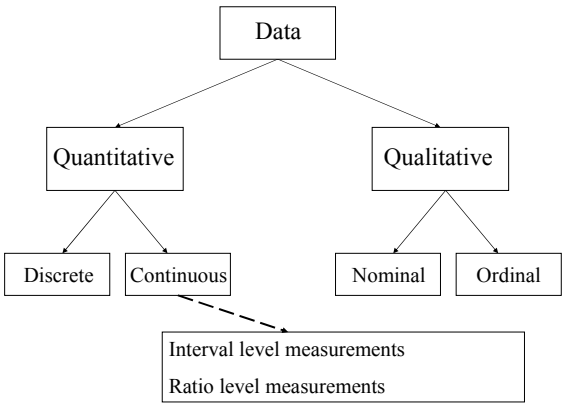
Starting Definitions

- Data
- Statistics
- Population
- Census
- Sample
- Parameter
- Statistic



Where do data come from?

Common ways of obtaining data

- Observational studies
- Experiments
- Sample Surveys

Observational Studies

Observations or measurements of specific characteristics with no attempt to ***modify*** the ***subjects*** being studied

- Three types
  - Cross-sectional study (at one point in time)
  - Retrospective (case-control) study
  - Prospective (longitudinal or cohort) study

Observational Studies (continued)

Interpretation of results subject to effects of ***confounding***

- ***Confounding variable*** is one that affects the response variable and is related to the explanatory variable
- Can often establish an association, but generally can't conclude cause and effect

Experiments (continued)

Observe effects on subjects after the application of some ***treatment***

- Might want to compare a treatment versus a control or multiple treatments
- Key elements in experimental design are
  - Control for effects of variables
  - Use replication
  - Use randomization

Experiments (continued)

- Controlling for effects of variables
  - blinding
  - placebo effect
  - double dummy
  - blocking
- Replication and sample size
  - need sufficiently large enough samples to be able to distinguish between a true effect and natural variability
  - experimental results should be reproducible

Sampling Strategies

Using randomization

Expect all components of the population to be approximately proportionately represented

- **Random sample:** each individual has an equal chance of being selected
- **Simple random sample:** each sample of the same size n has the same chance of being chosen
- **Probability sample:** each member has a known chance of being selected

Sampling Strategies (continued)

- Other sampling techniques
  - Systematic sampling
  - Stratified sampling
  - Cluster sampling
  - Convenience sampling
- Good designs may combine elements
  - Randomized block design experiment
  - Multistage sampling

Sample Surveys

- a type of observational study
- phone, mail, email, web-based, in person
- some additional issues
  - Wording of questions can introduce bias (deliberate or unintentional)
    - "Do you agree…?"
  - Ordering of questions (planting ideas)
  - Convenience samples/Self-selected samples
  - Desire of respondents to please
  - Confidentiality concerns may influence responses
  - Non-response bias

Fundamental Rule

Data must be representative of the population with regards to the question(s) of interest

-- regardless of how data were collected

-- random selection

- ❖ Helps to ensure that all components of the population will be approximately proportionately represented—prevents selection bias

Sampling (chance) error

- Difference between the sample result and the true population result due to chance sample fluctuations.
- Will never know the population parameter value exactly, even with perfect sampling
- Estimate = Population parameter value + chance error

Nonsampling error

- Errors due to sample data that are incorrectly collected, recorded, or analyzed
- Estimate = Population parameter value + bias + chance error

Things to be aware of

- Already mentioned
  - Sample sizes
  - Loaded questions
  - Order of questions
  - Nonresponse
  - Association versus causation

Things to be aware of

- Some other potential issues
  - Graphs used to exaggerate or understate (scaling of axes)
  - Pictographs
  - Percentages (misleading or unclear)
  - Missing data
    - At random meaning unrelated to values
    - Special reasons
  - Self-interest studies
  - Precise numbers ➔ accuracy