Wissenschaftliches Arbeiten (WIA)

Vorlesung – Hochschule Mannheim

Research Methods

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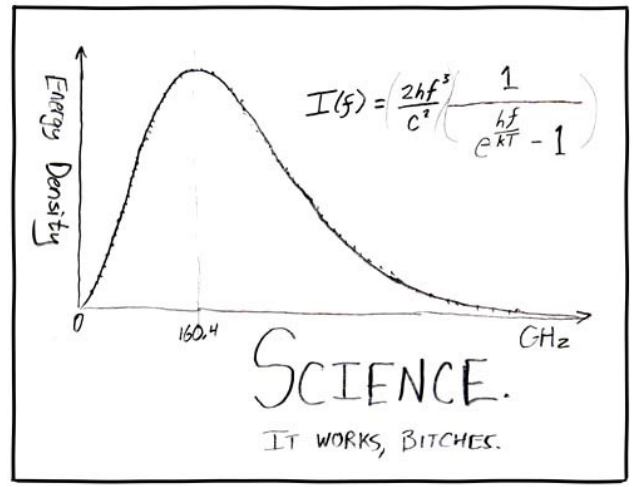

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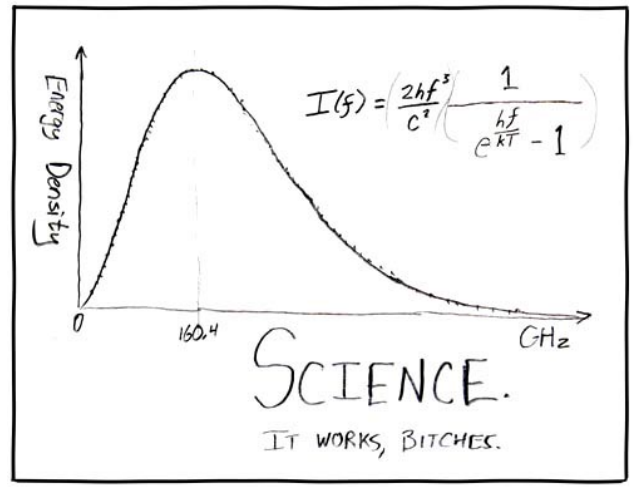
Objectives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$I(f) = \frac{2hf^3}{c^2} \Big/ \frac{1}{e^{\frac{hf}{kT}} - 1}$
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SCIENCE.
IT WORKS, BITCHES.

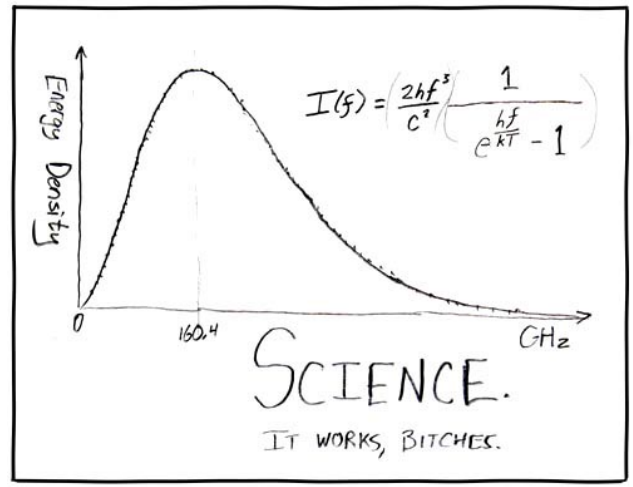
Key Questions

- What kinds of research do we know?
- What scientific methods are available to me?
- What are the specifics of the methods?
- When should I use which method?

Learning Objectives

- Know different kinds of research
- Tell the difference between quantitative and qualitative research
- Understand the basic concept of different research methods
- Apply the right method to your research question

Overview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Scientific Methods

- A *method* is a type of approach using specific instruments to reach a certain goal
- A *scientific method* consists of
  - a system of rules
  - used by the acting persons
  - with an explicit description of the rules and terms
  - that allows to check whether or not the subjects applied and obeyed the rules
- Different Methods can have a hierarchical relationship

Types of Research

- *Normative Research*: how should things be
- *Positive Research*: describes how things are and why
- *Theoretical Research*: builds models and solves them mathematically
- *Empirical Research*: observes real events and tests theoretical models
  ($\rightarrow$ requires theoretical model/research as input)

Forms of Research methods

- *Exploratory research* identifies and defines a problem or question
  e. g. The sales of our product dropped. What are possible reasons?
- *Constructive research* develop and proposes solutions to a problem
  e. g. How can we increase the efficiency of a solar cell?
- *Empirical research* tests the feasibility of a solution using empirical evidence or searches for correlations
  e. g. How strong is the correlation between noise and heart diseases in urban areas?

Qualitative vs. quantitative research

- *Qualitative research* investigates a question without attempting to quantifiably measure variables ($\rightarrow$ broad, open questions)
- *Quantitative research* systematic empirical investigation of quantitative properties and phenomena and their relationships ($\rightarrow$ narrow questions, numerical data)

Design vs. Behavioral Science

In computer science two mayor perspectives on the research methods are possible

- *Design Science*: Create and evaluate IT solutions in terms of models, methods and systems
- *Behavioral Science*: Researches the effect of IT solutions on organizations and individuals

Overview: Design Methods

Design methods

- Prototyping
- Simulation
- Modeling / Reference Modeling
- Deductive Analysis
- Action Research

Overview: Behavioral Methods

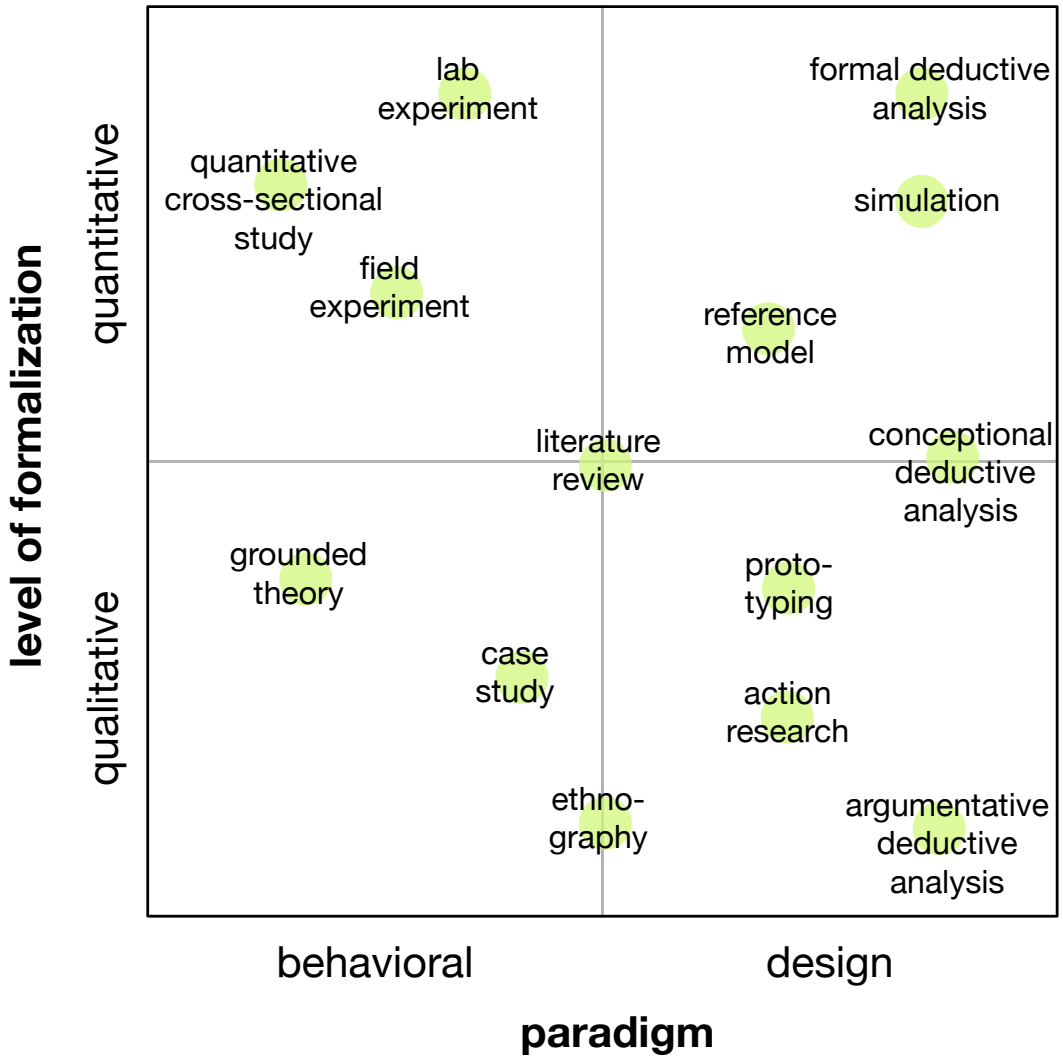
Behavioral Methods

- Grounded Theory
- Cross-Sectional Study
- Case Studies
- Lab and Field Experiments
- Ethnography

Special guest

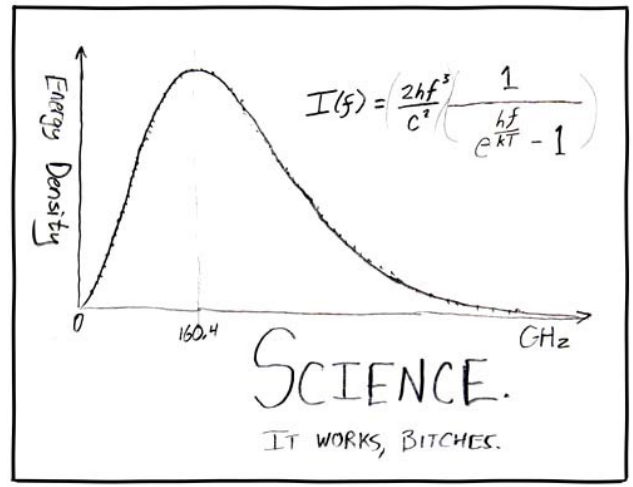
- Literature Review (State of the Art)

Matrix of methods



Source: Wilde, Hess - Methodenspektrum der Wirtschaftsinformatik

Design methods



Prototyping

Prototyping

- Often used if the full solution could not be built or only certain aspects should be evaluated
- Build a prototype of the application system or product
- Evaluate the prototype to answer the research question (e. g. regarding performance characteristics, usability, ...)
- Different kinds of prototypes possible
  - User interface prototype
  - Functional prototype
  - Horizontal prototype
  - Vertical prototype
  - ...

Simulation

Simulation

- Transform target system into a simulation model
- Evaluate the simulation to answer the research question (e. g. behavior of the system under certain conditions)
- Often used if the problem can be formalized (mathematically) but not solved analytical

Modeling / Reference Modeling

Modeling *(Modellierung)*

- Create a model (formal or semi-formal) based on
  - observations (inductive) or
  - theories (deductive)
- Not a full method, only a means to describe reality

Reference Modeling *(Referenzmodellierung)*

- Create a model of a desired target state
- Create a model of the current state
- Compare the models with each other

Deductive Analysis

Deductive Analysis (Deduktion)

- Use logic to deduce new statements from
  - formal models (*formal deductive analysis*) or
  - semi-formal models (*conceptional deductive analysis*)
  - general arguments (*argumentative deductive analysis*)

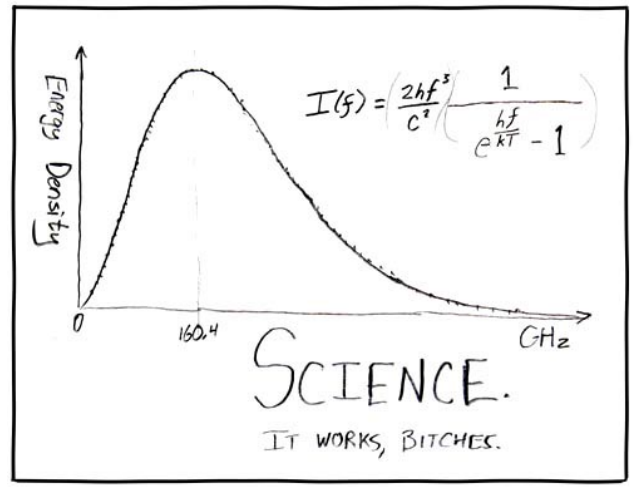
Action Research

Action Research (Aktionsforschung): Introduced by Kurt Lewin → solve real problems in the social sciences instead of only describing phenomena

- Solve a practical problem with a group consisting of
  - practitioners
  - scientists
- Iterate the solution in multiple cycles

Kurt Lewin: Aktionsforschung und Minderheitenprobleme. 1948. In: K. Lewin (Ed.): Die Lösung sozialer Konflikte. Christian-Verlag, Bad-Neuheim, S. 278–298.

Behavioral Methods



Grounded Theory

Grounded Theory (gegenstandsverankerte Theoriebildung)

- Intensive observation of the subject
- Collect, categorize and evaluate qualitative data using well defined methods
- Derive new theories by induction from the data

Bryant, A. & Charmaz, K. (Eds.) (2007) The SAGE Handbook of Grounded Theory. Los Angeles: Sage.

Cross-Sectional Study

Cross-Sectional Study (Querschnittsanalyse)

- Quantitative data on the research object (or subject) is gathered in large quantities
  - surveys
  - interviews
  - Delphi method
  - Szenarios
- Data is analyzed with statistical methods to derive knowledge about the research object

Case Studies

Case Studies (Fallstudie)

- Analysis of complex, difficult to isolate phenomena in their natural environment
- Focus on single objects and events (no large amount of data) $\rightarrow$ qualitative study
- Validation of a thesis with the case or interpretation of behavior
- Focus on behavior but also usable for design $\rightarrow$ Mostly behavioral Sciences

Lab and Field Experiments

Experiment

- In a controlled environment a variable is changed and
- the effect on other variables is measured
- Is performed either in a controlled, artificial environment ($\rightarrow$ *Lab Experiment*) or
- in the natural environment of the subject analyzed ($\rightarrow$ *Field Experiment*)

Ethnography

Ethnography (Ethnographie)

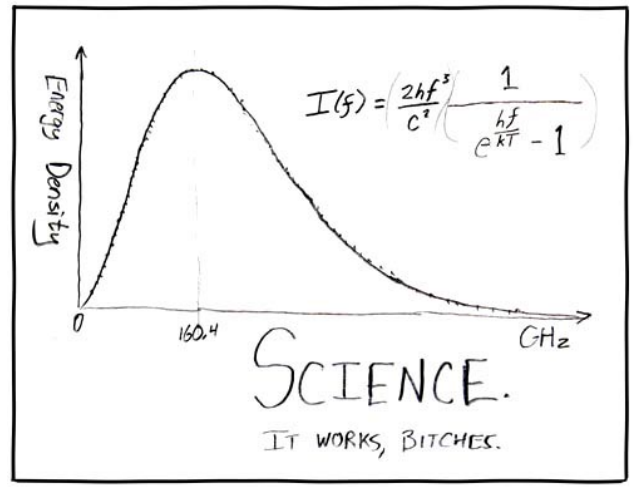
- Method from the behavioral sciences
- The subject is observed in its natural environment to generate insights and knowledge
- In contrast to case a study is the researcher deeply embedded in the social context (living together with the subjects)

Literature Review (State of the Art)

Literature Review *(Literaturstudie)*

- Review of the relevant literature to capture the current knowledge in an area ($\rightarrow$ *state of the art*)
- Derive the current state of the art by aggregating and comparing the existing works
- If done systematically to identify, appraise, select and synthesize all high-quality literature in an area, a *systematic review* is performed
- Every scientific paper should contain a section of the state of the art

Recommendation



What to use when?

Research	Prototyping	Simulation	Modeling	Deductive	Action R.
Exploratory	X	X	X	-	X
Constructive	X	X	X	X	X
Empirical	-	-	-	-	-

Research	Grounded T.	C-S Study	Case S.	Experiment	Ethnography
Exploratory	X	-	X	-	X
Constructive	X	-	-	-	-
Empirical	-	X	X	X	X

Combine Methods for the Best Result

Example

- Examine the field with state of the art
- Model a the current business process to understand shortcomings ($\rightarrow$ explore)
- Prototype a possible solution ($\rightarrow$ construct)
- Validate the prototype with experiments ($\rightarrow$ empirical)
- ...