CS-525H:
Immersive HCI

Statistical Methods

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Descriptive Methods: Frequency Distributions

- How many people were similar in the sense that according to the dependent variable, they ended up in the same bin
- Table
- Histogram (vs. Bar Graph)
- Frequency Polygon (Line Graph)
- Pie Chart

Descriptive Methods: Distributional Shape

- Normal distribution (bell curve)
- Skewed distribution
  - Positively skewed (pointing high)
  - Negatively skewed (pointing low)
- Multimodal (bimodal)
- Rectangular
- Kurtosis
  - High peak/thin tails (leptokurtic)
  - Low peak/thick tails (platykurtic)

Descriptive Methods: Central Tendency

- Mode (*Mo*)
  - Most frequently occurring score
- Median (*Mdn*)
  - Divides the scores into two, equally sized parts
- Mean (M, $\bar{X}$, μ)
  - Sum of the scores divided by the number of scores
- Example: 6, 2, 5, 1, 2, 9, 3, 6, 2
- Normal distribution: mode ≈ median ≈ mean
- Positive skew: mode < median < mean
- Negative skew: mean < median < mode
- What do these look like in graph form?

Descriptive Methods: Measures of Variability

- Dispersion (level of *sameness*)
- Homogeneous vs. heterogeneous
- Range
  - max - min of all the scores
- Interquartile range
  - max - min of the middle 50% of scores
- Box-and-whisker plot
- Standard deviation (*SD*, *s*, σ, or *sigma*)
  - Good estimate of range: *4 * SD*
- Variance (s^2 or σ^2)

Descriptive Methods: Standard Scores

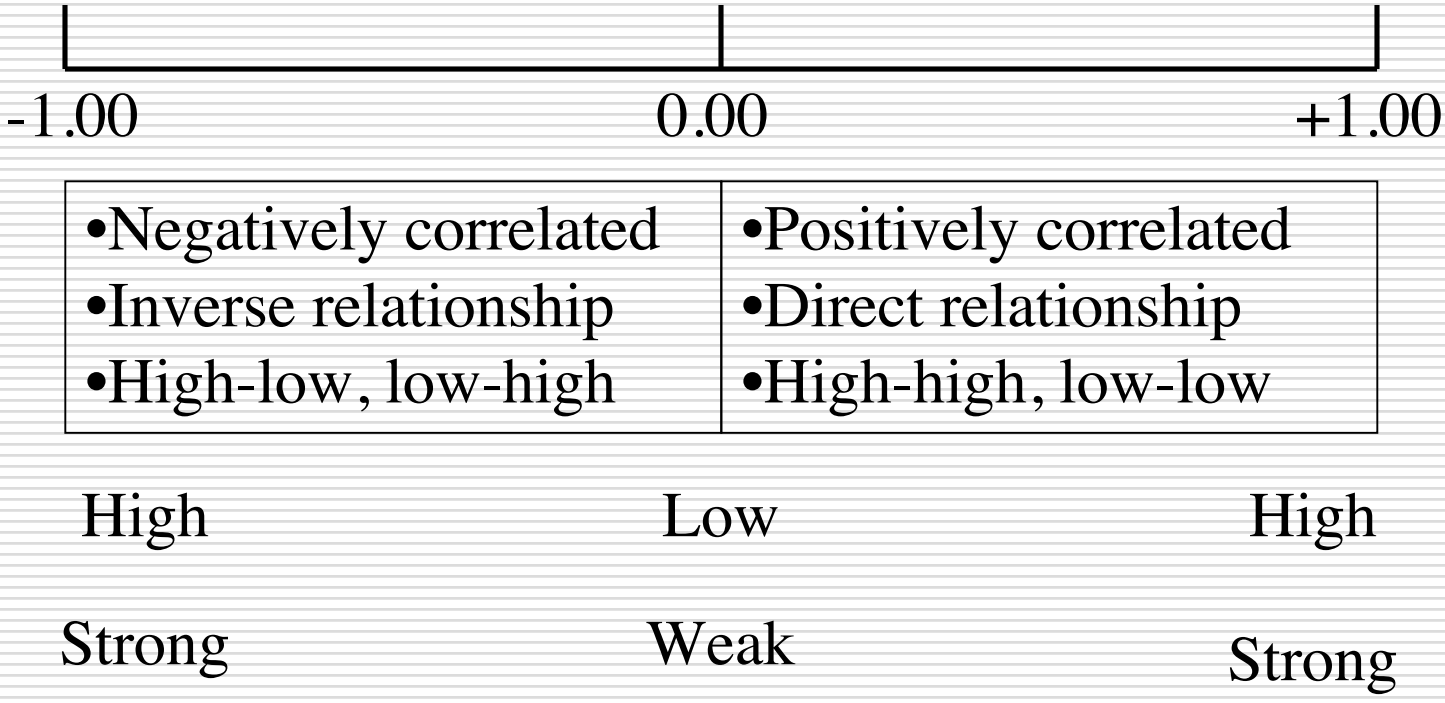
- How many SDs a score is from the mean
- *z*-score: mean = 0, each SD = +/-1
  - *z*-score of +2.0 means the score is 2 SDs above the mean
- *T*-score: mean = 50, each SD = +/-10
  - *T*-score of 70 means the score is 2 SDs above the mean

Bivariate Correlation

- Discover whether a *relationship* exists
- Determine the *strength* of the relationship
- Types of relationship
  - High-high, low-low
  - High-low, low-high
  - Little systematic tendency

Bivariate Correlation (cont.)

- Scatter plot
- Correlation coefficient: *r*



Bivariate Correlation (cont.)

- Quantitative variables
  - Measurable aspects that vary in terms of intensity
    - **Rank**; **Ordinal scale**: Each subject can be put into a single bin among a set of *ordered* bins
    - **Raw score**: Actual value for a given subject. Could be a composite score from several measured variables
- Qualitative variables
  - Which categorical group does one belong to?
    - E.g., I prefer the Grand Canyon over Mount Rushmore
    - **Nominal**: Unordered bins
    - **Dichotomy**: Two groups (e.g., infielders vs. outfielders)

Reliability and Validity

- Reliability
  - To what extent can we say that the data are consistent?
- Validity
  - A measuring instrument is valid to the extent that it measures what it purports to measure.

Inferential Statistics

- Definition: To make statements beyond description
  - Generalize
- A ***sample*** is extracted from a ***population***
- Measurement is done on this ***sample***
- Analysis is done
- An educated guess is made about how the results apply to the ***population*** as a whole

Motivation

- Actual testing of the whole population is too costly (time/money)
  - "Tangible population"
- Population extends into the future
  - "Abstract population"
- Four questions
  - What is/are the relevant populations?
  - How will the sample be extracted?
  - What characteristic of those sampled will serve as the measurement target?
  - What will be the study's statistical focus?

Statistical Focus

- What statistical tools should be used?
  - Even if we want the "average," which measure of average should we use?

Estimation

- Sampling error
  - The amount a sample value differs from the population value
  - This ***does not*** mean there was an error in the method of sampling, but is rather part of the natural behavior of samples
    - They seldom turn out to *exactly* mirror the population
  - Sampling distribution
    - The distribution of results of several samplings of the population
  - Standard error
    - SD of the sampling distribution

Analyses of Variance (ANOVAs)

- Determine whether the means of two (or more) samples are different
  - *If we've been careful*, we can say that the treatment is the source of the differences
  - Need to make sure we have controlled everything else!
    - Treatment order
    - Sample creation
    - Normal distribution of the sample
    - Equal variance of the groups

Types of ANOVAs

- Simple (one-way) ANOVA
  - One independent variable
  - One dependent variable
  - Between-subjects design
- Two-way ANOVA
  - Two independent variables, and/or
  - Two dependent variables
  - Between-subjects design

Types of ANOVAs (cont.)

- One-way **repeated-measures** ANOVA
  - One independent variable
  - One dependent variable
  - Within-subjects design
- Two-way **repeated-measures** ANOVA
  - Two independent variables, and/or
  - Two dependent variables
  - Within-subjects design

Types of ANOVAs (cont.)

- Main effects vs. interaction effect
  - Main effects present in conjunction with other effects
- Post-hoc tests
  - Tukey's HSD test
    - Equal sample sizes
  - Scheffé test
    - Unequal sample sizes

Types of ANOVAs (cont.)

- Mixed ANOVA
- 2 x 3
  - Time of day
  - Real Walking / Walking in-place / Joystick

References

- Schuyler W. Huck *Reading Statistics and Research*, Fifth Edition, Pearson Education Inc., 2007.
  - http://www.readingstats.com/
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