Data Preparation and Exploration

Please download:
SPSSExam.sav

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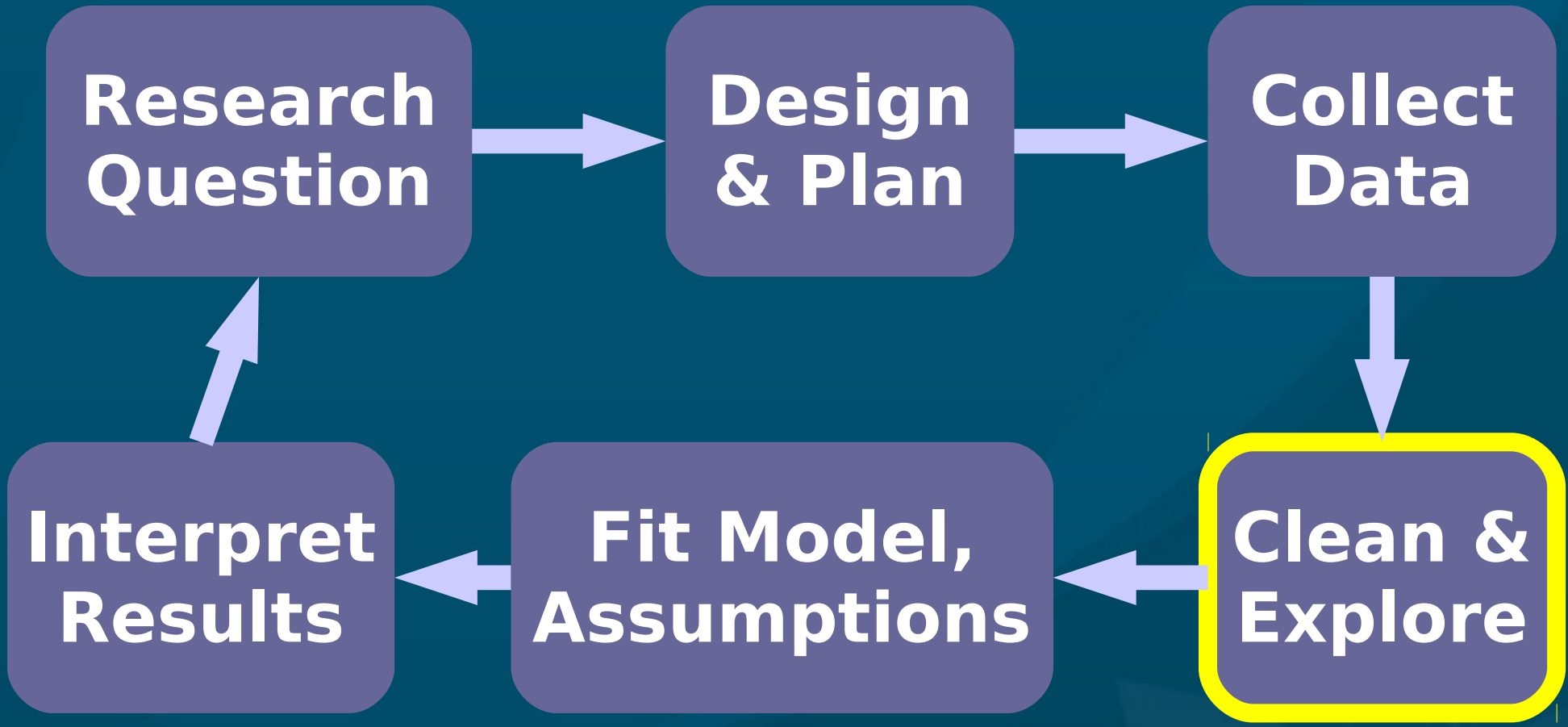
Research / Analysis Cycle



- The relationship between exploring, preparing and analyzing is reciprocal and hermeneutic!

Data Preparation & Exploration

- With real data, we often spend far more time examining and preparing the data than actually running the statistical tests!
- Failure to identify and correct problems will prevent the tests from working properly
    - Or worse: lead to misleading results that do not reflect real relationships / effects.
- (1) Create / fix variables
- (2) Deal with missing data & outliers
- (3) Assess assumptions of tests

Outline: Data Preparation

- Creating secondary "derived" variables
- Descriptives of a dataset, error checking
- Missing data and outliers
- Assumptions of Parametricity
- What to report:
  "Informationally adequate" statistics

- Appendix: Project data sources

Derived Variables

- Not new data: derived from existing vars. Why?
- Build total or "subscale" scores from individual test items
  - e.g., BDI total
- Create grouping vars or modify categories
  - e.g., age groups by year of birth
- Correct problems in the data
  - e.g., transform data to make it more normally distributed
  - e.g., missing data

SPSS: Compute Variable

- Transform → Compute Variable
- Many kinds of transformations / computations from existing variables into new variables
- Can combine information from multiple old variables into a single new variable
  - e.g., sum, average
  - Must address missing scores first
- Can compute for specific subsets/groups within a data set using the "if" option

Application Examples

- Example dataset: SPSSExam.sav
- Combining marks:
- Create a new var: "Average assignment mark"
  - Transform → Compute Variable → Mean
- Mean vs. Sum:
  - Generally, means are easier to interpret: does not depend on number of assignments
  - However, many standard subscales do use sum of individual questions

Recode Options

- Recoding can be done into the same variable, or into a new variable
  - I generally recommend recoding into new:
  - Transform → Recode into different vars
    - Specify what variable you want to recode
    - Specify old and new values
- We can recode specific parts of a variable using the "if" option

Example: Coding for Ethnicity

- We can draw upon categories used by StatsCan and information on generational status
- Once data gathering has been completed and demographic description is conducted, then
- That sample can be recoded for ethnic, cultural, linguistic, and generational status
- e.g., recode from country of heritage
    - e.g., China, Philippines, etc.
- To ethnicity:
    - e.g., Asian, Pacific Islander, etc.

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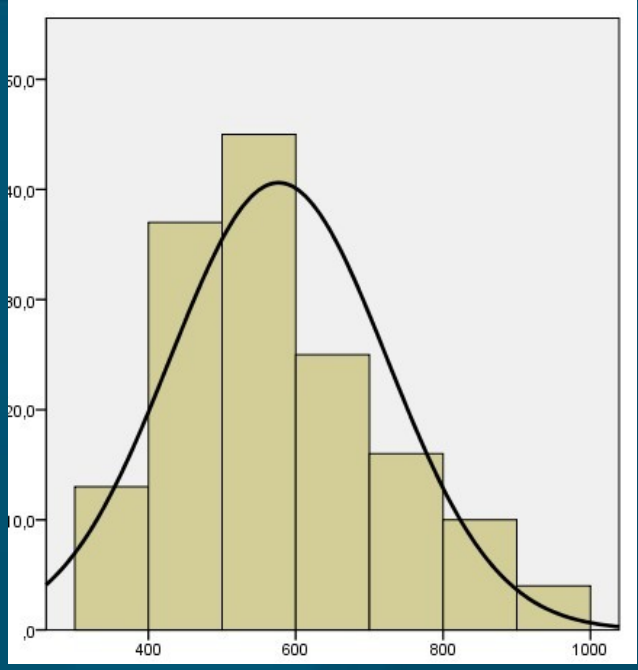
Data Exploration



- Get overall feel of the dataset and identify any problems with the data (for fixing)
- In final rounds: report & describe basic characteristics of the data (use APA style)
- SPSS: Analyze → Descriptive Statistics
  - → Descriptives, Frequencies, P-P plots, ...
  - → Explore has more stats, plots
- Graphs: Legacy Dialogs → Boxplot, Error Bar, Histogram, Scatterplot, ...

Signs of Data Entry Errors

- Scores that are outside of what is possible
- Unexplained gaps in the frequency output / histogram, or odd patterns in boxplots
- Cases on your boxplots or histograms that do not fit with the rest of the sample (outliers?)
- Standard deviations much larger than expected
- Means much different from expected
- For possible errors, compare the SPSS file against your original data source

Missing Data

- Reasons for missing data, in real research?
  - Systematic gaps indicate a real problem
  - Random gaps may be okay, as long as less than ~5% of the data is missing
- To check if missing data impacts analysis:

  (1) code it as a separate variable
    - Dichotomous: “missing” vs. “not missing”

  (2) compare responses on other variables for “missing” vs. “not missing” groups

Random Missing: Strategies

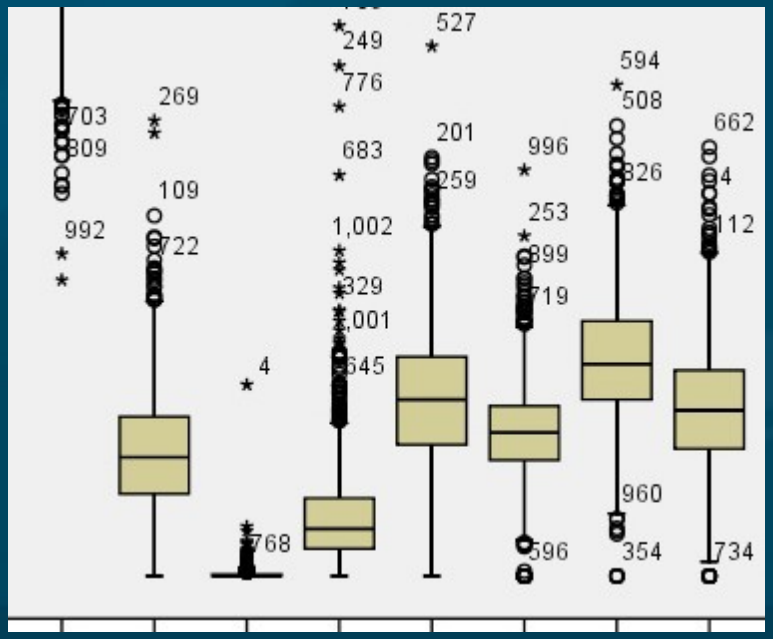
- Go back and obtain the bits that were missing
  - Not always practical, ethical, or effective
- Eliminate variables with the most problems
  - Unless they are central to the study!
- Drop cases/people with too much missing data
  - May result in insufficient sample size
- Estimate and replace missing values
  - Simple imputation methods like mean substitution have problems

Systematic Missing: Strategies

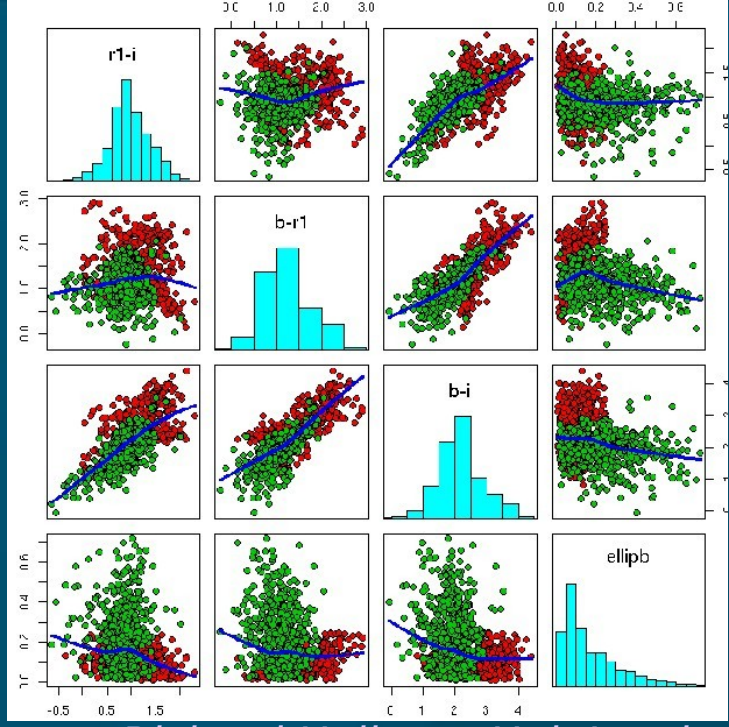
- Code "missing" var and include it in analysis
  - Might not help clarify import of omissions
- Return to participants & collect missing data
  - No guarantee of improved response rates
- Exclude the kind of participants that choose not to respond from your sample
  - Reduces generalizability of the results
  - May end up altering research question
- Start over, change design and data collection procedures

Univariate Outliers

- Definition: Patterns that reflect persons from a different population from the rest of the sample
- Use boxplots to spot them (outliers: *)
- From (a) knowledge of the literature and (b) extremity of an outlying score, decide
  - (1) whether to keep or exclude the outliers
  - (2) whether to use robust strategies for analysis
- Multivariate outliers can also exist



Multivariate Outliers



Richard Holbrey, Uni. Leeds

- Cases that might not appear extreme in any one variable, but that don't fit the pattern across several variables

- Try using scatter plots to detect outliers:
  - Graphs → Legacy Dialogs → Scatter/Dot
  - Choose "matrix scatter" to examine several quantitative variables at once.
- Use the "simple scatter" option to "zoom in" on a combination of variables of interest.

Handling Outliers

- If the person is a valid case, keep it in the dataset and check for impact.
  - Compare results with and without it
- Otherwise, remove the entire case from dataset
  - Other strategies exist, but more complex
- Check for univariate outliers ONCE, then
- Check for multivariate outliers ONCE
  - Do not repeat!
  - Excessive elimination of outliers may result in a very distorted dataset!

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Checking Test Assumptions

- Most statistical tests make assumptions of data.
  - Must always check these assumptions!
- If any assumptions are violated:
  - Use a different procedure, and/or
  - "Clean up" the data to meet assumptions
- Procedures based on the General Linear Model all assume that the data are parametric.
  - e.g., parametric correlation, *t*-tests, multiple regression, the ANOVA family, factor analysis, multi-level modeling, ...!

Assumptions of Parametricity

- *(These generally apply to the DV)*
- Scale (interval/ratio) level of measurement
- Independence:
  - No systematic links between cases
- Homogeneity of variance:
  - Variability of scores should be roughly similar across all variables and all participant groups
- Normally distributed within each group
  - Bell-shape, not skewed or kurtotic

Parametricity: Interval/ratio

- Check: level of measurement for each variable
- Solutions: try alternative, non-parametric tests:

Parametric	Non-parametric
Pearson's *r*	Spearman's r_s, Kendall's τ
Multiple Regression	Log-linear or Logistic Regression
Between-group *t*-test, Within-group *t*-test	Mann-Whitney *U*, Wilcoxon Signed-Rank
ANOVA family	Friedman's ANOVA, Chi-square, ...

Parametricity: Independence

- Check: sampling process, meaning of vars
  - e.g., participants from same family?
- Solutions:
  - Eliminate the offending cases or vars
  - Methods designed for "dependent" data
    - Repeated-measures ANOVA, multi-level (hierarchical) modelling, …
  - Split data into independent subgroups
    - e.g., analyze males and females separately

Homogeneity of Variance

- Check: examine variance of each subgroup:
  - Analyze → Descriptive Statistics → Explore
  - Plots → Spread vs. Level → Untransformed
  - Choose group (factor) vars and DVs
    - If ratio of largest variance to smallest is more than 4:1, we have a problem
- Or: use Levene's test:
    - If $p<0.05$, then assumption may be violated. (non-significance = good)
- Solutions: use conservative α, transform data, or try non-parametric methods

Parametricity: Normality

- Check: Kolmogorov-Smirnov, Shapiro-Wilk tests
  - Skewness / kurtosis (w/confid. interval)
    - If $p<0.05$, then we may have a problem
  - Normality plots, P-P plots
    - Analyze → Descriptive Statistics → Explore → Plots → check "Normality plots w/tests"
- Solutions:
  - Transform data as appropriate, or
  - Change problematic scores (yipes!)
- Remember normality applies per-cell

Transform Data for Normality

(cf. Beherns, 1997)

- Minor deviations: try square-root (sqrt)
- Medium deviations: try logarithmic (log10)
- Severe deviations: try reciprocal (1/score)
  - If tail is to the right, reflect data first:
    - **maximum_score – variable**
- SPSS: Transform → Compute Variable
  - Apply appropriate transformation
  - Use menus (Arithmetic, etc.) to find operations

Practise: Check Parametricity

- Datasets: SPSSExam.sav, HW1-ADD.sav
- Let's study the "effect" of gender (IV) on number of lectures (DV) or ADD symptoms (DV)
- Are the data parametric? Try it yourself!
  - Level of measurement
  - Independence
  - Homogeneity of variance
  - Normality

Order of Data Preparation

- Clean: spot/fix data entry errors, missing data
- Explore: overall patterns, use lots of graphs!
- Create derived vars (subscales, demographics)
- Outliers (uni-/multi-variate): identify & handle
- Check assumptions for your chosen analysis (e.g., parametricity)
    - Deal with any violations of assumptions
- Obtain descriptive information for the final dataset, and proceed with the analysis

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"Informationally Adequate"

- APA has standards on what you must report. In order to be "informationally adequate":
- Sample size (total N and n_i for each subgroup)
- Mean and SD for each outcome variable
  - Globally and for each sub-group
- Statistical significance ("exact" p–values)
- Measures of effect size (d, η^2, R^2, etc.)
- Evidence of sufficient statistical power
- Other test-specific info (APA, §2.07, pp. 32-35)

Further Reading -- Articles

- Wintre et al. (2000).
  Generational status and ethnicity in Canada
- Tabachnick et al. (2007). *On cleaning data*
- Schafer et al. (2002). *Missing data primer*

APPENDICES

- StatsCan resources
- Coding ethnicity
- Data archive sources available on-line

StatsCan Downloads

- Selected Demographic and Cultural Characteristics (102), Visible Minority Groups (15), Age Groups (6) and Sex (3) for Population, for Canada, Provinces, Territories and Census Metropolitan Areas, 2001 Census - 20% Sample Data
  - http://www.statcan.ca/bsolc/english/bsolc?catno=97F0010X2001044
- Selected Demographic and Cultural Characteristics (105), Selected Ethnic Groups (100), Age Groups (6), Sex (3) and Single and Multiple Ethnic Origin Responses (3) for Population, for Canada, Provinces, Territories and Census Metropolitan Areas, 2001 Census - 20% Sample Data
  - http://www.statcan.ca/bsolc/english/bsolc?catno=97F0010X2001040
- Place of Birth of Father (35), Place of Birth of Mother (35) and Generation Status (4) for the Population 15 Years and Over of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 20% Sample Data
  - http://www.statcan.ca/bsolc/english/bsolc?catno=97-557-X2006009

StatsCan Definitions

Source: *Ethnic Diversity Survey - Methodology and Data Quality*

- "questions on the birthplace of respondents and their parents were used to establish the respondent's generational status. The first generation includes respondents born outside Canada. The second generation includes respondents born in Canada with at least one parent born outside Canada. The third-plus generation includes respondents born in Canada to two Canadian-born parents."
- "Responses to the ethnic origin question were divided up to form the two main categories of interest: **CBFA+** (Canadian or British or French or Americans or Australians and/or New Zealanders) and Non-CBFA+ (all other responses containing at least one origin other than CBFA+). The **non-CBFA+** category was divided into European origins (for example, German, Italian, Dutch, Portuguese) and non-European (for example, Chinese, Jamaican, Lebanese, Iranian)."

StatsCan Definitions (cont.)

- “CBFA+
- Canadian only – Generation 1 and 2
- Canadian only – Generation 3 and more
- Canadian with BFA+ – Generations 1 and 2
- Canadian with BFA+ – Generations 3 and more
- BFA+ – Generation 1 and 2
- BFA+ – Generation 3 and more
- Non-CBFA+
- Other Europeans with Canadian – Generation 1 and 2
- Other Europeans with Canadian – Generation 3 and more
- Other Europeans – Generation 1
- Other Europeans – Generation 2
- Other Europeans – Generation 3 and more
- Other non-Europeans with Canadian – All generations
- Other non-Europeans – Generation 1
- Other non-Europeans – Generation 2 and more

ICPSR

- Interuniversity Consortium for Political and Social Research:
  “Established in 1962, ICPSR is the world's largest archive of digital social science data.”
    - http://www.icpsr.umich.edu/ICPSR/
- e.g., National Institute of Mental Health (NIH) Collaborative Psychiatric Epidemiology Surveys (CPES)