# Multivariate Methods With Nondetects

Dennis Helsel

Practical Stats

# Common Goals of Multivariate Procedures

- Classify observations into groups
- Test for differences or trends based on multiple measures
- Classify and relate variables to one another

# Methods for dealing with nondetects

- NOT Substitution!  This adds invasive data
- For one RL:
  - Rank data and run procedure on the ranks
  - Use a nonparametric method

# For 1 RL, run procedure on the ranks

- PCA on ranks
- Discriminant Function on ranks
- All nondetects are tied with each other at the lowest rank:

<1 <1 <1 3 7 10 18 data

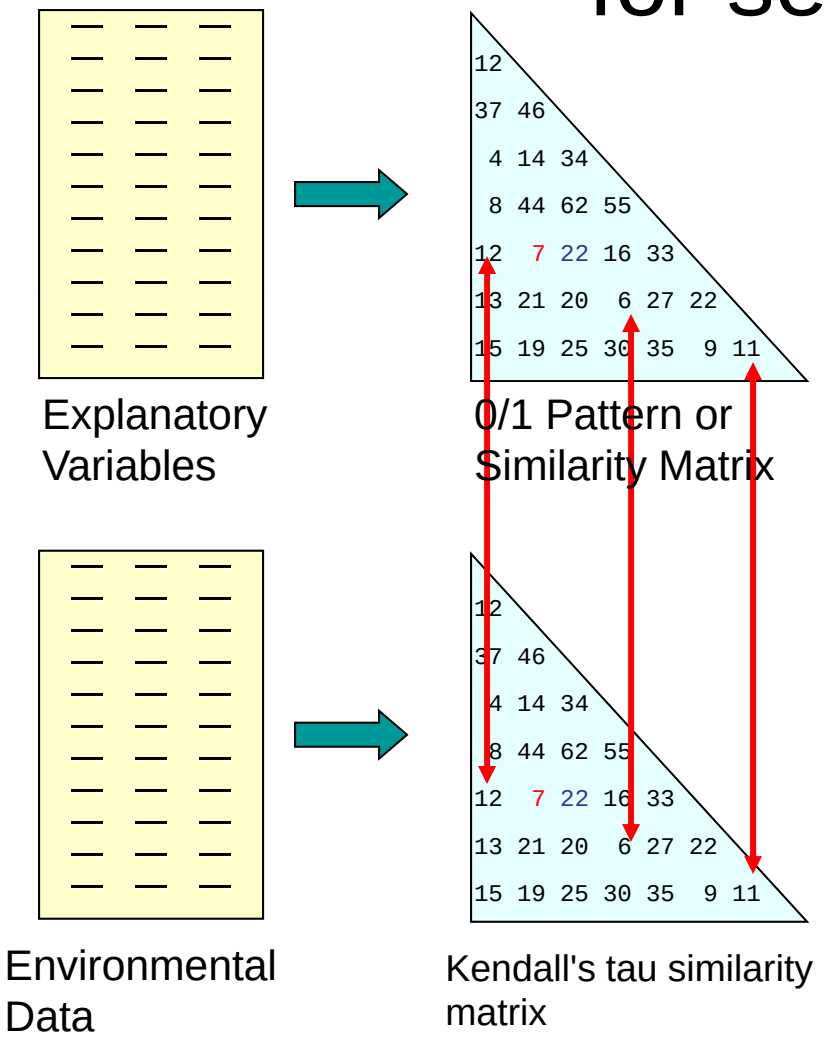
2 2 2 4 5 6 7 ranks

- MANOVA, Cluster Analysis have nonparametric analogues, so no reason to do this approach

# For 1 RL, use a nonparametric method

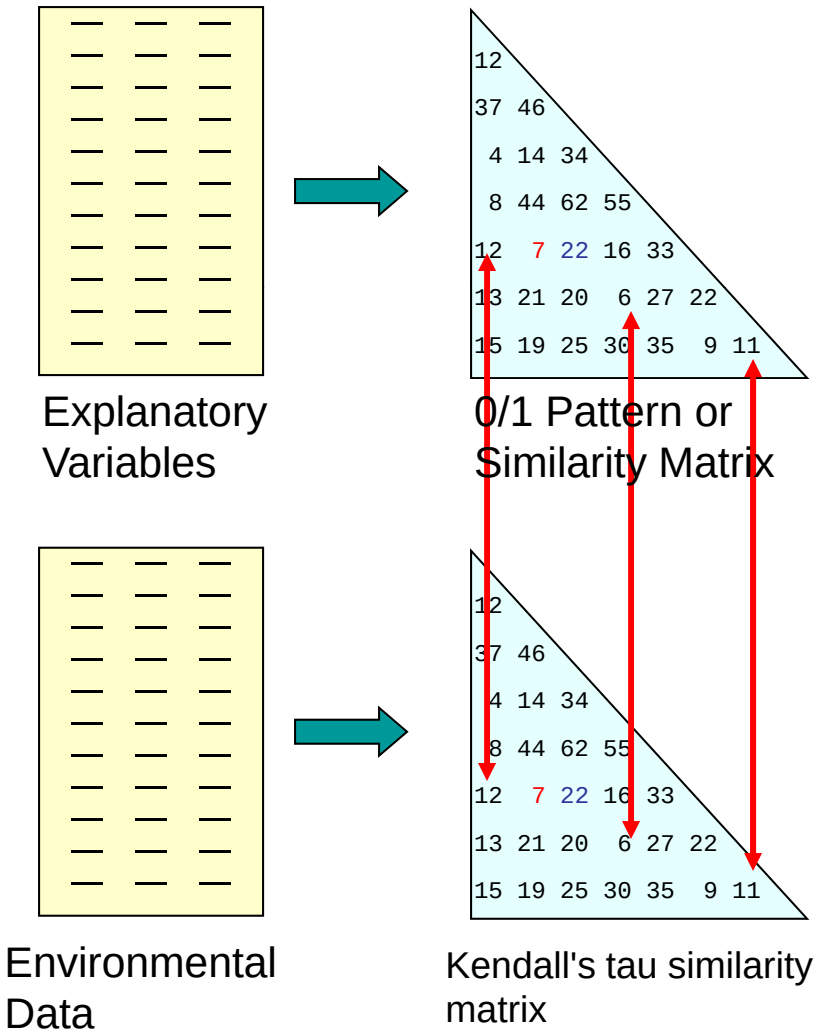
- ANOSIM (Nonparametric MANOVA)
- Test for seriation (Nonparametric Trend Test)
- Nearest Neighbor Cluster Analysis
- Nonmetric Multidimensional Scaling

# General Method: ANOSIM and test for seriation



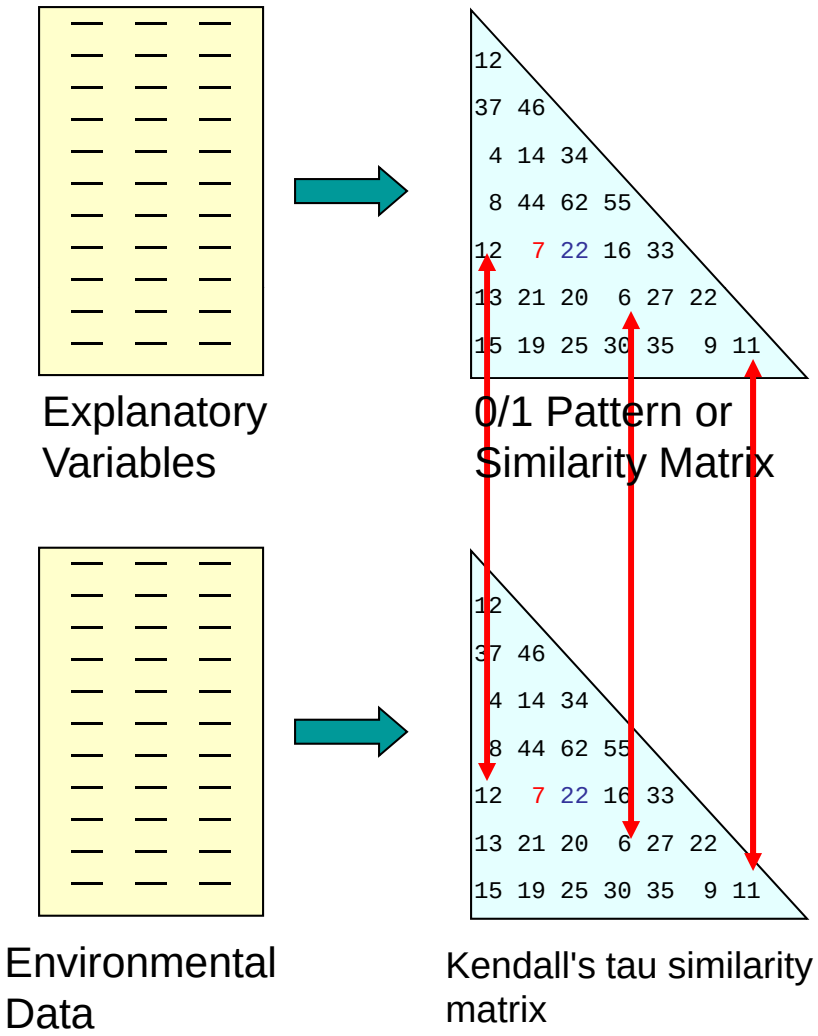

Element by element Kendall's tau correlation between similarity matrices

# Test for seriation



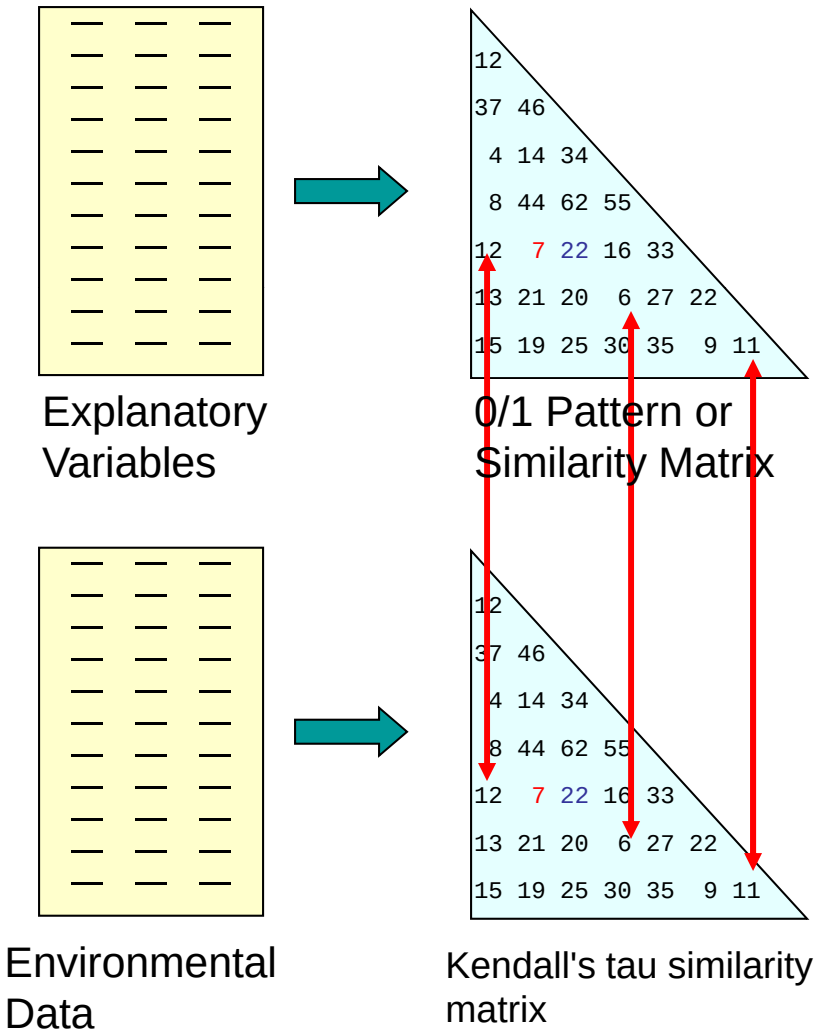

For trend, the explanatory matrix contains the number of time steps between measurements

# ANOSIM



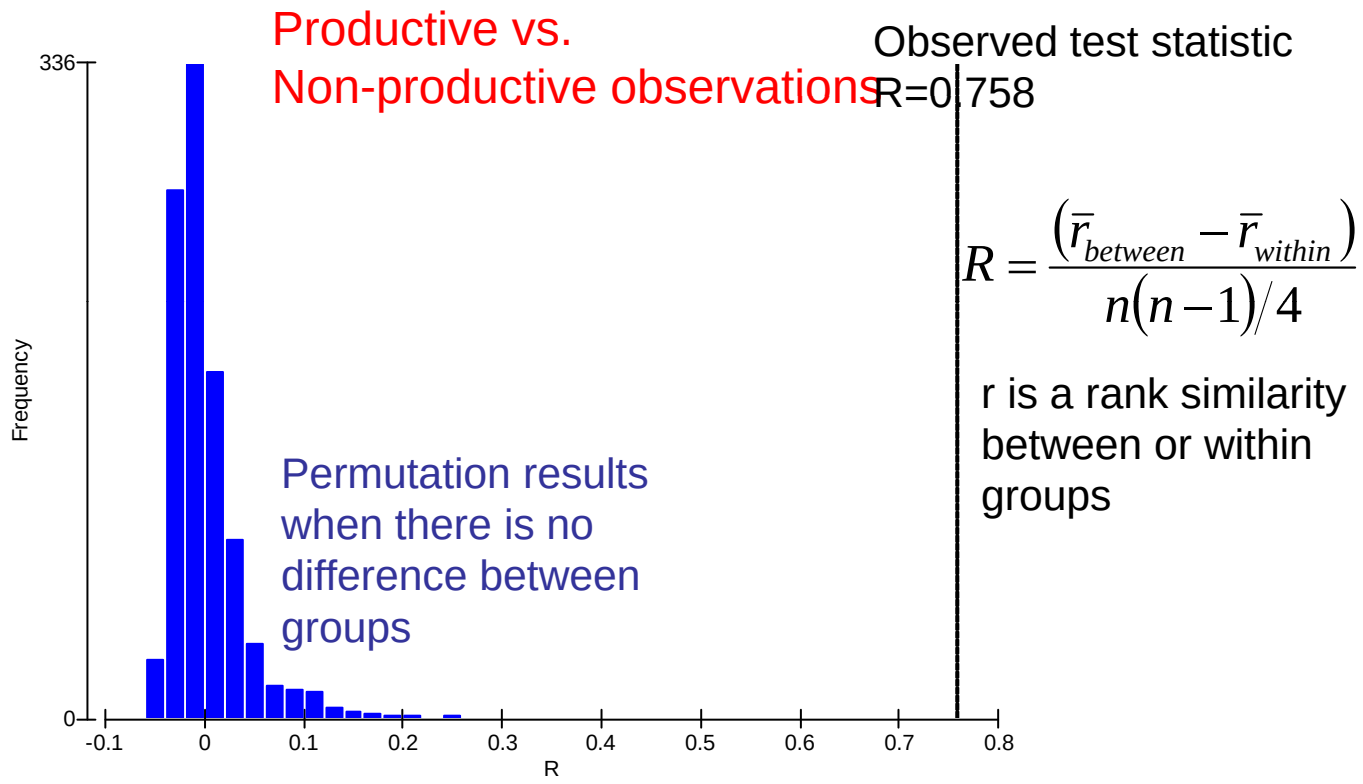

For tests between groups, the similarity matrix is a 1 if two values are in the same group, and a 0 otherwise.

# General Method




For other, regression type problems, the similarity matrix uses something like Kendall's tau

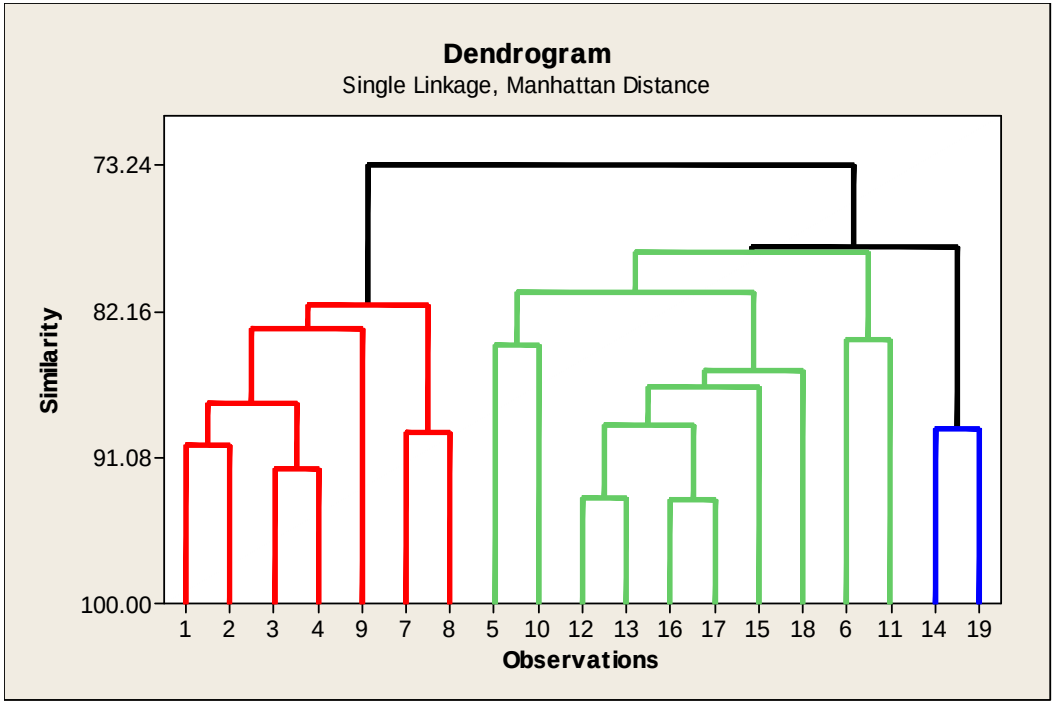
# Permutation p-values




Observed test statistic higher than all 1000 results in permutations, so p-value = 0.001

# Nearest-neighbor clustering

- ranks of distances between locations in multivariate space



# Methods for dealing with nondetects

- For more than one RL:
  1. Compute Kaplan-Meier percentiles and run a procedure on these 'scores'
  2. Use maximum likelihood (MLE) versions of methods, where those exist

# For >1 RL, compute procedure on K-M percentiles

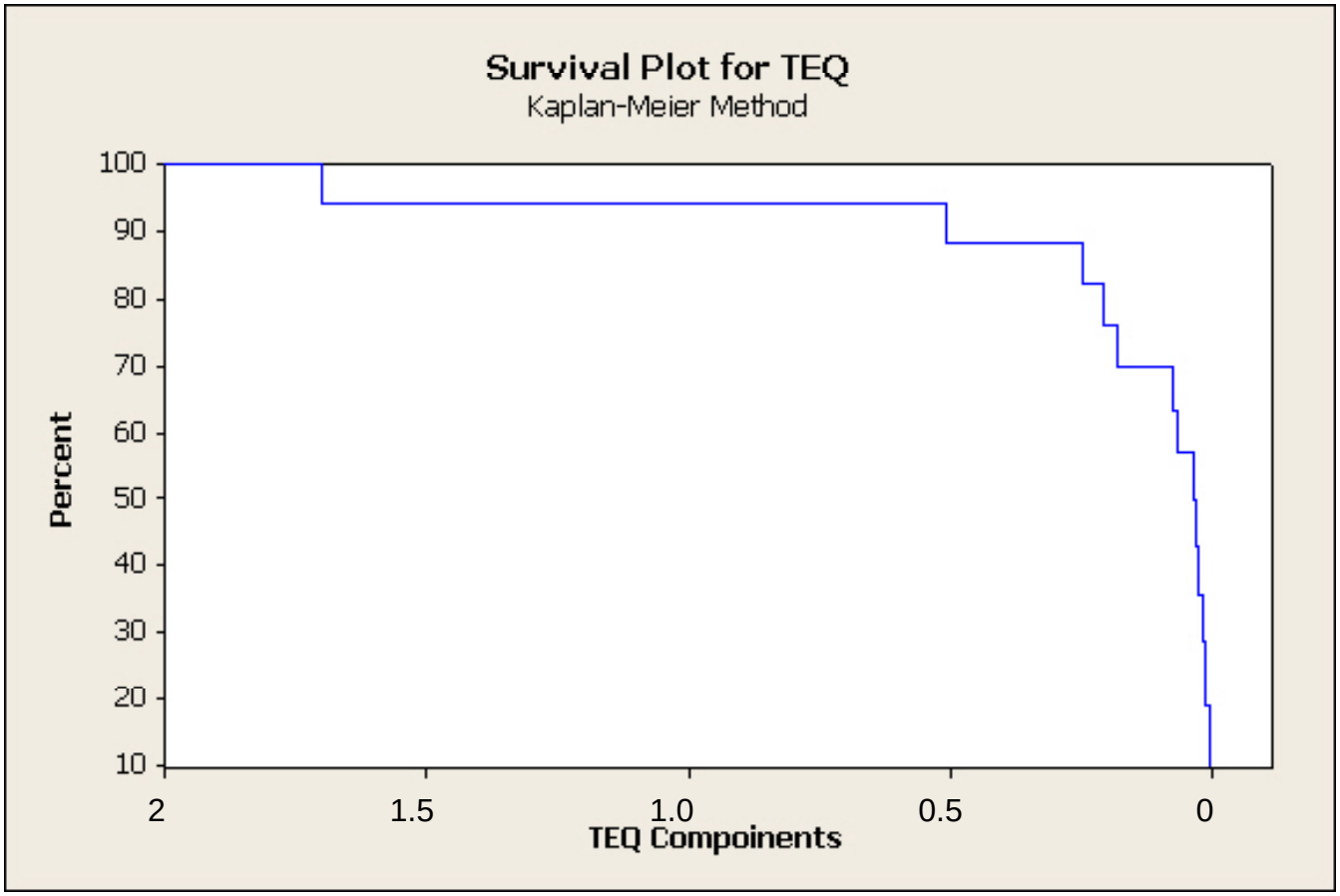
- existing tests take multivariate measures and convert to a univariate composite score. Test the scores for differences between groups. Scores are combinations of K-M percentiles for each variable

# Kaplan-Meier

(nonparametric method )

- K-M estimates the survival function S, the probability of <= each detected value
- S estimates the empirical CDF (percentile function) of the original data
- Percentiles only estimated for detects, not nondetects
- Percentile values are affected, however, by the number of and DL value

# Kaplan-Meier survival curve




Same as a cdf
(plotted left to right)

# MLE methods for >1 RL

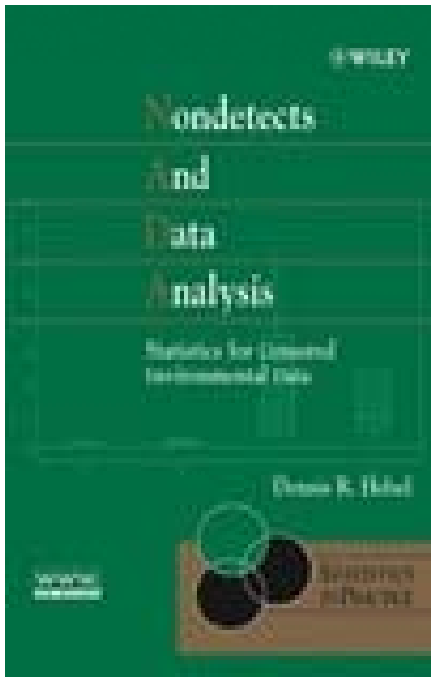
- Multiple regression analogue:  predicting a Y with nondetects from multiple explanatory variables.
- Use MLE with an assumed distribution (normal, lognormal, other) to determine the best predictors.
- Censoring only allowed for the Y variable
- Has been extended to factor analysis, but software not readily available

= Practical Stats

# 2nd Edition will be even better!

**Nondetects**
**And**
**Data**
**Analysis**

Statistics for Censored Environmental Data




Helsel (2005)

**www.PracticalStats.com / nada**

**Stop by our booth in the right corner of the exhibit hall**