

## Lecture Outline

### Measurement Theory

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- Why use measurement theory?
- Background
- What is measurement?
- Measurement scales

### Why Use Measurement Theory?

- Indicates
  - appropriateness of operations on data
  - relationships between measurements at different levels
- Allows analysis to reflect reality rather than the numbers
- Relevant to collection and analysis of data

### Why Use Measurement Theory?

- Fundamental ideas
  - Measurements are not the same as the attributes (concept) to be measured
  - Conclusions about the attributes need to take into account the correspondence between reality and the measured attribute

### What is Measurement?

- Measurement is
  - an operation performed over attributes of objects
  - assigning numbers to objects according to a rule
  - assigning numbers to things so that the numbers represent relationships of the attributes being measured

### What is Measurement?

- The conclusions of a statistical analysis should say something about reality
- Should not be biased by arbitrary choices about the measurements
- Use of measurement scales assists with this

## Measurement Scales

- Particular way of assigning numbers to measure something
- Specific transformations and statistics permitted for the measurement of different scales
- Permissible transformations
  - transformations that preserve the relationships of the measurement process *for that measurement scale*
  - different scales have different permissible transformations / statistics

## Measurement Scales

- Several different measurement scales exist
- From weakest to strongest
  - Nominal
  - Ordinal
  - Interval
  - Ratio
  - Absolute

## Nominal Scale

- Objects are classified into groups
- No ordering involved
- Based on set theory
  - objects classified into sets
- Any numerical labels are totally arbitrary
- Objects have the same label if they have the same attributes

## Ordinal Scale

- Objects are ordered
- Objects are sorted according to some kind of pairwise comparison
- Numbers reflect the order of the attributes
- Categories without the arithmetic properties of numbers

## Interval Scale

- Objects are placed on a number line with an arbitrary zero point and arbitrary interval
- Interval is the 'gap' between each object
- Numerical values themselves have no significance
- Difference in values reflect differences in measured attributes

## Ratio Scale

- Difference between two interval measures
- Have a true zero point (origin) and arbitrary intervals
- Zero means absence of the attribute being measured
- Values have significance
- Differences and ratios of numbers have meaning

## Absolute Scale

- Abstract mathematical concepts
  - e.g. probability
- Permissible transformations
  - identity transformations

## Implications of Measurement Theory

- Possible to transform to weaker scales
  - Cannot go other way
- Validity & reliability of collected data
- Caveats
  - Not all real-world measurement can be classified
    - Can fit into more than one
  - Must select an appropriate scale at the start

## Summary

- Measurement theory
  - Relates measurements to the real world
  - Separates measurements from the attribute being measured
  - Places measurements in different strength scales
- Scale of a measurement determines what can be done with it