Unit 4: Inference for numerical data
3. ANOVA

Sta 101 - Spring 2015

Duke University, Department of Statistical Science

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Slides posted at http://bitly.com/sta101sp15

1. Housekeeping

2. ANOVA Review

3. Main ideas
    1. To identify which means are different, use pairwise t-tests
    2. If you want to test many hypotheses simultaneously, use the Bonferroni correction

4. Summary

- ▶ PA4 after class today, due Friday at 11:59pm
- ▶ RA5 Monday after spring break

[These data are] from an experiment run by a British video-game manufacturer in an attempt to calibrate the level of difficulty of certain tasks in the video game. Subjects in this experiment were presented with a simple `Where's Waldo?"-style visual scene. The subjects had to find a number (1 or 2) floating somewhere in the scene, to identify the number, and to press the corresponding button as quickly as possible. The response variable is their reaction time.

	Subject	PictureTarget.RT	Littered	FarAway
1	10	635	0	0
2	10	1144	0	0
3	10	570	0	0
4	10	589	0	0
5	10	754	0	0
6	10	601	0	0
...				

▶ `PictureTarget.RT`: the subject's reaction time in milliseconds.

▶ `Subject`: a numerical identifier for the subject undergoing the test.

▶ `FarAway`: was the number to be identified far away (1) or near (0) in the visual scene?

▶ `Littered`: the British way of saying whether the scene was cluttered (1) or mostly free of clutter (0).

Do some subjects in the study have different mean reaction times?
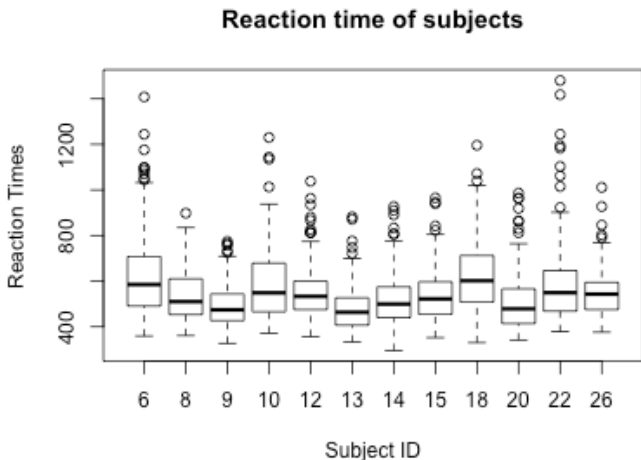
Reaction time of subjects

Number of observations $n = 1920$.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rxntime$Subject	??	4060822.10	369165.65	20.05	0.0000
Residuals	??	35129401.48	18411.64		

Clicker question

What are the degrees of freedom?

(a) 1 and 1909

(b) 11 and 1908

(c) 11 and 1909

(d) 12 and 1908

Number of observations $n = 1920$.

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What are the degrees of freedom?

(a) 1 and 1909

(b) *11 and 1908*

(c) 11 and 1909

(d) 12 and 1908

(Assume $\alpha = 0.05$.)

What is the most appropriate conclusion?

(a) There is no evidence that the subjects have different mean reaction times.

(b) There is no evidence that some of the subjects have the same mean reaction times.

(c) Some pairs of subjects have different mean reaction times.

(d) All paris of subjects have different mean reaction times.

(Assume $\alpha = 0.05$.)

What is the most appropriate conclusion?

(a) There is no evidence that the subjects have different mean reaction times.

(b) There is no evidence that some of the subjects have the same mean reaction times.

(c) *Some pairs of subjects have different mean reaction times.*

(d) All paris of subjects have different mean reaction times.

3. Main ideas

    1. To identify which means are different, use pairwise t-tests

    2. If you want to test many hypotheses simultaneously, use the Bonferroni correction

Clicker question

Suppose we want to determine which subjects have a mean reaction time different than Subject 6. How many pairwise t-tests will we need to do? Remember: there were a total of 12.

(a) 6

(b) 11

(c) 12

(d) $\frac{6 \times 5}{2} = 15$

Clicker question

Suppose we want to determine which subjects have a mean reaction time different than Subject 6. How many pairwise t-tests will we need to do? Remember: there were a total of 12.

(a) 6
(b) *11*
(c) 12
(d) $\frac{6 \times 5}{2} = 15$

Clicker question

Suppose we want to determine which means are different from each other. How many pairwise t-tests would we need to conduct? Remember: there were a total of 12 groups.

(a) 12

(b) $12! = 479{,}001{,}600$

(c) $12 \times 11 = 132$

(d) $\frac{12 \times 11}{2} = 66$

Clicker question

Suppose we want to determine which means are different from each other. How many pairwise t-tests would we need to conduct? Remember: there were a total of 12 groups.

(a) 12

(b) 12! = 479,001,600

(c) $12 \times 11 = 132$

(d) $\frac{12 \times 11}{2} = 66$

Bonferroni correction:

- ▶ Target type I error rate: α.
- ▶ Number of null/alt hypotheses to be tested using the same data set: K
- ▶ If you set the significance level for each test to be

$$\alpha^* = \alpha/K,$$

  then the probability of making one or more type I errors is $\leq \alpha$.

Application exercise: 4.5 ANOVA - Pt 2

See the course webpage for details.

1. To identify which means are different, use pairwise t-tests
2. If you want to test many hypotheses simultaneously, use the Bonferroni correction