Introduction to Empirical Methods

Idaho State University | Computer Science

Isaac Griffith

CS 4422 and CS 5599
Department of Computer Science
Idaho State University

ROAR

Idaho State University
Computer Science

Outcomes

At the end of this lecture you should be able to:

- Understand basic concepts of the philosophy of science and empiricism
- Understand basic notions of different empirical methods

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Inspiration

"Science, done right, works hard to respect absolutely no authority at all other than experience and empirical data. It never succeeds entirely, but it comes closer and has a better track record than any other method we apes have found for learning about the world around us." – Adam Becker

5 Classes of Methods

- Controlled Experiments
- Case Studies
- Survey Research
- Ethnographies
- Action Research

Exploratory Questions

- Existence
- Description and Classification
- Descriptive-Comparative

Base-Rate Questions

- Frequency and Distribution
- Descriptive-process

Relationship Questions

- Is X related to Y?
- If X occurs, will Y also occur?

Causality Questions

- Does X cause Y? Does X prevent Y?
- Causality-Comparative
- Does context affect causality?

Design Questions

- How to effectively achieve X?
- What helps?
- What does not help?

Empirical Truth

Epistemology
the nature of human knowledge,
and how we obtain it.

Onthology
the nature of the world
irrespective of our attempts
to understand it.

Plato: On Knowledge

to know something, you must
believe it to be true, and
have a clear justification for
believing it to be true

Constructivists

we cannot separate knowledge from the language we use to express it

The Philosophical Stances

- Positivism
- Constructivism
- Critical Theory
- Pragmatism

Positivism

- All knowledge comes from a set of basic observable facts.
- Reductionist
- Sometimes comes to wrong conclusions
- Associated to controlled experiment

Constructivism

- Interpretivism
- Often adopted in social sciences
- Qualitative data about human beings
- Exploratory case studies or survey research

Critical Theory

- Political act
- Emancipatory and advogacy role
- e.g. Open Source movement and Agile Community
- Action research and case studies

Pragmatism

- All knowledge is approximate and incomplete and depends on methods
- Truth is whatever works for me
- Truth is relative to observer
- Values practical knowledge
- Mixed methods

Abstract

- **To the positivist**, science is the process of verifying theories by testing hypotheses derived from them.
- **To the constructivist**, science is the process of seeking local theories that emerge from (and explain) the data.
- **To the critical theorist**, theories are assertions of knowledge (and therefor power), to be critiqued in terms of how they shape that power.
- **To the pragmatist**, theories are the products of a consensual process among a community of researchers to be judged for their practical utility.

Theories

Theory becomes a ”lens” through which the world is observed

Theories

Real-world phenomena are simply too rich and complex to study without a huge amount of filtering

Theories

Software Engineering researchers have traditionally been very poor at making theories

Method Selection

Research Design is the process of selecting a method for a particular problem

Controlled Experiments

- Independent variables effects over dependent ones
- Precondition: a clear hypothesis
- Demonstrate hypothesis by testing it on a representative population
- Control unwanted variables
- If critical variables are ignored, experiment might not generalize real world
- Theory-driven is both a strength and a weakness

Case Studies

- Exploratory or confirmatory
- Critical case
- Multiple case
- Weakness: open to interpretation and researcher bias
- All philosophical stances

Survey Research

- Questionnaires for data collection
- Representative sample from well defined population
- Challenge: control of sampling bias
- Harder challenge: ensure that questions are designed in a way that yields useful and valid data
- Positivism tradition

Ethnographies

- Goal: study community of people
- Result: a rich description of it
- Participant observation – possible if researcher is technical person
- Challenge: avoid preconceptions on data observation and analysis
- Constructivism

Action Research

- Solve real-problem while studying it. Researcher is also a change agent.
- Education, information science fields
- Long term commitment, expensive
- Is a new idea, immature method
- Iterative process
- No attempt to create a control group
- Critical theory

Mixed-Methods

- Sequential explanatory - quantitative followed by qualitative
- Sequential exploratory - qualitative followed by quantitative
- Concurrent triangulation - what people say is different from what people do
- Difficult to resolve contradictions

Data Collection

- Each technique has its strengths and weaknesses
- If different kinds of data support the same conclusions, it strengthens the study
- Pilot-test the data collection

Empirical Validity

- Conclusion – validity of the (statistical) relationship between the treatment and the outcome
- Internal – validity of a causal relationship between the treatment and outcome
- Construct – validity of the relationship between theory and observation
- External – validity of the generalizability of the relationships
- Reliability – extent to which the data and analysis are dependent on specific researchers

Are there any questions?