STA 674

Regression Analysis And Design Of Experiments

Treatment Comparisons – Lecture 4

STA 674, RA Design Of Experiments:
Treatment Comparisons

- Last time, we investigated Bonferroni's method of dealing with multiple comparisons' effect on Type I error "piling up."
- This time, we will look at the more sophisticated methods of working against this phenomenon.

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Introduction

- Suppose that we want to perform a series of n tests with an experimentwise error rate of α_E.
- Bonferroni's Correction correction will provide provide an experimentwise error rate that is at most α_E no matter what n tests we choose. However, the actual experimentwise error rate may be much less than α_E. In this case we are being too conservative – and we will reduce the power. In some special circumstances we can get use special strategies to get the experimentwise error rate closer to α_E.

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Strategy #2: Multiple Comparisons with a Control

- Objective: Determine whether or not every treatment is different from the control treatment while maintaining a desired experimentwise error rate (α_E).
- Method: Dunnett's Method.
- SAS Code:

```
/* Multiple Comparisons with a Control (Dunnet)*/;
PROC GLM DATA=TOMATO;
     CLASS treatment;
     MODEL growth=treatment;
     LSMEANS treatment / PDIFF=CONTROL('Control');
RUN;
```

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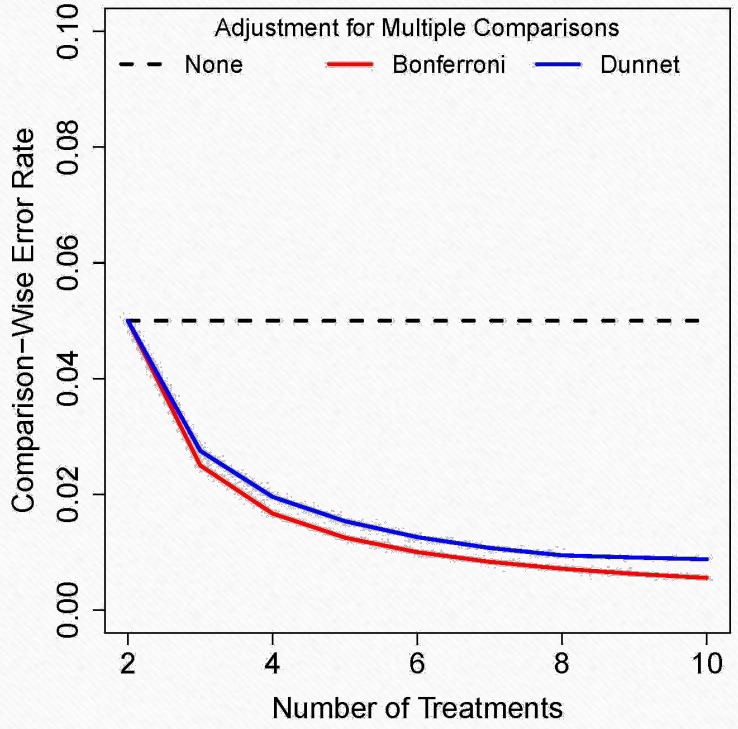
Specific Strategies for Multiple Comparisons:

Comparison of Dunnet and Bonferroni Corrections

- Imagine that an experiment has t treatments with $r = 5$ units per treatment and we wish to compare $t - 1$ of the treatments vs the control.
- This plot illustrates the adjusted comparisonwise error rate, α_C, required to obtain $\alpha_E = 0.05$ with either the Bonferroni or Dunnet correction.



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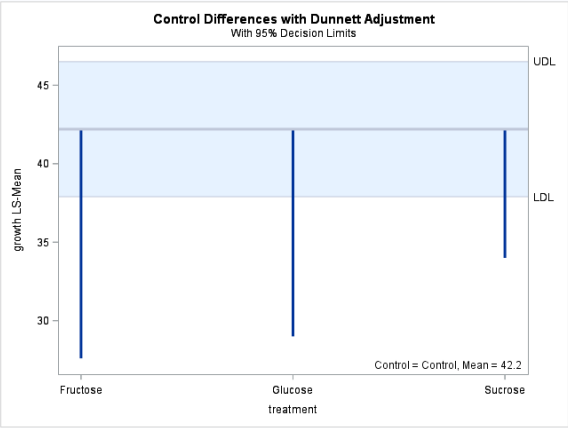
Example exercise: tomato growth

- Consider the tomato experiment again and suppose that we wish to compare each sugar solution against the control.
- SAS Code

```
/* Multiple Comparisons with a Control (Dunnet)*/;
PROC GLM DATA=TOMATO;
    CLASS treatment;
    MODEL growth=treatment;
    LSMEANS treatment / PDIFF=CONTROL('Control');
RUN;
```

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

treatment	growth LSMEAN	H0:LSMean=Control Pr > |t|
Control	42.2000000	
Fructose	27.6000000	<.0001
Glucose	29.0000000	<.0001
Sucrose	34.0000000	0.0004



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Strategy #2: Multiple Comparisons with any level

- Objective: Determine whether or not every treatment is different from any particular treatment while maintaining a desired experimentwise error rate (α_E).
- Method: (still!) Dunnett's Method.
- SAS Code:

```
/* Multiple comparisons with the best (Dunnet)*/;
PROC GLM DATA=TOMATO;
    CLASS treatment;
    MODEL growth=treatment;
    LSMEANS treatment / PDIFF=CONTROL('Fructose');
RUN;
```

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Strategy #3: All Pairwise Comparisons

Objective: Determine which pairs of treatments are significantly different while maintaining the desired experimentwise error rate (α_E).

- Method: Tukey's Honest Signicant Differences..
- SAS Code:

```
/* Tukey's pairwise comparisons */;
PROC GLM DATA=TOMATO;
    CLASS treatment;
    MODEL growth=treatment;
    LSMEANS treatment / PDIFF=ALL;
RUN;
```

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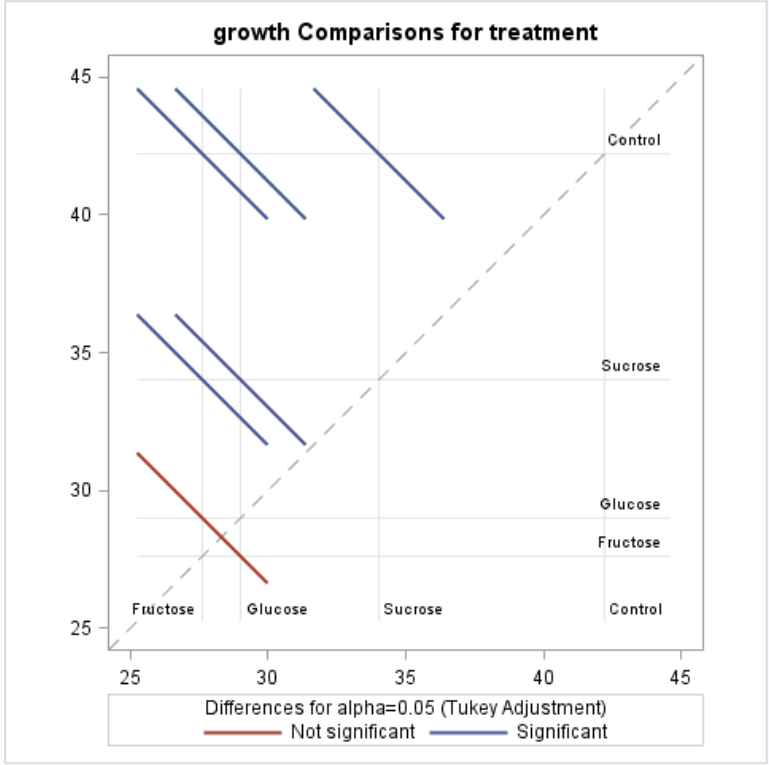
Least Squares Means for effect treatment
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: growth

i/j	1	2	3	4
1		<.0001	<.0001	0.0008
2	<.0001		0.8327	0.0068
3	<.0001	0.8327		0.0371
4	0.0008	0.0068	0.0371	

Example exercise: tomato growth

- Consider the tomato experiment again and suppose that the best treatment is actually the one with the smallest growth.
- SAS Code

```
/* Tukey's pairwise comparisons */;
PROC GLM DATA=TOMATO;
    CLASS treatment;
    MODEL growth=treatment;
    LSMEANS treatment / PDIFF=ALL;
RUN;
```



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General Recommendations

Plan Ahead!

1. If possible, choose a small number of comparisons that you wish to test and use Bonferroni's criterion to adjust the comparisonwise error rate to obtain a specified experimentwise error rate.
2. If it makes sense to compare all treatments to a control or to the best, then use Dunnett's comparison in place of the Bonferroni correction.
3. Avoid making all comparisons unless this is what you really want to do. Running all comparisons is often a bandage for a poorly designed experiment without a well-defined hypothesis.