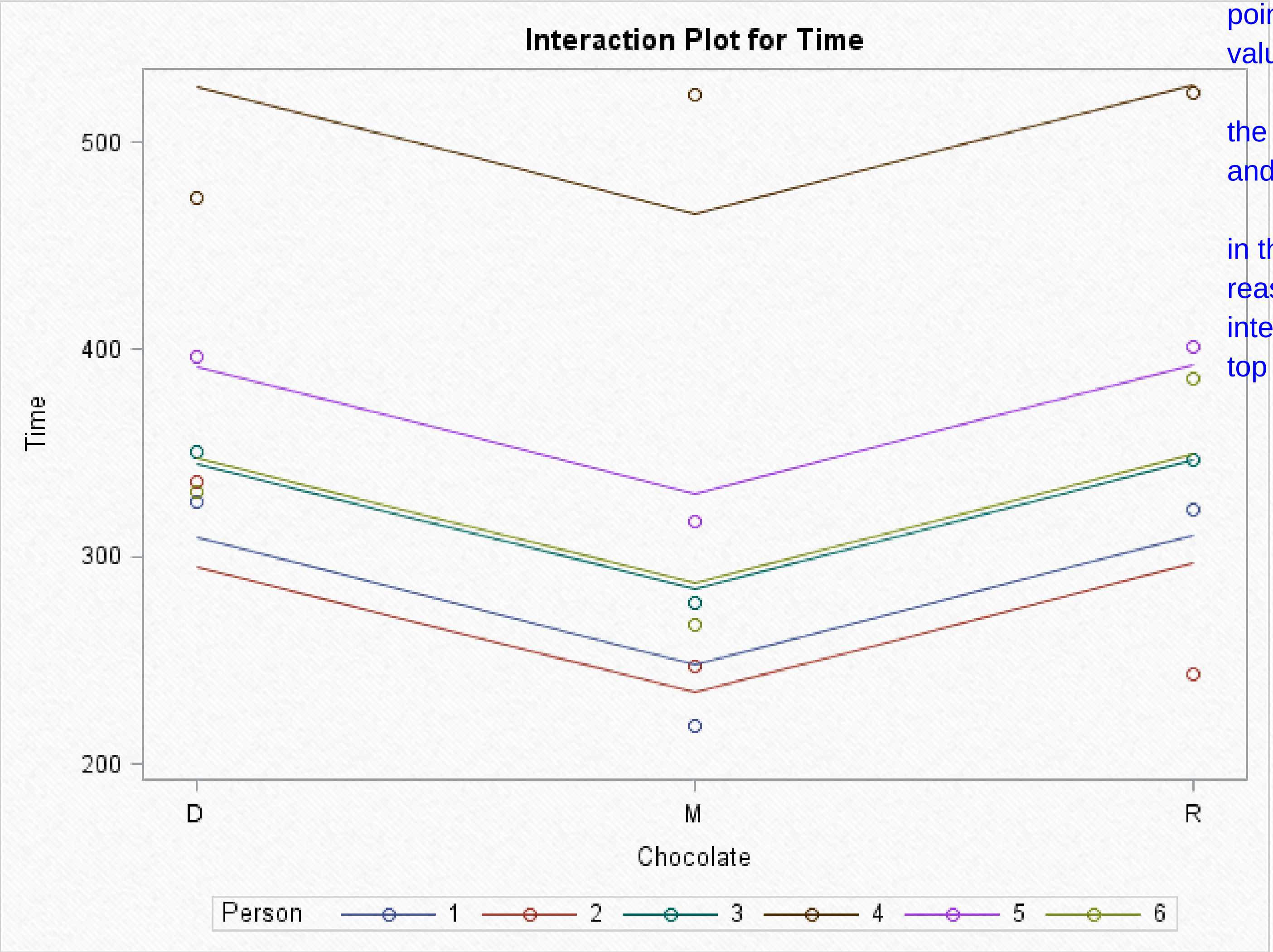
Blocking

The key assumption is that there is **no interaction** between factors and blocks.

Why?

Example – chocolate melting, with results blocked by group member



"No" interaction plot...

lines represent ideal means
if there were no interactions

points represent observed
values

the differences between observed
and ideal should be about the same

in this plot, everything looks
reasonable for no
interaction (except maybe
top block for D and M chocolate)

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Randomized Complete Block Design

A **randomized complete block design** (RCBD) is one in which every treatment occurs and equal number of times within each block.

Randomization

1) Blocking: Separate experimental units into similar groups (blocks).

2) Randomization: Randomly assign treatments to experimental units in each block.

Key Assumption

Blocks do not interact with factors: the difference between the true means for any pair of treatments is the same in all blocks.

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Example – fertilizer effect

- SAS code for analyzing the RCBD:

```
DATA CORN;
 INPUT plot block fertilizer yield;
 CARDS;
1 1 3 11.6
2 1 2 11.7
3 1 3 10.0
```

etc.

```
9 2 1 16.0
10 2 4 18.1
```

```
/* Analysis with blocks */;
PROC GLM DATA=CORN;
    CLASS block fertilizer;
    MODEL yield=block fertilizer;
    LSMEANS fertilizer / CL;
RUN;
```

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Example – fertilizer effect

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```

Dependent Variable: yield

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	127.1675000	31.7918750	78.29	<.0001
Error	11	4.4668750	0.4060795		
Corrected Total	15	131.6343750			

R-Square	Coeff Var	Root MSE	yield Mean
0.966066	4.574203	0.637244	13.93125

fertilizer	yield LSMEAN	95% Confidence Limits	
1	13.150000	12.448718	13.851282
2	13.600000	12.898718	14.301282
3	14.075000	13.373718	14.776282
4	14.900000	14.198718	15.601282

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Example – fertilizer effect

- SAS code for testing for interaction:

```
/* Testing for interaction */;
PROC GLM DATA=CORN;
    CLASS block fertilizer;
    MODEL yield=block fertilizer block*fertilizer;
    LSMEANS fertilizer / CL;
RUN;
```

Source	DF	Type I SS	Mean Square	F Value	Pr > F
block	1	120.4506250	120.4506250	455.61	<.0001
fertilizer	3	6.7168750	2.2389583	8.47	0.0073
block*fertilizer	3	2.3518750	0.7839583	2.97	0.0973

interaction term...not significant

Example – fertilizer effect
Testing for interaction

interaction is questionable in this plot...
for blocks green and red in middle...could
go either way