TOM 460

Dr. R. H. Miller

Levels of Measurement

Categorical Scales:

Nominal

Scale Characteristics: No order, distance, or point of origin.
Basic Empirical Operations: Determination of equality.
Scale Requirements: Categories are mutually exclusive and exhaustive.
Scale Example: "Numbering" of baseball players. Assignment of identification numbers to groups. Using numbers to name categories.
Common Statistical Measures:
- Central Tendency: Mode.
- Variability: None.
- Tests: Nonparametric.

Ordinal

Scale Characteristics: Order, but no common unit of measure or point of origin.
Basic Empirical Operations: Determination of greater or lesser, in addition to equality.
Scale Requirements: Satisfies the transitivity postulate.
Scale Example: Street numbers. Grades of lumber. Military rank.
Common Statistical Measures:
- Central Tendency: Median, in addition to the Mode.
- Variability: Average Absolute Deviation, Quartile Deviation.
- Tests: Nonparametric.

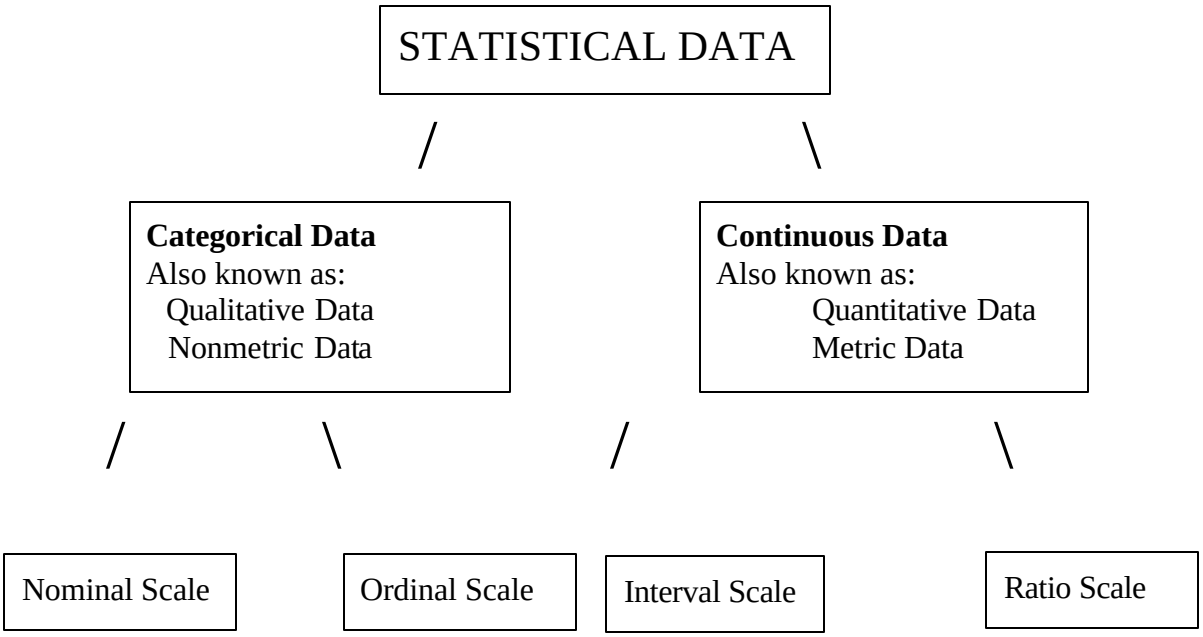
Continuous Scales:

Interval

Scale Characteristics: Order; common unit of measure; arbitrary zero point of origin.
Basic Empirical Operations: Determination of equality, greater or lesser, and measurement of differences on some scale.
Scale Requirements: Intervals on the scale are equal.
Scale Example: Time. Money.
Common Statistical Measures:
- Central Tendency: Arithmetic Mean, in addition to Median and Mode.
- Variability: Variance and Standard Deviation.
- Tests: Parametric.

Ratio

Scale Characteristics: Order; common unit of measure; true zero point of origin.
Basic Empirical Operations: Determination of equality, greater or lesser, measurement of differences on some scale, and equality of ratios.
Scale Requirements: Meets all assumptions to perform arithmetic operations.
Scale Example: Length. Weight.
Common Statistical Measures:
- Central Tendency: Harmonic and Geometric Means, in addition to the Arithmetic Mean; also: Median and Mode.
- Variability: Coefficient of Variation, in addition to the Variance and Standard Deviation.
- Tests: Parametric.



TYPES OF DATA AND MEASUREMENT SCALES

DATA ANALYSIS

Basic Rule of Data Analysis:

"The kind of data you have determines the kind of statistical analysis that you do."

<u>Selection of statistical analysis procedure according to the kind of data you have</u>:

I. Descriptive Statistics

Categorical Data:

Nominal Data: (e.g.: gender, ethnic group, type of organization, yes/no)

Ordinal Data: (e.g.: income group, educational group, rating scale category)

- Frequency count by category ("how many of what kind?")
- Mode ("what are there the most of?")
- Total n ("how many total in all categories combined?")
- Percentage ("what % of the total does each category represent?")

Continuous Data:

Interval Data: (e.g.: time, money, some rating scales)

Ratio Data: (e.g.: age, income, some rating scales)

- Mean ("what is the average for the group? where are the data values centered?")
- Standard Deviation ("how spread out are the data values around the center?")
- Minimum/Maximum & Range ("what are the high and low data values? total spread?")
- Total n ("how many data values are there?")

II. Inferential Statistics

<u>Consideration of a single variable</u>:

Categorical Data:

Nominal Data: (e.g.: gender, ethnic group, type of organization, yes/no)

Ordinal Data: (e.g.: income group, educational group, rating scale category)

Use a Chi-Square Goodness of Fit to a Uniform Distribution test ("One-Way Chi-Square") to determine if there are approximately equal numbers in the several categories, or if the frequency count in some categories is significantly higher/lower than in other categories.

<u>Consideration of the relationship between two variables:</u>

Categorical Data:

Nominal Data: (e.g.: gender, ethnic group, type of organization, yes/no, before/after, with/without)

Ordinal Data: (e.g.: income group, educational group, rating scale category)

Continuous Data:

Interval Data: (e.g.: time, money, some rating scales)

Ratio Data: (e.g.: age, income, some rating scales)

If: a) Dependent is Continuous and Independent is Continuous → Regression Analysis (t-test or F-test)

Note: if you have several Continuous Predictors → Multiple Regression (F-test, then t-tests)

b) Dependent is Continuous and Independent is Categorical with 2 groups → t-test for a difference between two group means

Note: for more than 2 groups → One-Way ANOVA (F-test, then Scheffé tests, or similar)

[One-Way ANOVA ="Analysis of Variance" with only one categorical predictor]

c) Dependent is Categorical and Independent is Categorical → Two-Way Chi-Square

[Two-Way Chi-Square= "Chi-Square Test of Independence/Association"

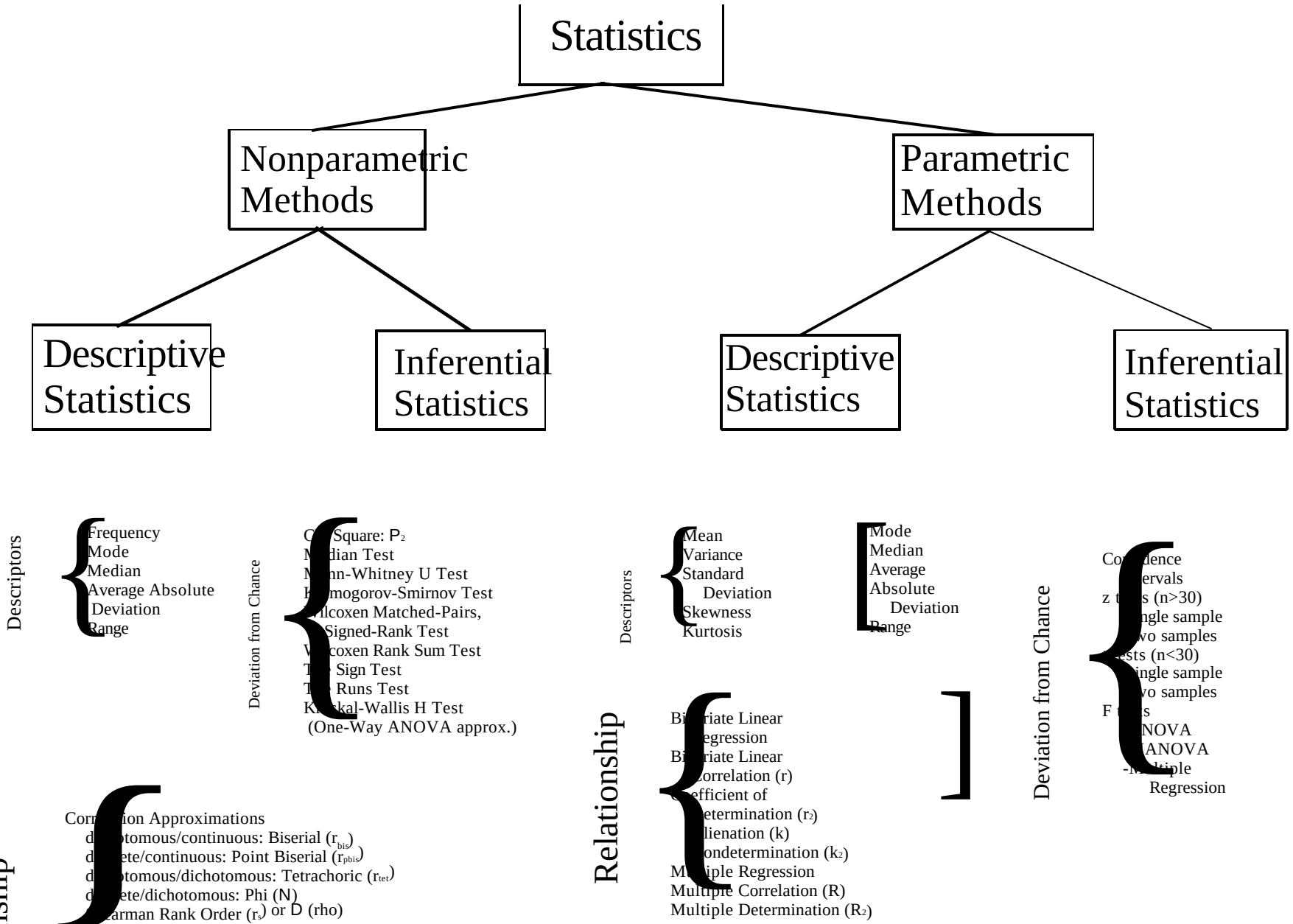
also known as "Cross-tabulation" or simply "Crosstabs"]

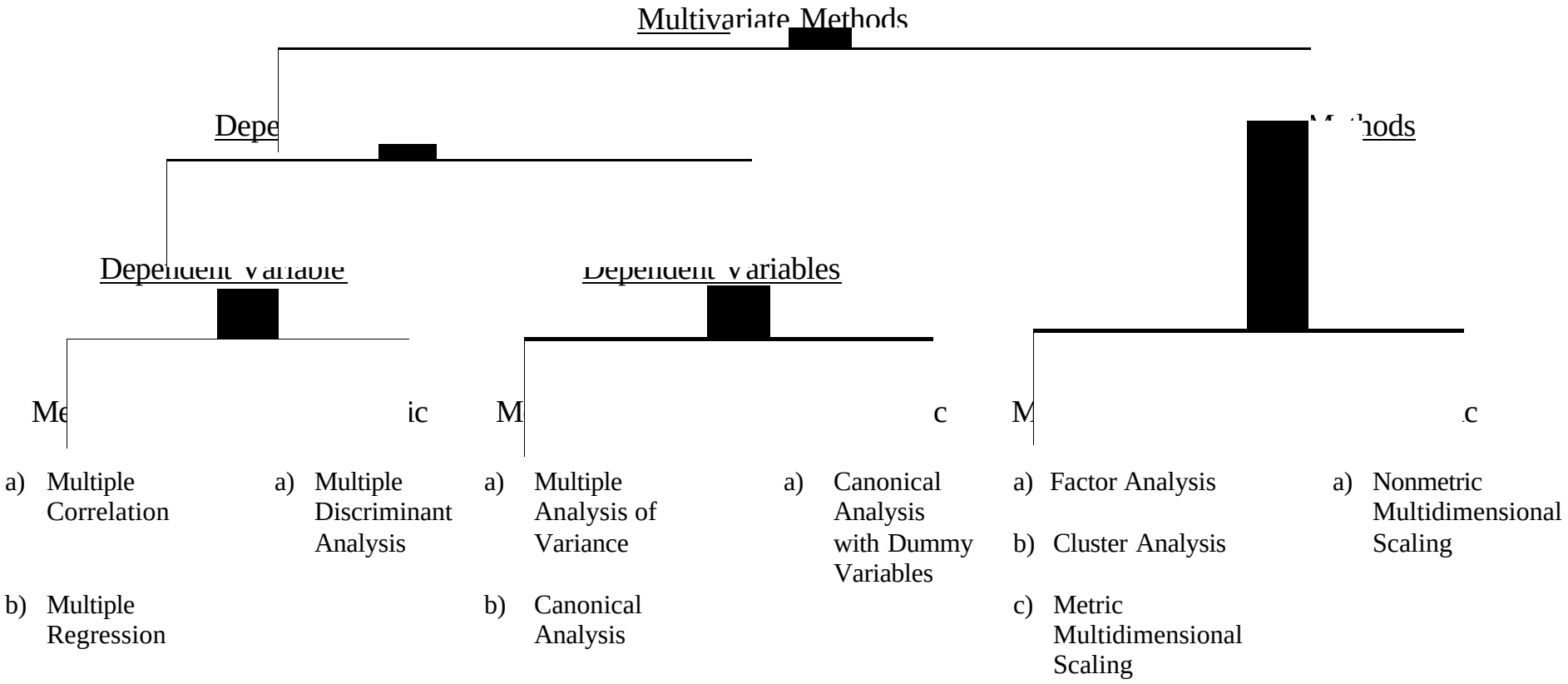
Independent Variable(s)

		Continuous	Categorical
Dependent Variable	**Continuous**	**Regression & Correlation** a) Simple Bivariate Regression and Correlation b) Multiple Regression and Correlation Note: Use of Dummy Variables	**t-Tests** Note: F-test on variances to choose separate or pooled approach **ANOVA** a) One-Way ANOVA Note: Follow up with Scheffé test b) Two-Way ANOVA Note: Test interaction effect first
	Categorical	**Discriminant Analysis** Two Categories Three Categories	**Chi-Square** a) One-Way Chi-Square b) Two-Way Chi-Square c) Three-Way Chi-Square Note: Expected Value Checks required

SELECTION OF DATA ANALYSIS TECHNIQUES

BY DATA AND VARIABLE TYPES


Statistics
Nonparametric Methods
Parametric Methods
Descriptive Statistics
Inferential Statistics
Descriptive Statistics
Inferential Statistics
Descriptors
Frequency
Mode
Median
Average Absolute Deviation
Range
Deviation from Chance
Chi Square: P2
Median Test
Mann-Whitney U Test
Kolmogorov-Smirnov Test
Wilcoxen Matched-Pairs, Signed-Rank Test
Wilcoxen Rank Sum Test
Test Sign Test
Test Runs Test
Kruskal-Wallis H Test (One-Way ANOVA approx.)
Relationship
Correlation Approximations
dichotomous/continuous: Biserial (rbis)
discrete/continuous: Point Biserial (rpbis)
dichotomous/dichotomous: Tetrachoric (rtet)
discrete/dichotomous: Phi (N)
Spearman Rank Order (rs) or D (rho)
Kendall Rank Order: Tau (J)
Tau b
Tau c
Contingency Coefficient C
Cramer's V
Somers's D
Lambda (! or 8)
Gamma (or ()
Correlation Ratio: Eta (H or 0)
Chi Square: P2)
Descriptors
Mean
Variance
Standard Deviation
Skewness
Kurtosis
Mode
Median
Average Absolute Deviation
Range
Relationship
Bivariate Linear Regression
Bivariate Linear Correlation (r)
Coefficient of Determination (r2)
Alienation (k)
Nondetermination (k2)
Multiple Regression
Multiple Correlation (R)
Multiple Determination (R2)
Deviation from Chance
Confidence Intervals
z tests (n>30)
Single sample
Two samples
t tests (n<30)
Single sample
Two samples
F tests
ANOVA
MANOVA
Multiple Regression



A Classification of Multivariate Methods

Taken from: Siegel, Sidney: *Nonparametric Statistics*, McGraw-Hill, 1956

	NONPARAMETRIC STATISTICAL TEST*					
LEVEL OF MEASUREMENT	One-sample case	**Two-sample case**		**κ-sample case**		**NONPARAMETRIC MEASURE OF**
	(Chap.4)	Related samples (Chap. 5)	Independent samples (Chap. 6)	Related samples (Chap. 7)	Independent samples (Chap. 8)	**CORRELATION (Chap. 9)**
Nominal	Binomial test, pp. 36-42 χ^2 one-sample test, pp. 42-47	McNemar test for the significance of changes, pp. 63-67	Fisher exact probability test, pp. 96-104 χ^2 test for two independent samples, pp. 104-111	Cochran Q test, pp. 161-166	χ^2 test for κ independent samples, pp. 175-179	Contingency coefficient: C, pp. 196-202
Ordinal	Kolmogorov-Smirnov one-sample test, pp. 47-52 One-sample runs test, pp. 52-58	Sign test, pp. 68-75 Wilcoxon matched-pairs signed-ranks test, † pp. 75-83	•Median test, pp. 111-116 •Mann-Whitney U test, pp. 116-127 •Kolmogorov-Smirnov two-sample test, pp. 127-136 •Wald-Wolfowitz runs test, pp. 136-145 •Moses test of extreme reactions, pp. 145-152	Friedman two-way analysis of variance, pp. 166-172	•Extension of the median test, pp. 179-184 •Kruskal-Wallis one-way analysis of variance, pp. 184-193	•Spearman rank correlation coefficient: r_s, pp. 202-213 •Kendall rank correlation coefficient: r, pp. 213-223 •Kendall partial rank correlation coefficient: r_{sy}, pp. 223-229 •Kendall coefficient of concordance: W, pp.229-238
Interval		Walsh test, pp. 83-87 Randomization test for matched pairs, pp. 88-92	Randomization test for two independent samples, pp. 152-156			

*Each column lists, cumulatively downward, the tests applicable to the given level of measurement. For example, in the case of κ related samples, when ordinal measurement has been achieved both the Friedman two-way analysis of variance and the Cochran Q test are applicable.

† The Wilcoxon test requires ordinal measurement not only within pairs, as is required for the sign test, but also of the differences between pairs. See the discussion on pp. 75-76.