BIO 682
Nonparametric Statistics
Spring 2010

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http://www4.nau.edu/shustercourses/BIO682/index.htm

Lecture 1

BIO 682
Nonparametric Statistics

Section Goals:

1. To introduce you to this statistical approach.
2. To demonstrate the similarity between parametric and nonparametric approaches.
3. Reading; mostly from S&R chapters 5, 13, 14, 15, 17.

Five Questions To Ask When Designing an Experiment

1. What do I want to know?
2. What type of data will give me the answers I need?
3. What statistical framework will allow me to test "no difference?"
4. How much data do I need to collect to identify differences?
5. How much data can I actually collect?

What do I want to know?

1. Are populations different?
2. Do individuals change over time?
3. Does a treatment change in experimental group in some way compared to a control?
4. Is there a relationship (a covariance) between certain variables?
5. How do combinations of variables interact to affect some other variable?

What type of data will give me the answers I need?

1. Classification
2. Ordering
3. Specific measurements on each case

What statistical framework will allow me to test "no difference?"

1. Probability of occurrence.
2. Ranks.
3. Means and variances.
4. Relationships or covariances.

How much data do I need to collect to identify differences?

1. Differences/relationships might be very subtle.
2. If experimental error or within-treatment variation is large, differences could be difficult to identify.
3. Larger sample sizes can help separate groups, provide more statistical power.

How much data can I *actually collect*?

1. Some differences are too subtle to be identified within existing time and energy constraints.
2. Some statistical questions require unrealistic (or unnatural) experimental designs.
3. Some designs do not possess adequate statistical power for rigorous tests.

Four Statistical Situations

1. One sample tests.
2. Two sample tests.
3. K-sample tests.
4. Tests of Association

One Sample Tests

Identify the probability that a given sample is similar to or different from some pre-described population.

Example: Could the observed body length of a particular spider have occurred by chance?

Two Sample Tests

Identify the probability that two samples were drawn from the same population.

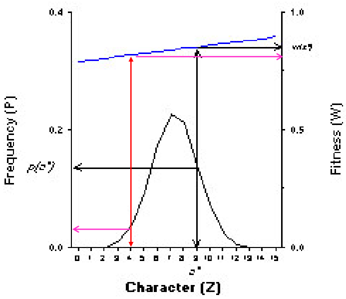
Example: Do squirrels from population A take a longer time to open nuts than squirrels from population B?

K-Sample Tests

Identify the probability that several samples were drawn from the same population.

Example: Do fruit flies grown under different conditions differ in body weight?

Tests of Association



Identify the probability that there is a relationship between variables.

Example: Is there a relationship between phenotype and fitness?

Tests of Independence

1. P(AB) = P(A)P(B)
2. The probability of two independent events occurring simultaneously is equal to the product of their independent probabilities of occurrence.
3. Non-independence: changes with time, matched samples.

Types of Statistical Tests

1. The first techniques in statistical method involved inferences made about the nature of the populations from which samples were drawn.
2. Thus, there are two types of statistical tests:

a. parametric

b. nonparametric

This is useful to mention because,

3. Both types of tests attempt to make ***inferences*** about populations

a. The basis for these inferences involve:

1. Differences in types of data used.
2. Differences in sample size.
3. Differences in assumptions made about sample population.

a. Therefore, each type of test may be appropriate in some cases and not in others.

These inferences are based on:

1. Certain *parameters* associated with the sampled distribution.
2. The assumption that the population AND samples were normally distributed (unskewed, equal variances).

3. Also that:

a. Relationships among variables were linear.

b. Samples were collected independently of each other.

If these assumptions are true,

1. Then the samples all can be characterized by certain *measures of central tendency*.

a. e.g., mean, variance, standard deviation, standard error.

b. These are PARAMETERS that describe the distributions of data

c. Thus, statistical procedures based on these parameters are

called PARAMETRIC statistics.

Parametric Statistics

1. IF the above assumptions are met, THEN statistical inference is valid
2. Other lecturers will discuss how robust tests are when these assumptions are violated.
   a. i.e., is inference still *possible*.

A Useful Mnemonic Device: LINE

1. A quick way to determine if parametric assumptions are likely to be met:
   a. **L**inear relationships among variables
   b. **I**ndependent sampling
   c. **N**ormally distributed data
   d. **E**qual variances

Nonparametric Statistics

1. Do not make such stringent assumptions about the sample population or the types of data collected.
   a. They get their name from this fact.
2. Their assumptions are not based on mean, variance, etc. they are nonparametric tests.
3. Also called *distribution-free*
   a. Instead of using comparisons of means and variances.
   b. Uses ranks, order or type of cases.

Data Used in Nonparametric Statistics

1. Can constrain the type of inferences possible.

a. Sometimes scale of measurement isn't as precise.

b. Has led some to conclude that nonparametric tests are somehow *weaker* than parametric tests.

c. This is not necessarily true

Power Can be Recovered

1. By increasing sample size.

2. Also, nonparametric tests permit analyses that are *impossible* with parametric statistics.

1. Changes in type, changes in sign etc.

Other Advantages

1. Sample size

a. Whereas parametric tests are possible only if LINE assumptions are met,

b. Nonparametric tests can handle small, non-normal samples.

The real source of their power…

1. The criterion for significant differences is categorical - based on exact probabilities.

2. Also,

a. They are easy to use and understand.

b. They are very good for the type of data collected by behavioral/ecological scientists.

A Common Misconception

1. Independence is not important with nonparametric tests.

a. This may be true in situations in which non-independence *is part of the test*,

b. Most nonparametric tests have same restrictions about independence as parametric tests do.

Statistical Power

1. It is easy to say "Power is equal to $(1 - \beta)$",

a. In fact, it is a bit more difficult to understand.

2. If H_o is "no difference" then this means,

$$\mu_1 = \mu_2$$

(note that this applies to any null hypothesis)

Type I Error

Is *rejecting* H_o when in fact, the means are *equal*.
That is:

$$\mu_1 = \mu_2$$

1. P[type I error] = α

2. Differently put, "rejecting H_o when it is actually true"

3. Or: "how do you explain a rare event?"

How DO you explain a rare event?

1. If you want to avoid rare events causing incorrect conclusions:

   a. You place a small value on α.

2. How small α is depends on how important it is to avoid a mistake in concluding there is an effect when in fact none exists.

3. A very small α means that you will ***only*** reject H_o if there is a large difference.

Type II Error

1. Is accepting Ho *when in fact* the means are unequal.

2. Here, P[type II error] = β

That is,

$$\mu_1 \neq \mu_2$$

3. Differently put, "accepting H_o when it is actually false."

4. Or: "how many 'rare events' are you willing to accept before considering effect important?"

How many 'rare events' ARE you willing to accept?

1. The more stringent your α, the more likely you are to ignore subtle differences when they *do in fact exist*.

a. How willing you are to do this depends on how important it is to *avoid* concluding there *is* an effect, when in fact, *there is none*.

Getting it Right

	Accepted	Rejected
True	Correct	Type I
False	Type II	Correct