STA 674

Regression Analysis And Design Of Experiments

Blocking and Precision – Lecture 1

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- Where does it fit in?
- What is it?
- What next?

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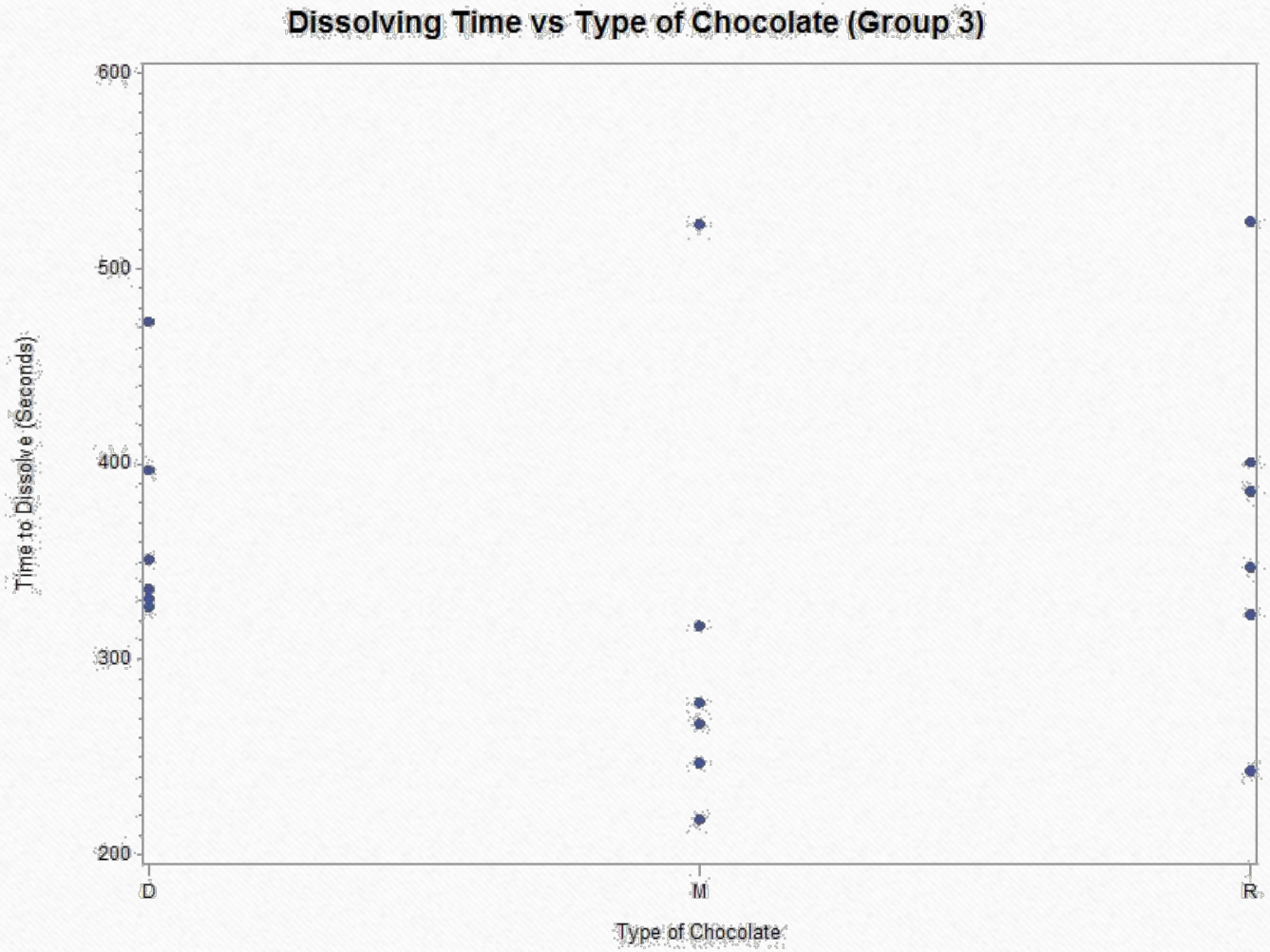
Example – chocolate melting

- In a previous incarnation of this course, an in-class experiment was conducted to try to infer whether different types of chocolate melted in different (average) times. One group conducted 6 trials for each type of chocolate. Here are the data ordered from fastest to slowest for each type of chocolate:

Chocolate	Observation					
	1	2	3	4	5	6
Dark (D)	327	331	336	351	397	473
Milk (M)	218	247	267	278	317	523
Raspberry (R)	243	323	347	386	401	524

- Can we conclude the mean dissolving time depend on the type of chocolate?

Example – chocolate melting



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Example – chocolate melting

- Simple analysis with no blocking:

```
TITLE "No Blocking";
PROC GLM DATA=CHOCOLATE1 PLOTS=(DIAGNOSTICS);
    CLASS chocolate;
    MODEL time=chocolate;
    LSMEANS chocolate / PDIFF=ALL;
RUN;
```

Dependent Variable: Time

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	15176.7778	7588.3889	0.94	0.4114
Error	15	120725.5000	8048.3667		
Corrected Total	17	135902.2778			

R-Square	Coeff Var	Root MSE	Time Mean
0.111674	25.67703	89.71269	349.3889

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Example – chocolate melting

- Simple analysis with no blocking:

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey

Chocolate	Time LSMEAN	LSMEAN Number
D	369.166667	1
M	308.333333	2
R	370.666667	3

Least Squares Means for effect Chocolate
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: Time

i/j	1	2	3
1		0.4856	0.9995
2	0.4856		0.4693
3	0.9995	0.4693	

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Blocking

Designed experiments will produce more precise results with narrower confidence intervals and more powerful tests if the experimental error variance is reduced.

One way to reduce the experimental error variance is to group similar experimental units and then to consider the effect of the factors within each group.

These groups are called **blocks**.

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Blocking Criteria

Experimental units are often grouped into blocks based on:

1. Proximity (neighboring plots in a field),
2. Physical characteristics (age, weight, gender),
3. Time (days within weeks within months),
4. Replications within people

Key Assumption

There is **no interaction** between factors and blocks: differences between the treatment means are assumed constant across blocks.

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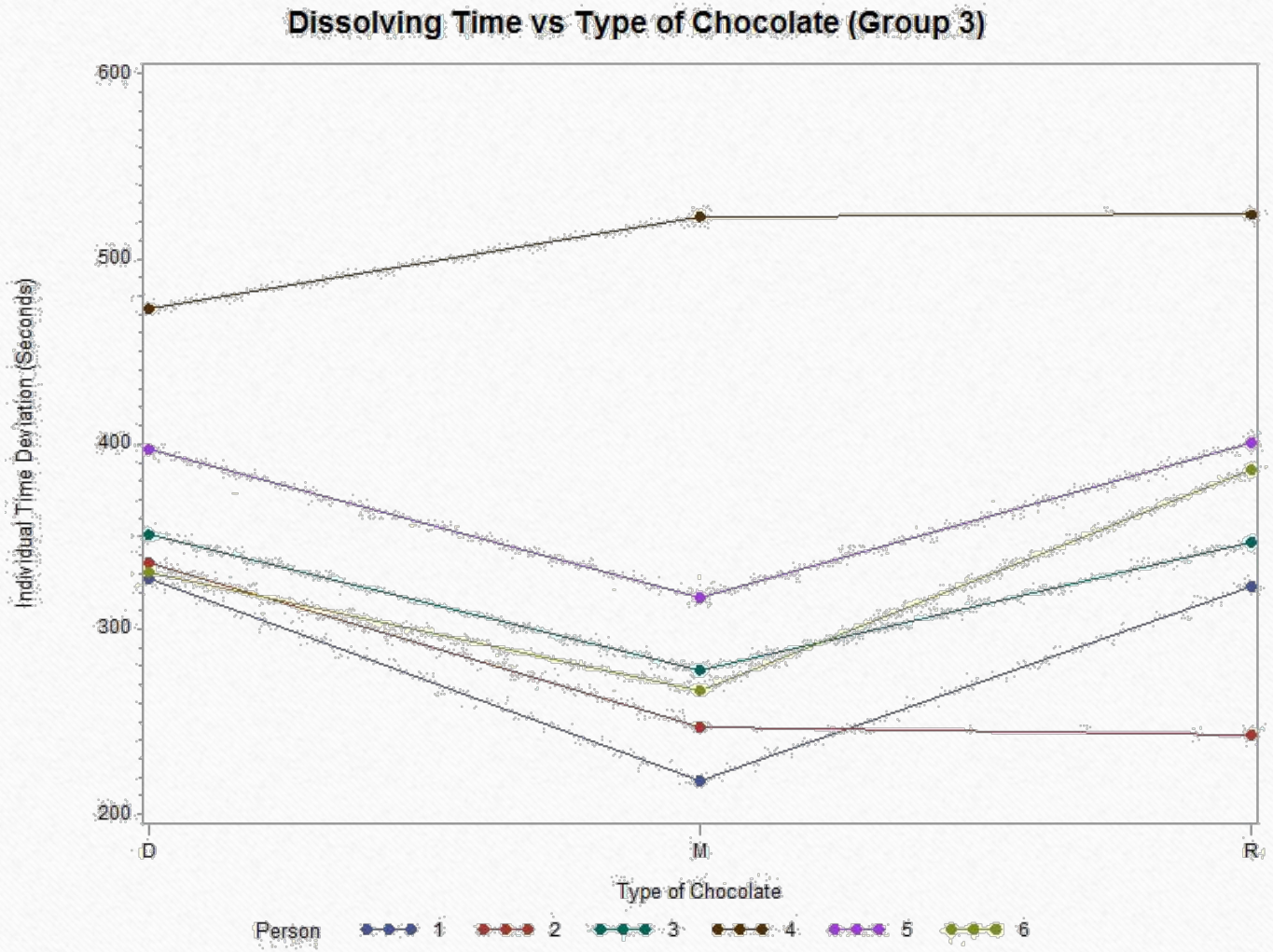
Example – chocolate melting

- Reconsider the chocolate experiment, blocking by group member. Here are the times it took the chocolate to dissolve in seconds, ordered by the group member:

Chocolate	Observation					
	1	2	3	4	5	6
Dark (D)	327	336	351	473	397	331
Milk (M)	218	247	278	523	317	267
Raspberry (R)	323	243	347	524	401	386

- Does the mean dissolving time depend on the type of chocolate?

Example – chocolate melting, with results blocked by group member



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Example – chocolate melting

- Analysis, blocked by group member:

```
TITLE "Blocking";
PROC GLM DATA=CHOCOLATE1 PLOTS=(DIAGNOSTICS);
    CLASS chocolate person;
    MODEL time=chocolate person;
    LSMEANS chocolate / PDIFF=ALL;
RUN;
```

Dependent Variable: Time

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	121255.7222	17322.2460	11.83	0.0004
Error	10	14646.5556	1464.6556		
Corrected Total	17	135902.2778			

R-Square	Coeff Var	Root MSE	Time Mean
0.892227	10.95365	38.27082	349.3889

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Example – chocolate melting

- Analysis, blocked by group member:

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey

Chocolate	Time LSMEAN	LSMEAN Number
D	369.166667	1
M	308.333333	2
R	370.666667	3

Least Squares Means for effect Chocolate
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: Time

i/j	1	2	3
1		0.0490	0.9975
2	0.0490		0.0439
3	0.9975	0.0439	