Data Analysis

16.621

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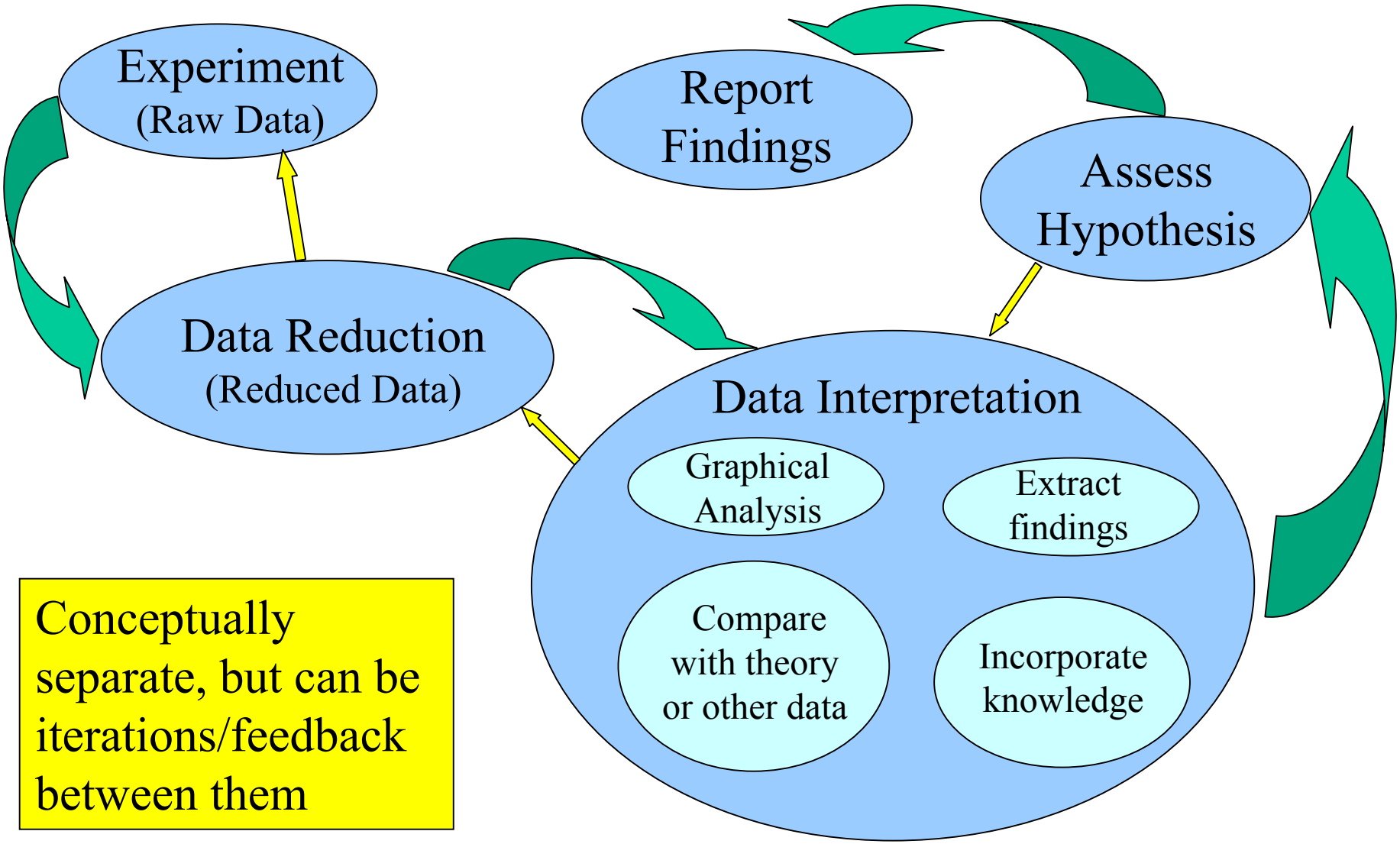
Data Analysis Process

Keep the end goal in mind!



Conceptually separate, but can be iterations/feedback between them

Experiment Step

- Experiment produces “raw data”
  - In measured units (volts, seconds, lbs, ….)
  - Organization determined by recording method (notebook, tabular form, database,….)
- Take data early to check-out experiment
- Do some “quick data reduction/analysis” during experiment to see if results look ok.
- Goal: Assure data set is complete and all information is collected while experiment is still set up.

Largely a recording process.

Data Reduction Step

- Convert and normalize or nondimensionalize raw data to “meaningful variables” (temperature, time of flight, force coefficients,...)
- Statistical analysis as appropriate (next class)
- Error analysis as appropriate
- Goal: assure data is “valid” before interpretation

Largely a deductive process.

Data Interpretation Step

- Interaction/Iteration of four sub elements
  - Graphical analysis: helps visualize data to see trends, patterns, relationships to theory,…
  - Compare with theory or other data to determine agreement or differences (both important)
  - Incorporate knowledge learned in classes or from experience
  - Extract findings which represent the *knowledge* generated from the experiment
- Implementation tailored to each project.
- This step is where "value" is added by researcher

A highly inductive process!

Error Analysis - A General Approach

- During the design of the experiment

1 Identify all possible sources of error:
   - Experiment set up: facility effects, environmental effects, human subjects, …..
   - Measurement system: velocity, temperature,...

2 Estimate possible severity of each source
   - Discuss with advisor.

3 For those that are considered "important", identify mitigation strategies.
   - Experimental design and/or test protocols (e.g. repeat tests)

4 Plan for quantitative analysis of reduced data
   - Quantitative analysis relies on math model of the system
   - Not possible for all situations: human factors tests, s/w studies
   - Often good for measurement systems: pitot probe, strain gauge,...
     - Sometimes quoted by manufacturer or supplier

Keep the end goal in mind!

Error Analysis - A General Approach II

- During the experiment
  - Execute experiment according to protocols
  - Record notes in lab notebook
  - Check for mistakes
- During data reduction
  - Calculate error bars for measurements
  - Check for outlier points
- During data interpretation/reporting
  - Consider errors when interpreting data
    - Assure findings are beyond uncertainty of experiment
  - Display error bars in way that aids in understanding findings

Goal: To "qualify" the accuracy of your data to support findings.

Exercise

- Make a sketch of a figure that you might put in your final report which displays your experimental data in a way that can be used to assess your hypothesis.
- What questions do you have about data reduction? For example
  - Statistical analysis
  - Graphical analysis
  - Error analysis
- Turn in your sketch and questions.