

Statistics 514: Design of Experiments

Topic 5 Summary

Causation

- *Motivation*: establish intuition for causal inference based on experimentation
- *Bacon*: objectivity makes nature emergent
 - *Critique*: Discovery is approximate, often illogical, and usually unprovable.
- Why do we experiment?
 - *Ideal*: manipulation important to reduce bias
 - “To find out what happens when you change something, it is necessary to change it.”
 - *Reality*: Subjectivity/assumptions can never be eliminated.
 - “Proof” is not possible with most empirical phenomena.
- *Quantifying evidence*: use indirect measures such as p -values
 - Not always easy to understand or apply in important practical contexts.
 - Researchers want simple, consistent conclusions of causality.
- *Causation*:
 - Can say what it looks like
 - Can say what it's not (association)
 - Experimentally validated (or invalidated)

Statistical definitions list what experiments can do and what they can't.

Role of Statistics

- Leverages empirical evidence.
- Necessarily reductive in nature (disproof, not proof)
- Establishes a culture (with a canon, history, ambiguity, and capriciousness) of dialogue.
- Often shapes the questions it can answer
- Embedded in bigger cycle of inquiry

Causation

- Special type of conclusion
- Result of experimental (manipulated) evidence and probability mechanism ($P(E|C \text{ and } B) > P(E|B \text{ and not } C)$ for all B)
- Need to eliminate B 's (homogeneous classes) and verify/eliminate/trust assumptions
- Generalizable
 - Consistent with subject knowledge
 - Repeatable in other circumstances (Finite Causation)
- In most circumstances, can only describe aspects of system
- Provides conceptual bridge from causation/experimentation to randomization hypothesis