University of Applied Sciences Northwestern Switzerland
School of Business

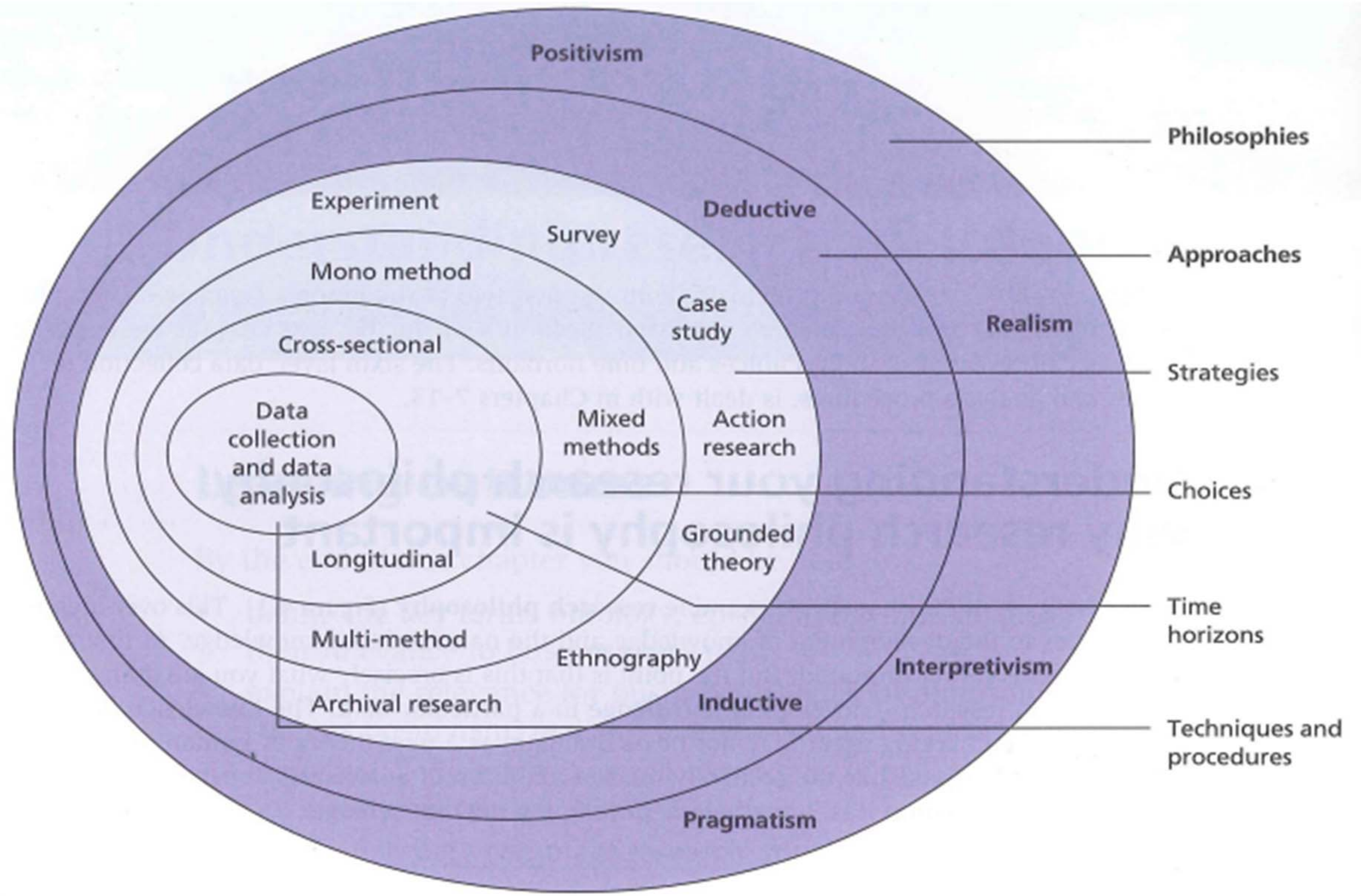
How to choose a research methodology?

Learning goals

- understand ways of looking at research (meta science)
- get to know methodologies to guide your research
- understand the principles of design-based research

META SCIENCE

Research Onion



(Saunders et al. 2009)

Meta science

- The science about science: systematic categorisation of research according to dimensions such as:
  - Philosophy: positivist vs. interpretivist, analytical vs. design
  - Approach: deductive vs. inductive
  - Choice of Data: quantitative vs. qualitative
  - Strategy: Survey vs. experiment vs. case study vs. …

Philosophy: Positivist vs. interpretivist

1. **Positivist:** believes in the possibility to observe and describe reality from an objective viewpoint
   - ***observe*** the world in some neutral and objective way, ***discover*** "general" relationships and "universal" laws, ***derive*** theories, ***test*** them
   - observations should be repeatable
2. **Interpretivist:** believes that it is necessary to understand differences between humans in our roles as social actors
   - understand the world from the point of view of the social actors, different interpretations are possible and thus are subjective
   - qualitative, non-quantitative questions

Philosophy: Analytical vs design (1)

- Analytical science (empirical)
  - understanding reality, concerned with general statements about reality
  - fields: natural sciences, economics, sociology,…
  - new research results can falsify existing theories
- Design science (constructive)
  - concerned with the design of artificial constructs (concepts, designs)
  - fields: mathematics, engineering (including computer science), humanities (languages, literature, law, arts)
  - existing constructs remain valid but new constructs may be considered as superior. Examples:
    - a new algorithm shows a better performance than a previous one
    - a new software shows a substantial increase in usability

adapted from Thomas Hanne

Philosophy: Analytical vs design (2)

- Analytical and design research in information systems

design science	analytical science
design and study of: • formal languages • mathematical models • algorithms • prototypes	interviews case studies

adapted from Thomas Hanne

Trends: Research in Business Information Systems

America: Information Systems Research

- Focus is „Explanation“
- Result: Observation
  - Properties of Information Systems
  - Behaviour of users
- Social Sciences:
  - „Behaviourism“,
  - „Positivism“
- Strength: Scientific
- Problem: Relevance for practice

Europe: Business Informatics

- Focus is „Design“,
- Result: Artefacts
  - Constructs, methods,
  - Models, instantiations, prototypes
- Engineering:
  - „Design Science Research“,
  - „Constructivism“
- Strength: Relevance for practice
- Problem: Research methodolgy

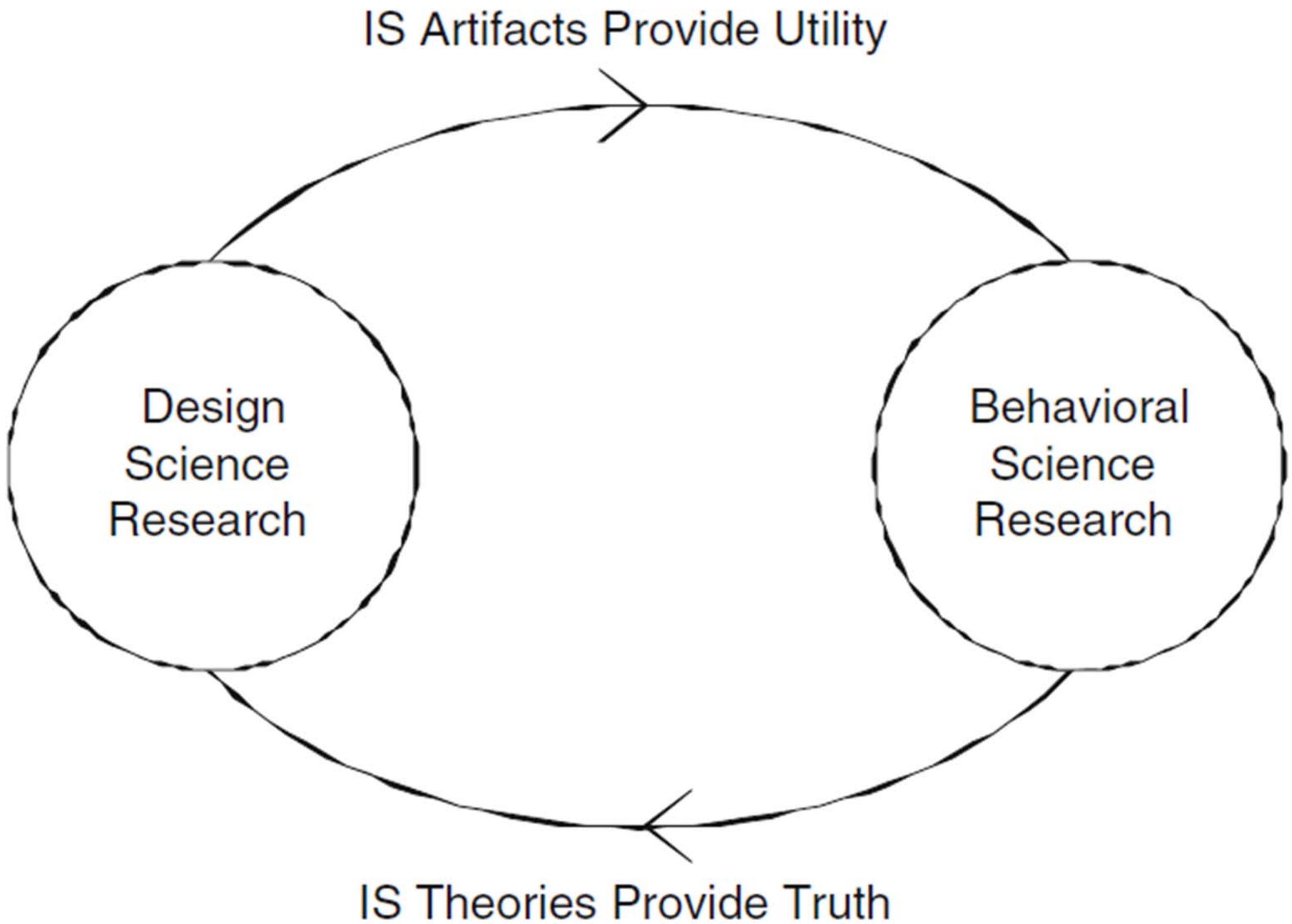
nach (Österle et al. 2010)

Goal of Research

- The goals of **design-oriented** research are
  - guidelines for the construction and operation of information systems
  - innovations of information systems (instances)
- The goals of **behavioristic** research are
  - analyses information systems as a phenomenon (actual situations)
  - cause-effect relationships in the use of information systems

nach (Österle et al. 2010)

Design Science vs. Behavioral Science



(Hevner & Chatterjee 2010)

Problems of Design Orientation

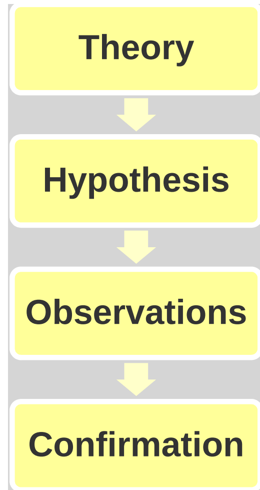
- Success criterion: relevant, useful results
- Validation often by
  - implementation in practice
  - economic payoff
- Consequence:
  - Many publications of results are without rigouros, scientific evidence
    → no research

Goal: Simultanuous achievement of
- Design orientation
- Scientific rigor

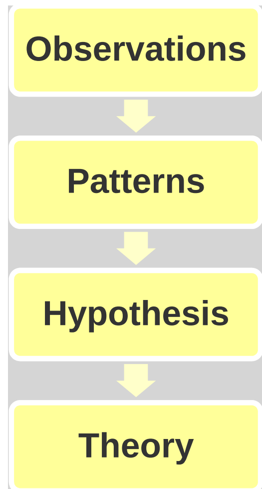
based on (Österle et al. 2010)

Approach: Deductive vs. Inductive (1)

- Deductive approach: from general to specific
  - Develop a **theory** (out of previous findings (literature), experience, some first observations,…)
  - Derive a **hypothesis** from the theory
  - Make **observations**
  - obtain a **confirmation** or rejection of the hypothesis



- Inductive approach: from specific to general
  - Make **observations**
  - Find **patterns**
  - Create a **hypothesis**, explore/validate it
  - Form a **theory** out of hypotheses



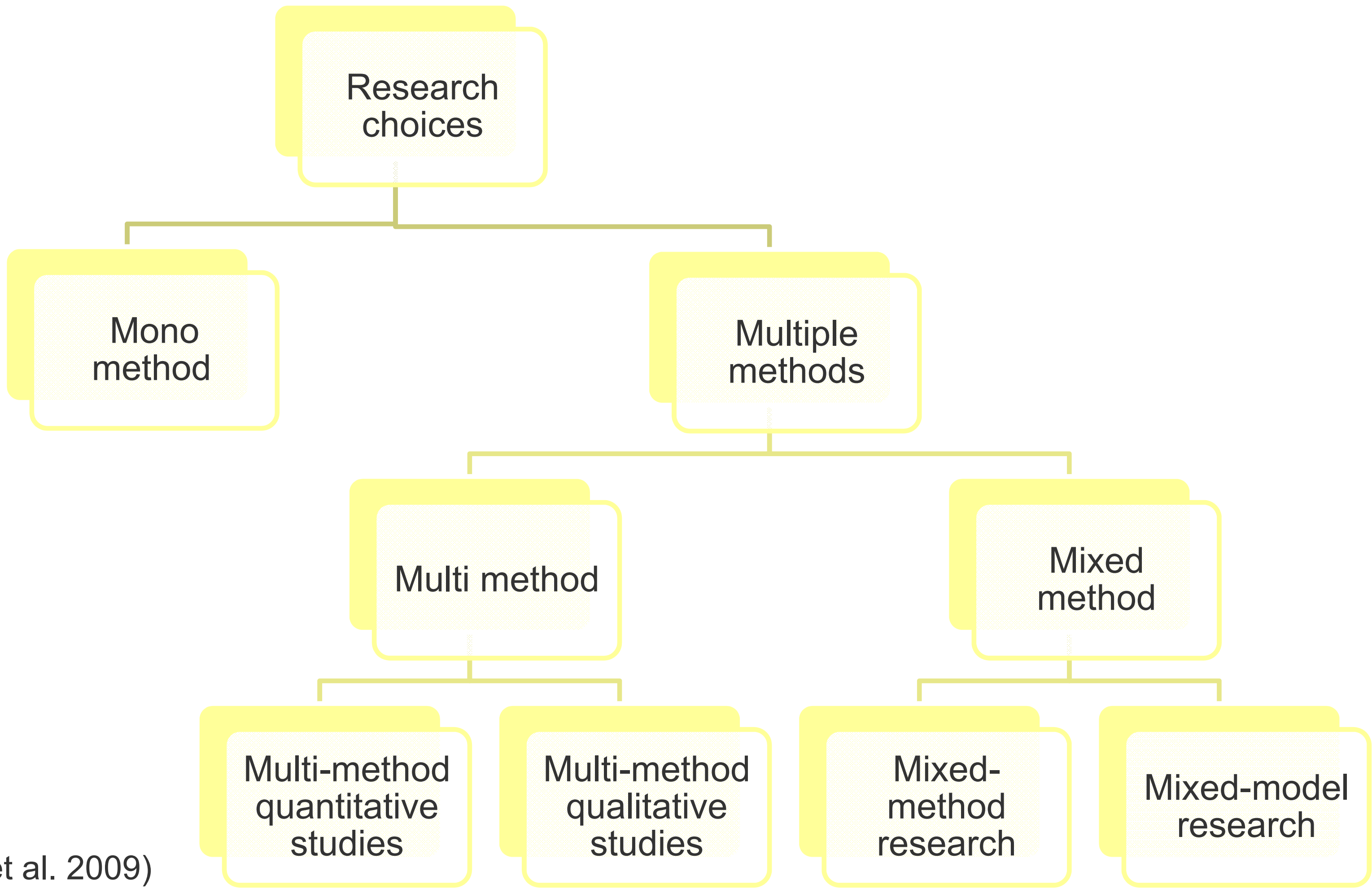
Approach: Deductive vs. Inductive (2)

- **Question:** If you've read literature (=theory?), does that mean automatically that your approach must be deductive??

Choices: Quantitative vs. qualitative

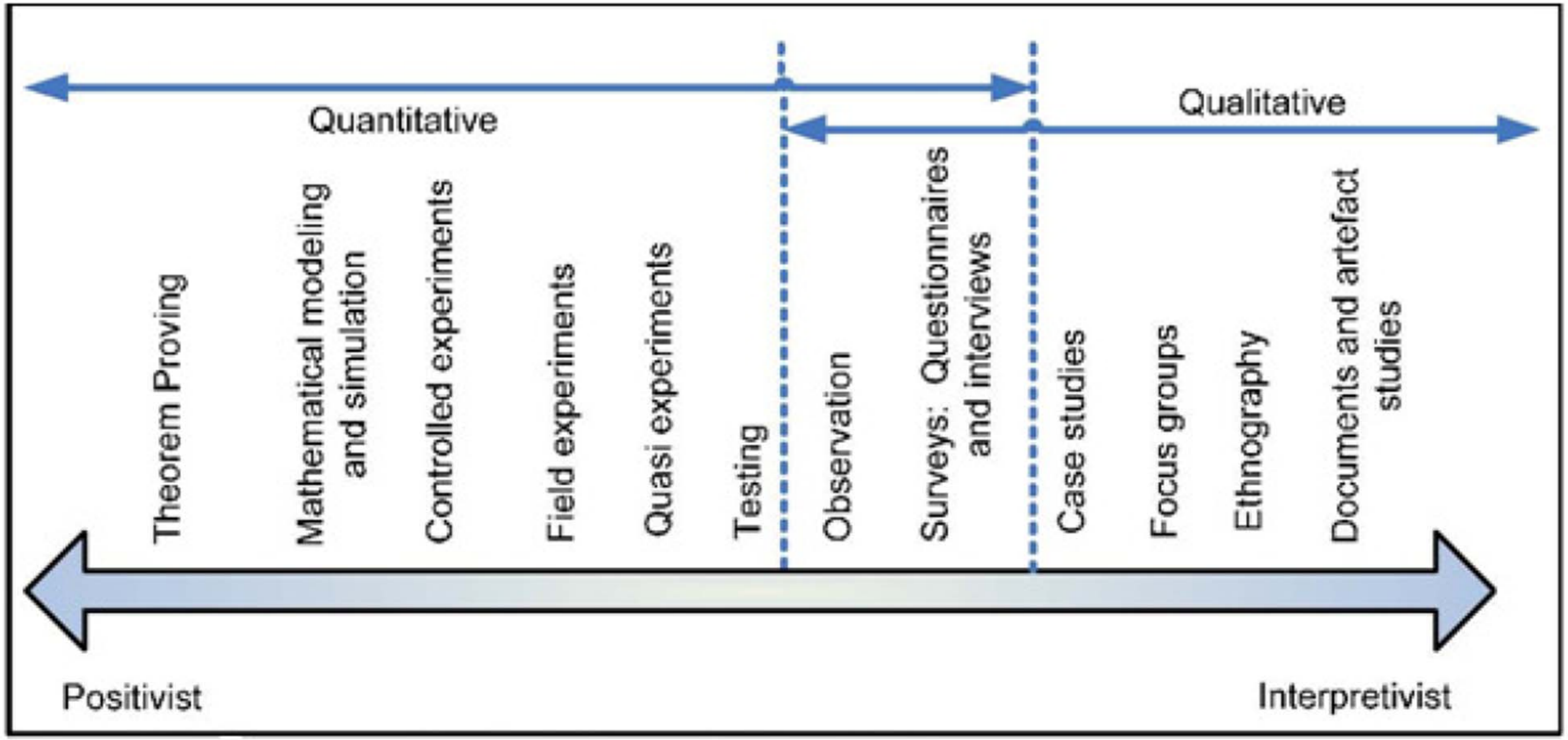
- **Quantitative research:**
  - focuses on verifying hypotheses (deductive) or finding patterns (inductive) using typically *large amounts of data*
- **Qualitative research:**
  - focuses on understanding the important characteristics of typically *small samples of data*
- **Example:** investigate users' response to an interface
  - quantitative approach: collect ratings, verify user acceptance
  - qualitative approach: understand *why* users interact with the interface in certain ways

Research Choices



(Saunders et al. 2009)

Research Strategies, Choices and Philosophy



(De Villiers 2005)

STRATEGIES

What is a research strategy?

- A research strategy usually has
  - A goal: something it can be used for
  - A procedure: steps to follow to achieve results
  - A set of techniques involved in the procedures
- … and it is often based on a certain type of science (see previous slide block)

Research methodologies – overview

Strategy	Goal
Survey studies	find patterns in data
Experiments	test hypotheses
Case studies	study the characteristics of a real-life instance
Action research	iteratively solve a problem with a community of practice
Design research	generate an artefact

Survey studies

- **Goal:** find patterns in data
- **Procedure:**
  1. collect data from a large group of objects in a standardized and systematic way
  2. evaluate the data, e.g. by using statistical methods
  3. identify patterns, especially those which were not expected
  4. interpret results
- **Techniques:** observation, measurement, construction, questionnaires, interviews, literature research
- **Type of research:** inductive, empirical

adapted from Thomas Hanne

Survey studies – data collection (1)

- Sources: nature, technical or information systems, people, companies, literature, …
- Means of collecting:
  - Observation: using one's senses
  - Measurement: using technical instruments (e.g. a thermometer)
  - Construction: data is obtained using an artefact (e.g., the output of some algorithm)
  - Data transactions
  - Questionnaires
  - Interviews
  - Literature research

adapted from Thomas Hanne

Survey studies – data collection (2)

primary and secondary data – double meaning

1. primary data: data collected within one‘s own research

   secondary data: usage of data in research collected by someone else

2. primary data = input data of a research method

   secondary data = derived data (resulting from a research method)

adapted from Thomas Hanne

Survey studies – interpretation of data

- Quantitative analyses:
  - counting the frequency of specific events
  - observing the timing of specific events (requires some measurement)
  - counting the number of objects (e.g. persons in a queue)
- Qualitative analyses:
  - observing the specific behavior of a person (e.g. a computer user for evaluating the usability of a software)
  - interviewing stakeholders (e.g. users of an information systems)
  - observing the nonverbal communication of people in a meeting
    - some observations are hardly possible to separate from interpretation

adapted from Thomas Hanne

Experiments

- **Goal:** test hypotheses
- **Procedure:**
  1. formulate a hypothesis
  2. collect evidence
  3. test hypothesis based on evidence
- **Techniques:** benchmarking, statistical significance tests
- **Type of research:** positivist, deductive, quantitative

Experiments – verification problem

- problem: falsification of a hypothesis can be done with one experiment, verification usually not!
  - it is usually not possible to draw conclusions from one instance being tested because the observed results may be different using other test data
  - E.g.: how many test instances are needed for testing your new algorithm?

adapted from Thomas Hanne

Experiments – requirements

1. Ensure validity of claims by careful design. Popular designs:
   a) Statistical significance testing
      - formulate a null hypothesis, then (possibly) reject it based on significance test
      - e.g. comparative evaluation with test and control groups

   b) benchmarking (compare to e.g. a gold standard)

2. Repeatability: need to describe setting of experiments and test instances carefully
   - ♦ try to control influences of environment, avoid random effects

Case studies

- **Goal:** study the characteristics of a real-life instance
- **Procedure:**
  1. select an instance to study
  2. collect data, analyse and interpret it in a systematic way
  3. understand the reasons for characteristics of the instance
- **Techniques:** interviews, discussions, observations, questionnaires
- **Type of research:** interpretivist, inductive, empirical, qualitative

Case study approach

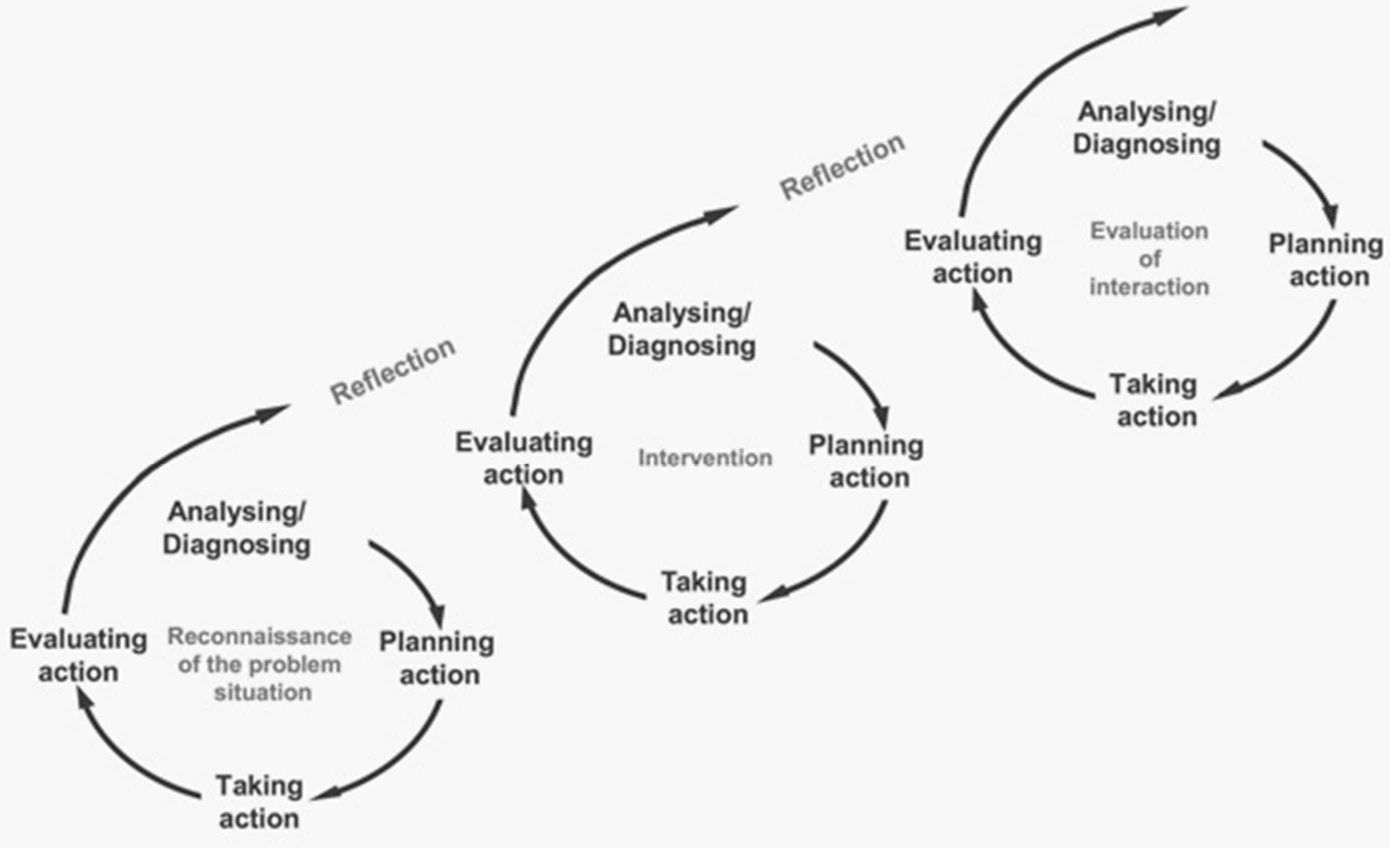
- empirical investigation of a particular contemporary *phenomenon* within its real life *context*
- gaining a rich understanding of the context of the research and the processes being enacted
- Triangulation: using multiple, different sources of data to ensure reliability, e.g. triangulating quantitative data from questionnaires using qualitative data from semi-structured interviews
- Four case-study strategies based upon two dimensions
  - single case vs. multiple case
  - holistic case vs. embedded case

Saunders et al. 2009, p. 146f)

Participatory action research

- **Goal:** iteratively solve a problem with a community of practice
- **Procedure:**
  1. Planning:
     a) analyse problem together with practitioners
     b) develop solution(s) with the help of theories, plan actions
  2. Action:
     a) implement solution/action, evaluate
     b) Learning: improve solution as required
  3. Reflection: derive design principle(s) from outcome
- **Type of research:** interpretivist, constructive, qualitative

Action research – procedure



Source: Adapted from Coghlan and Brannick (2001), p. 19; Cardno and Piggot-Irvine (1996), p. 19

Action research in computer science

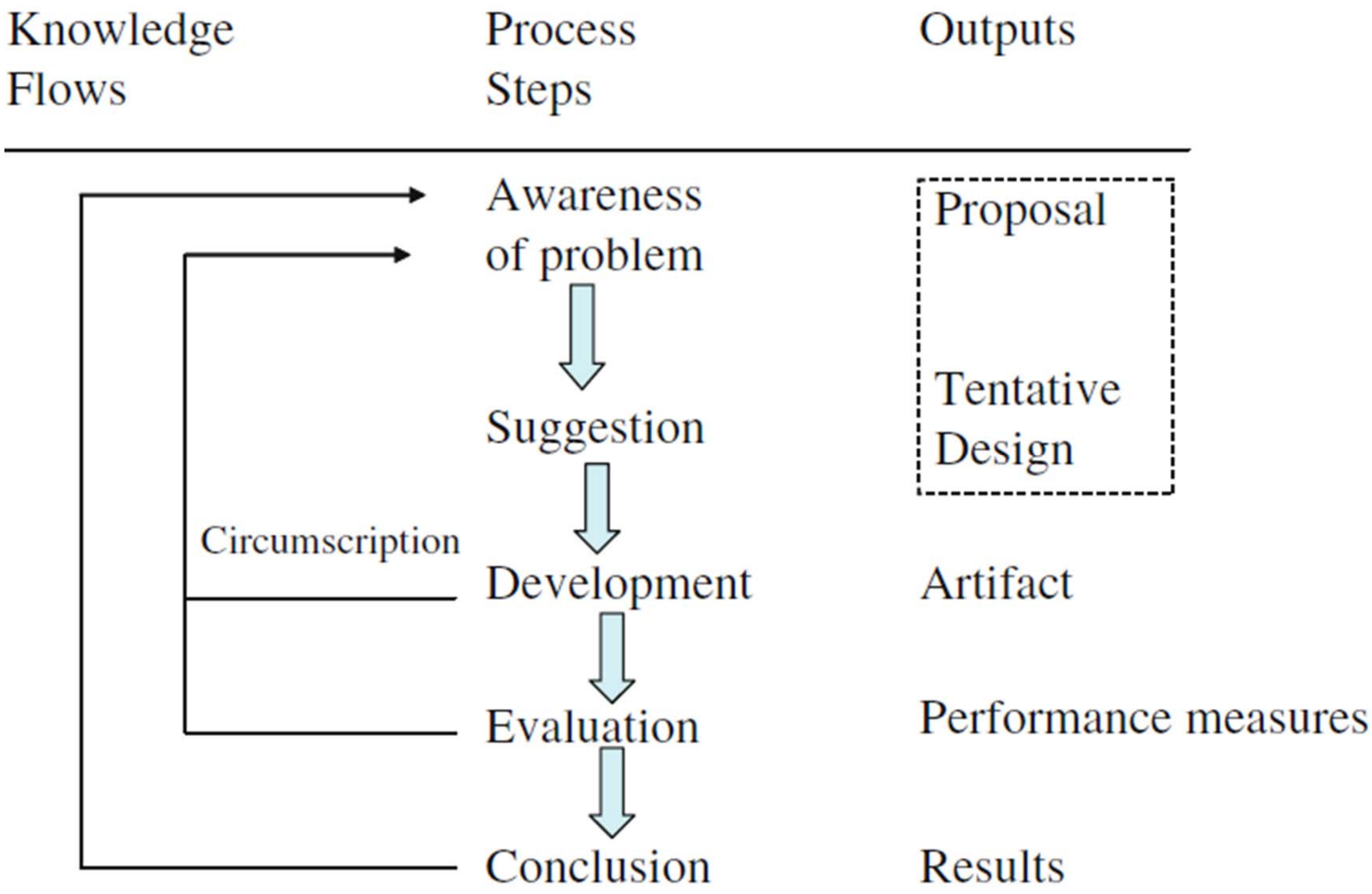
- might be appropriate in many studies in computer science or information systems because
  - the researcher wants to solve a problem in real-life settings
  - not only the problem solution is in focus but also its consequences (e.g. in the social environment), e.g. to help a community address a certain type of problem better in the future.
- However, action research is often not applicable because
  - it is time-consuming and expensive
  - it requires to bring into practice and observe an information system and thus to re-organise an enterprise in several iterations which is not possible

adapted from Thomas Hanne

Design science research

- **Goal:** designing and creating artifacts (constructs, models, methods, instantiations – see above)
- **Procedure:**
  1. Analysis: analyse problem and determine research goals
  2. Development
     a) develop artifact with recognized methodologies
     b) justify solution and differentiate from known solutions
  3. Evaluation: validate approach with respect to research goals
  4. Dissemination: publication, implementation organisations
- **Type of research:** interpretivist, constructive, qualitative

Alternative Procedure: Design Science Research Framework



(Hevner & Chatterjee 2010, p. 27)

Design Science Research Framework (2)

Another view on design an creation processes (cf. Oates (2006), p. 111f):

- awareness
  - recognition of a problem which can be solved by or using new artifacts
- suggestion
  - discussing what kind of artifact might solve the problem
- development
  - designing and creating the artifact
- evaluation
  - checking whether the artifact solves the problem, analyzing its strengths and weaknesses
- conclusion
  - compilation of results and future aspects such as open questions or plans for further development

(Hevner & Chatterjee 2010, p. 27), (Oates 2006, p. 111f)

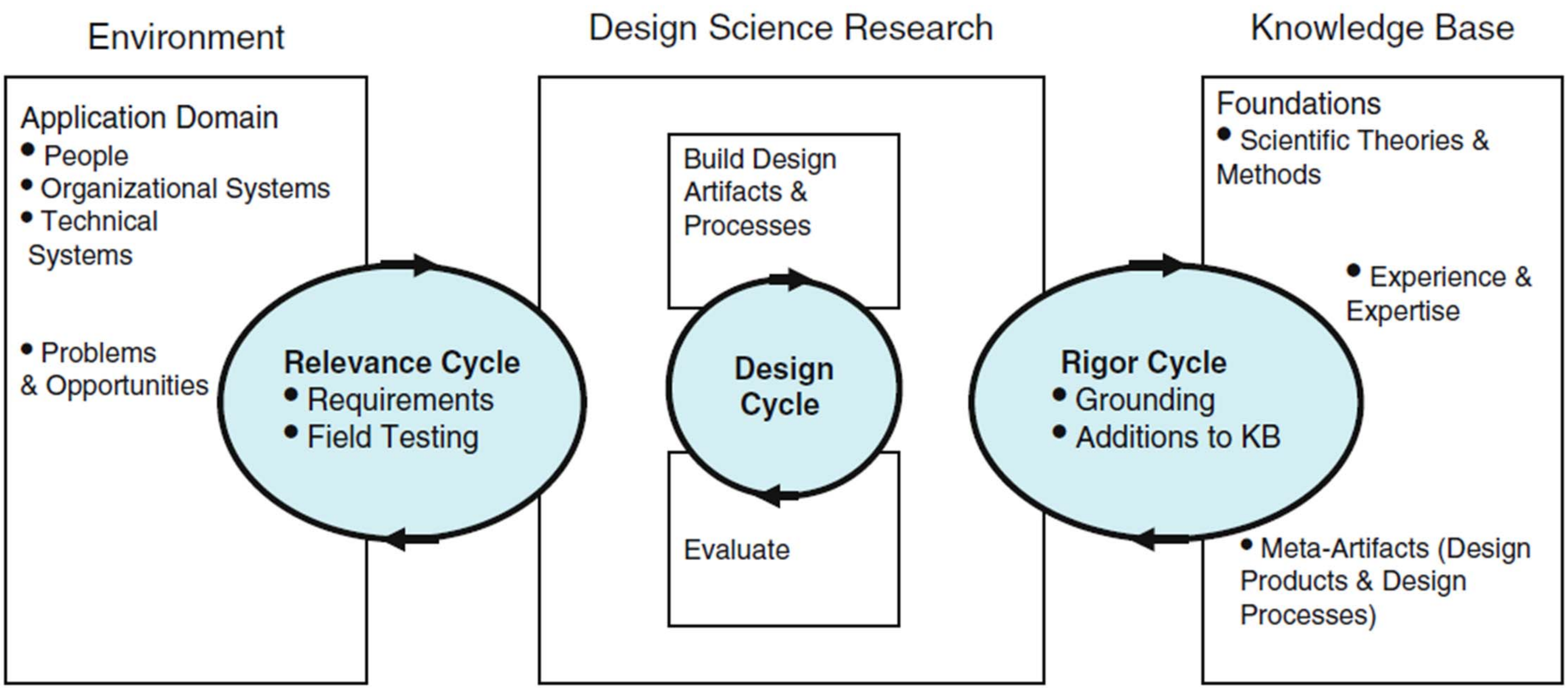
Novelty and usefulness of an artifact

When does an artifact constitute research?

- it must be sufficiently new - with respect to knowledge base
  - thus, it must sufficiently differ from existing artifacts
  - this can be proven by a careful literature review
- it must be sufficiently useful and relevant
  - others must be convinced of its usefulness, e.g.
    - by comparing it with existing artifacts used for the same or a similar purpose
    - by benchmarking it (see below)
    - by demonstrating its benefits in a real-life setting

adapted from Thomas Hanne

Design Science Research Cycle



Relevance and Rigor Cycle refer to usefulness and novelty

(Hevner & Chatterjee 2010, p. 16)

Research with a focus on artifacts

Types of research with a main focus on the developed artifacts

- artifact is something fundamentally new
  - e.g. a new computer language, a new modeling concept, a new method
- artifacts are used for an application in a new domain
  - e.g. an information system used in a new field
- artifacts demonstrate a novel application of a theory
  - e.g. a learning theory is demonstrated, analyzed, or supported by an e-learning package
- (artifact is a work of art)

adapted from Thomas Hanne

Research with a focus on artifacts (2)

Examples of artifacts in research

- the 97th e-business suite or the 317th enterprise resource planning system do not constitute research unless
  - there is a completely new functionality integrated in that software
  - it is an instantiation of a new development technique, software architecture, process model, etc.
  - it is shown that the system leads to better results in some aspect than existing systems (e.g. speed of computation, quality of results, ease of use), i.e. an additional research method is applied (see below for benchmarking)

adapted from Thomas Hanne

Literature for Design Research

- A. R. Hevner & S. Chatterjee. 2010. *Design Research in Information Systems*. *Media*. New York Dordrecht Heidelberg London: Springer.
- M. Sounders, P. Lewis, A. Thornhill. 2009. Research methods for business students, 5th ed, Prentice Hall.

Further reading on designing and creating artifacts as a research methodology

- S. A. Carlsson: Towards an information system design framework: A critical realist perspective. Proceedings of the First International Conference on Design Science in Information Systems and Technology, 192-212, Claremont, 2006
  available at: http://wesrac.usc.edu/wired/bldg-7_file/6B_1.pdf
- S. A. Carlsson: Developing information system design knowledge: A critical realist perspective. The Electronic Journal of Business Research Methodology 3, 2, p. 93-102, 2005
  available at: http://www.ejbrm.com/vol3/v3-i2/v3-i2-art1-carlsson.pdf
- J. R. Venable: The role of theory and theorising in design science research. In: S. Chatterjee, A. Hevner (eds), First International Conference on Design Science Research in Information Systems and Technology, Claremont, 2006
  available at: http://ncl.cgu.edu/designconference/DESRIST%202006%20Proceedings/2A_1.pdf
- J. McKay, P. Marshall: A review of design science in information systems. In: Proceedings of the 16th Australasian Conference on Information Systems (ACIS 2005), Sidney, 2005.
  available at:
  http://www.utas.edu.au/infosys/publications/research/phil_research/A_Review_of_Design_Science_in_Information_Systems.pdf

Case Studies and Design Research - Problem

- By their nature, single case studies and design of instantiations do not meet our requirement of «generality» that we defined for research
- Possibilities for solving this problem
  - need to do multiple case studies for generalisable results
    - can be part of e.g. a survey study
  - identify characteristics that justify generalisations
  - validate artifacts in several enterprises during evaluation

Example: Success factors of Enterprise 2.0

- Context: Forum and Wiki software on the web has led to the emergence of tremendous knowledge bases, e.g. Wikipedia or Yahoo! Answers. Attempts to transfer these into companies have often been less successful.
- Research question: what are the critical factors that motivate employees to participate in the knowledge sharing process of a company?

- Question: Which strategy would you choose to answer this research question?

SELECTED TECHNIQUES

Interviews

- dialogue between people to obtain specific information
- Some advice:
  - make a plan for the information you want to elicit
  - get background information of the interviewees and their context
  - sometimes it's useful to send information to the interviewee in advance
  - schedule the interview (time, place, equipment)
  - make notes and/or record (audio, video) the interview
  - establish a convenient atmosphere, start with some small talk
  - ask open questions (why, what, how, …)
  - ask for examples/details
  - make sure you understand: rephrase what the interviewee said
  - postpone "critical" questions to a late phase of the interview

adapted from Thomas Hanne

Questionnaires

- structured form of predefined questions
- collects quantitative data from a number of individuals
  - statistical evaluation
  - detection of patterns, trends etc.
- Use cases:
  - survey studies (see above)
  - Experiments (support or reject hypotheses)
- can be used for objective or subjective (e.g. opinions) data

adapted from Thomas Hanne

Questionnaires – some advice

- Design of questions:
  - clear, unambiguous, as brief as possible
  - clear relation to research question/hypothesis (for the researcher!)
  - can be closed (yes/no, Likert scales) or open
  - questions should be logically ordered and/or grouped
- Self-administered vs. researcher-administered
  - self-administered usually through online surveys (e.g. surveymonkey)
  - researcher-administered:
    - pro: better control, more detailed information can be extracted, possibility to explain (ambiguous)questions
    - con: personal bias, time-consuming
- Should be pre-tested to detect flaws in design and estimate time required

adapted from Thomas Hanne

Benchmarking

- comparative analysis of objects (companies, services, processes, systems, algorithms, …)
  - in a real-life setting (e.g. by observations) or
  - in controlled environments (e.g. computer experiments)
- Usually comparison to a fixed reference value (=benchmark)
  - in some areas **benchmark problems (e.g. gold standards)** are provided, i.e. problem instances which can be used for evaluating the effectiveness and efficiency of a new type of method in a specific domain of application
  - a benchmark problem includes one ore several quality criteria with associated measures (of e.g. effectiveness or efficiency)
  - Example: TREC collections in information retrieval

adapted from Thomas Hanne

RESEARCH PROPOSALS

Research proposals – submission and presentation

- Submission of research proposals until April 9, 15:00 via Moodle
- presentation: prepare a *short and concise* presentation (5 mins.)

Proposal presentations

Topic id	Groups 10.04.2013	Topic id	Groups 17.04.2013
11	Mettler, Wyss, Zehnder	3	Ryter, Stauffer
18	Rüttimann, Kropf	20	Vinh, Schär Ohlhoff
19	Sutz, Schellenberg, Schlüter	25	Friedli, Studer
35	Dreher, Kauppinen, Häusler	26	Oboussier, Wong, Tilahun
		34	von Bergen, Frei, Boernert