Purpose, Research Question, Hypothesis, and Evaluating an Article

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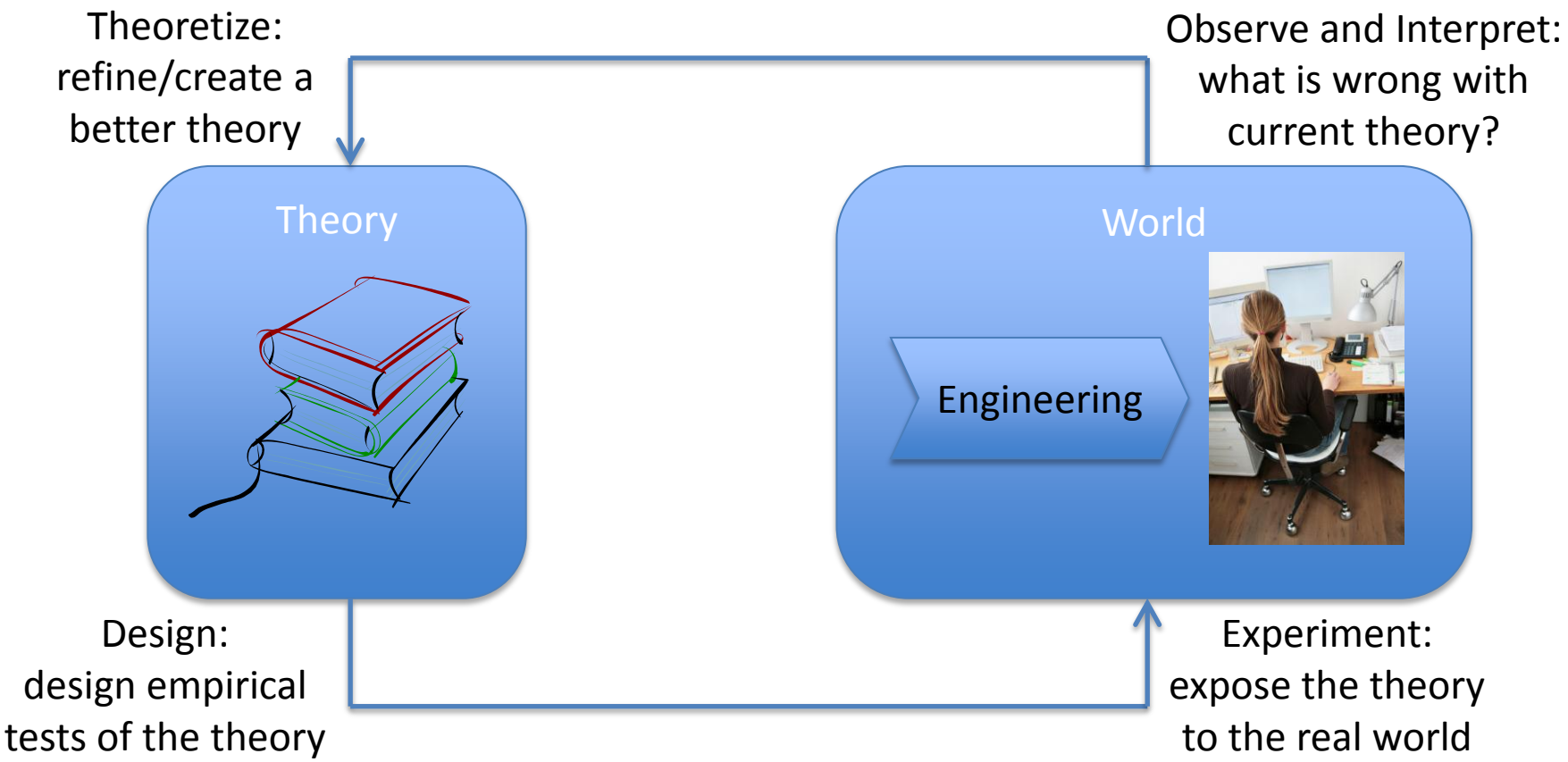
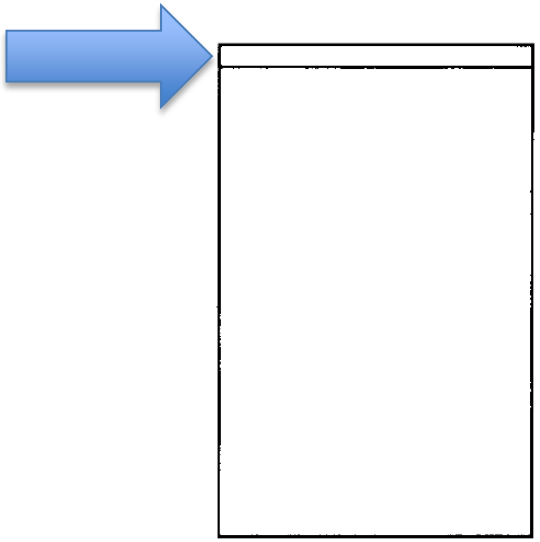
Research

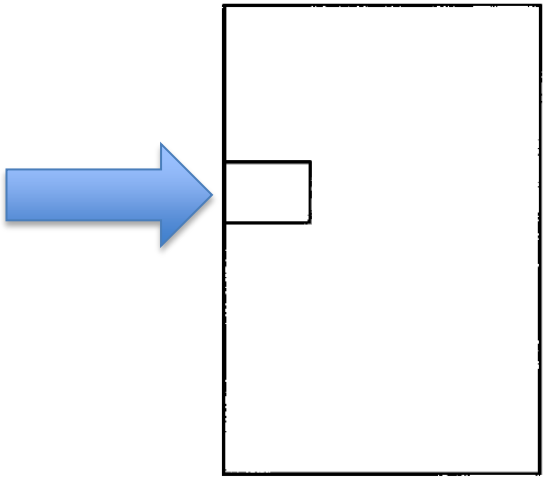

Theoretize:
refine/create a
better theory
Observe and Interpret:
what is wrong with
current theory?
Theory
World
Engineering
Design:
design empirical
tests of the theory
Experiment:
expose the theory
to the real world

Useful Research Contributions

- Add an increment to what we knew before



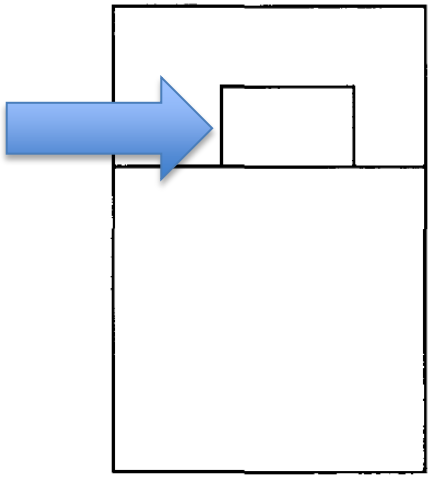
- Solve a so far unsatisfactorily solved problem



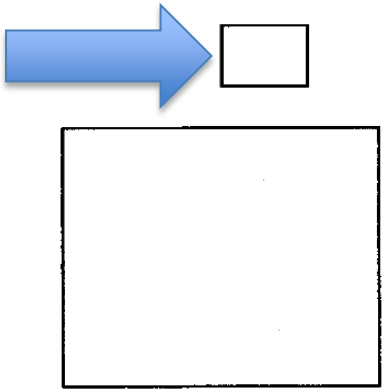
Deininger et al (2005): Studien-Arbeiten. vdf.

Useless Research

- Reinvention of the wheel, without adding novelty



- Castle in the air without a solid base



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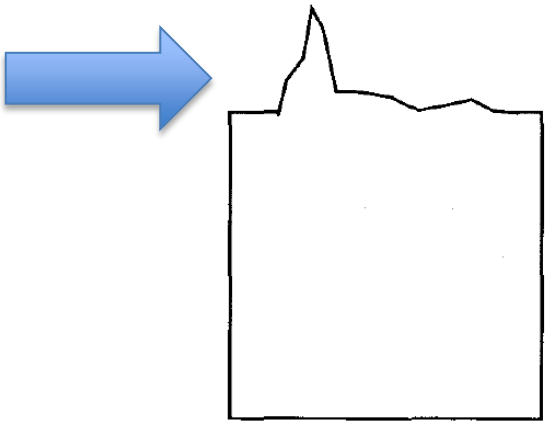
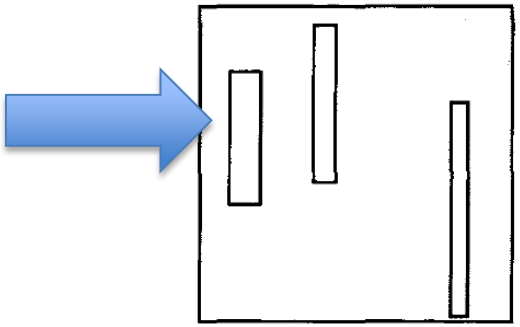
Useless Research

- Complication does not enable continuation of research



- Assembling solutions is not a contribution (here more is less)



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Contents

Understand

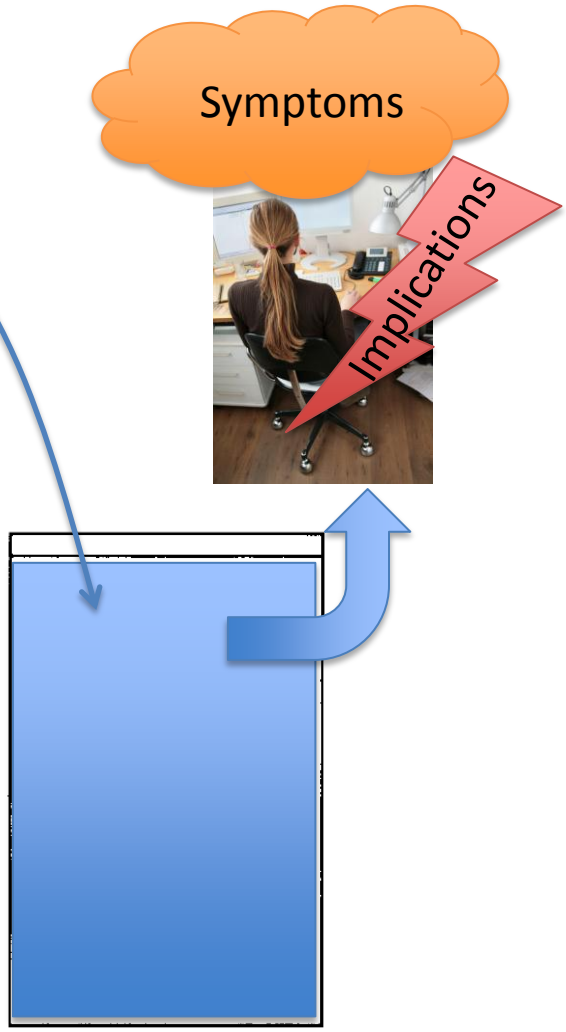
- How to formulate
  - Research problem,
  - Research objectives,
  - Research questions,
  - Hypotheses
- How to assess publications

Agenda

- Research Problem and Objectives
- Research Questions and Hypotheses
- Literature Quality Assessment

Problem Statement

- Roadmapping supports efficient development of long-lasting and evolving software solutions by supporting the coordination of product management, development, marketing, and other company functions. Roadmapping, though, is often decoupled from requirements management and the specification of the software products. This makes it difficult for practitioners to align software development with company strategy.
- The goal of this MSc thesis is to develop a software-supported approach for aligning product roadmaps with feature-based specifications of a software solution. The thesis shall identify approaches to automate this alignment, implement a software prototype, and validate the chosen approach in real-world software product management. The results of the thesis shall help practitioners to simplify the analysis of product evolution scenarios and facilitate decision-making in steering committees.



Research Objectives

- Roadmapping supports efficient development of long-lasting and evolving software solutions by supporting the coordination of product management, development, marketing, and other company functions. Roadmapping, though, is often decoupled from requirements management and the specification of the software products. This makes it difficult for practitioners to align software development with company strategy.
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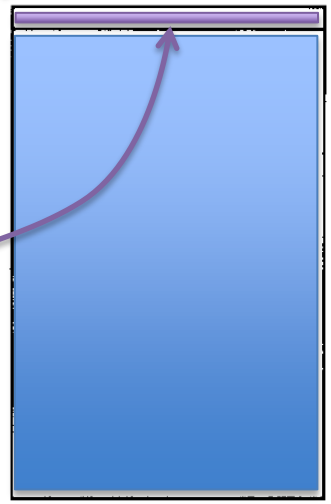


Problem and Objectives

Distinguish between these

- "The problem is XXX"
  - Example: decoupling of roadmapping from requirements management, which makes it difficult to align development with company strategy.
- "The objective of this study is YYY, [in the context of XXX]"
  - Example: identify approaches for software-based automated alignment that simplify analysis of product evolution scenarios
  - Keywords: "objective", "aim", "purpose", "intention", "goal"
  - Keywords: "discover", "identify", "evaluate", "explore", "compare", "analyse"

Other Examples of Objectives

- “The objective of this study is to...
  - evaluate the performance achieved by six java JIT-compilers concerning arithmetic expressions.”
  - elicit end-user viewpoints regarding the new calendar presentation, and analyse them for improvement suggestions.”
  - compare Requisite Pro with DOORS with respect to which tool that best fit our current requirements engineering practices.”
  - find measures to reduce energy usage in district heating by developing and using a simulation model.”

Importance of the Motivation

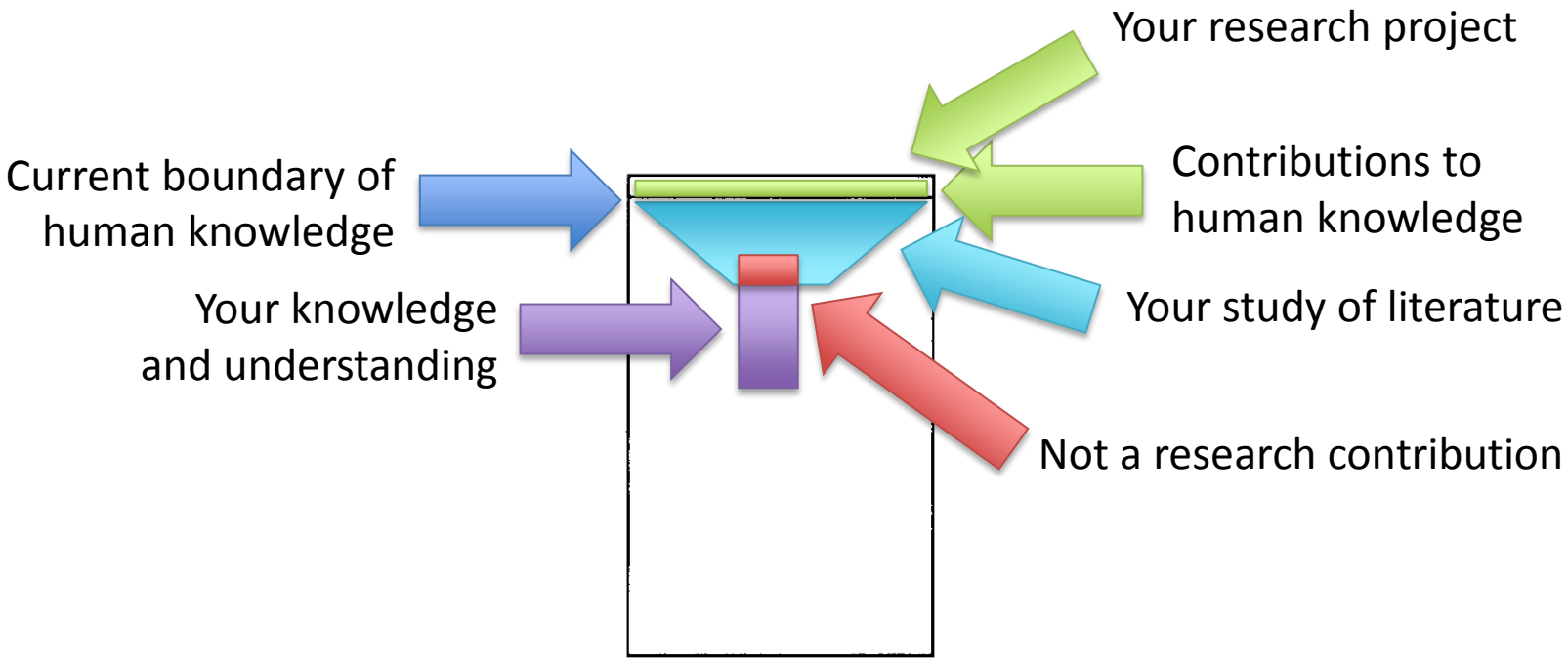
- Motivates the research
- Sets the stage
- Can limit the research methodologies we are able to use.

  The purpose of this study is to evaluate the use of Checklist-based Reading in the context of industry software development projects

  ... compare checklist-based reading with perspective-based reading ...

  ... identify the use of checklist-based reading ...

Your vs. Human Knowledge



partially based on Dawson: Projects in Computing and Information Systems.

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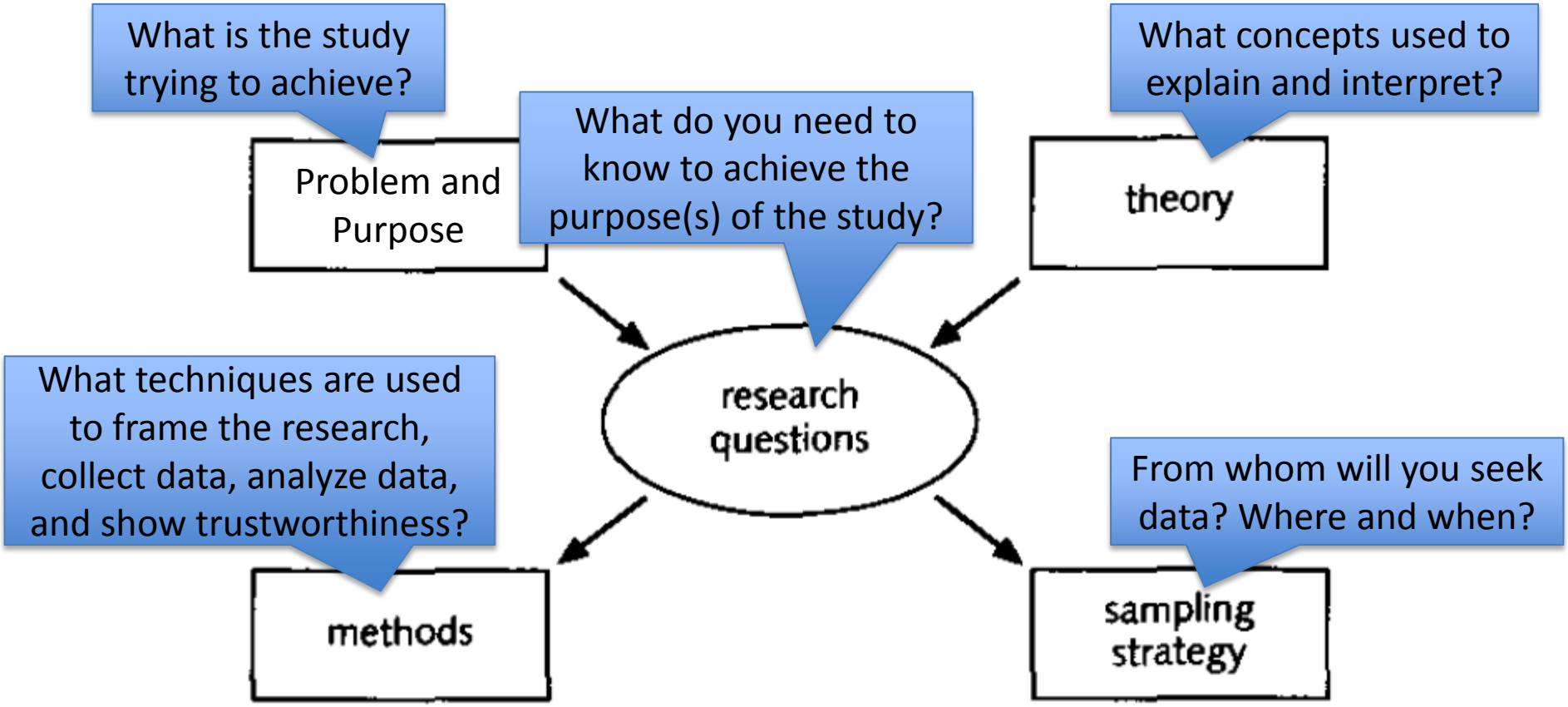
Research Proposal

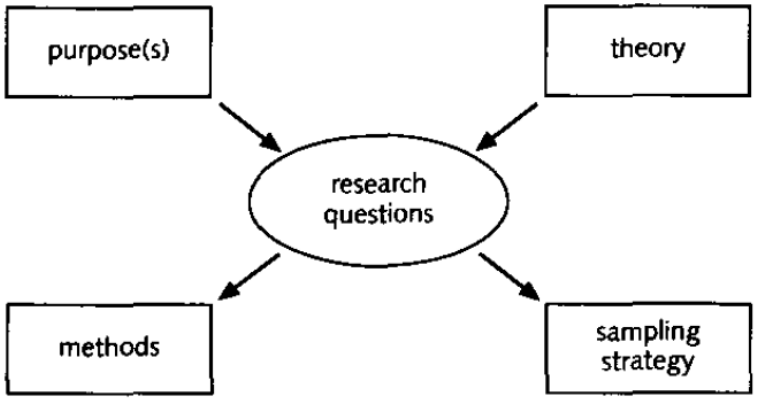


Robson (2002): Real World Research. Blackwell.

Posing Research Questions

- Planned research design
  - Research design fixed at study start
  - Necessary for quantitative studies
- Emerging research design
  - Research design stays at study end
  - Typical for qualitative studies
- Garbage can model of research design
  - Chaotic nature of first-time research

- Presentation of research: enable planning of replicating study



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Research Question

- In order to meet your purpose, what questions do you need answered?
- Guides your work
  - But you may also change the research question based on how the work progresses
- Answers to the research questions should **contribute** to the body of knowledge

Posing Research Questions

- One or several main questions
- A small number of sub-questions
- Not always possible (or necessary) to state
  - Example: Case Studies or mathematical theory
- Avoid
  - Letting available techniques steer you too much
  - Posing questions that cannot be answered
  - Asking questions that have already been answered
- The questions should be “answered” but not necessarily to full extent, e.g. the findings may only apply in some certain situations.

Research Questions: Examples

- Main Question
  - How can the performance of a container terminal (CT) be improved by using agent-based technologies?
- Sub-Questions
  - What is the state-of-the-art in research with respect to improving performance of container terminals and can this be classified into a framework?
  - How can agent-based modelling (MABS) be used to model the stakeholders in a container terminal environment?
  - In order to increase efficiency in a CT, how can agent based technologies be used to control the terminal operations?
  - How can MABS be used in evaluating CT management strategies for transhipment operations?
  - How can MABS be used to compare and evaluate two different types of automated guided vehicle systems?

Problem

Objective

Theory

Research Questions: Examples

- Given a set of requirements on quality attributes for a system and a set of architecture candidates, which architecture candidate is the most appropriate, i.e. fulfils the requirements on quality attributes on the system best?

- Is the perception of the strengths and weaknesses of different architecture candidates with respect to different quality attributes the same among a set of subjects?
- Are software architectures perceived as supporting different quality attributes differently?

Hypotheses

- Hypotheses: statements (predictions) based on literature or own experience that is to be verified or falsified in the project
- Use (typically in experimentation): often statistical analysis is used to verify or falsify hypothesis (logic reasoning could also be used)
- Dawson:
  - Either research question or hypothesis – not both.
- Svahnberg:
  - Sometimes it helps clarify what you are doing if you have both
  - Not always possible to have both
  - Not always possible to have hypotheses

Hypothesis Formulation

- Null hypothesis
  - There are no differences – differences are due to coincidence
  - H_0: $\mu_{old} = \mu_{new}$
  - Want to reject this
- Alternative Hypothesis
  - What you really want to prove in most cases
  - H_1: $\mu_{old} < \mu_{new}$

Hypotheses: Examples

- Null Hypothesis: There is no difference in productivity between computer science students and software engineering students
  H_0 : Prod(CS) = Prod(SE)
- Alternative hypothesis:
  H_1 : Prod (CS) ≠ Prod(SE)

Hypothesis Testing

- Type I error
  - Test indicates differences when there is no difference
  - P(type-I-error) = P(reject H_0 | H_0 true)
- Type II error:
  - Test indicates no difference, when there actually is a difference
  - P(type-II-error) = P(not reject H_0 | H_0 false)
- Power:
  - probability that the test reveals a difference (H_0 is false) if there is a difference
  - Power = P(reject H_0 | H_0 false) = 1-P(type-II-error)

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Assessing Literature Quality

- What is research?
  (Another view of Lecture 1)

- Published in Scientific Journals
  - Decided by reviewers (researchers).
  - Peer reviewing.
- Thus: no objective definition of research

Importance of Evaluating Research

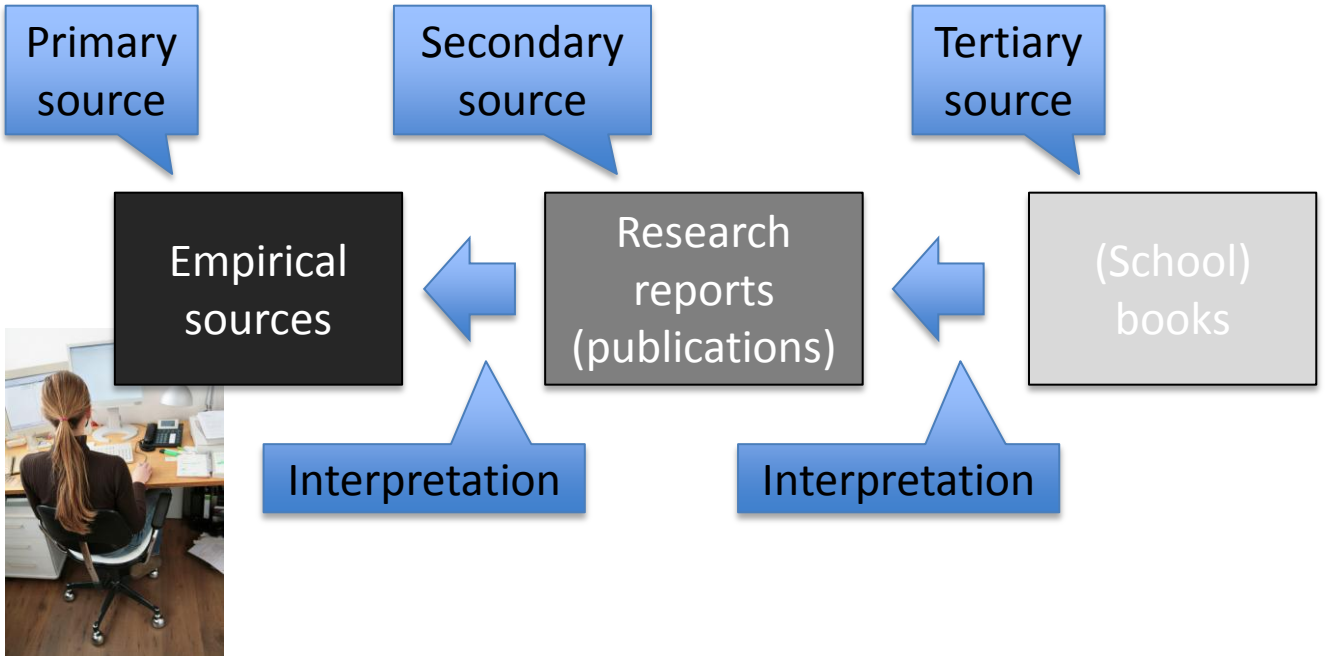
- Your research is based on other referenced work.
  - If that work is bad – your work is likely to be (regarded as) bad.
- Critical reviewing and thinking is fundamental for research
- Ability to assess other researchers work helps you to assess the quality of your own work.

Assessing the Quality of Research Publications

- Indirectly
  - Type of Publication (is it peer reviewed?)
  - Check references in publication (Have they done their homework?)
  - Check references *to* the publication (Are other people using this as a source?)
- Directly
  - Read the paper
  - Is the publication applicable to your work?
  - Does it make sense?

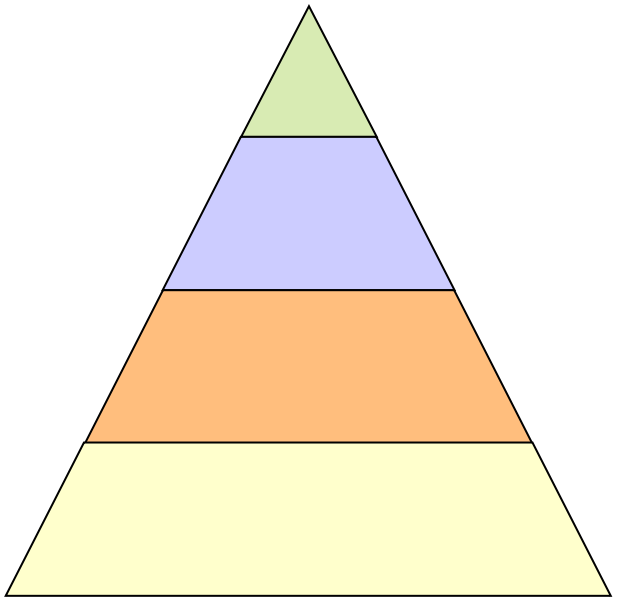
Closeness to „Truth“

- Primary, Secondary, and Tertiary Material



Publications Hierarchy

- Prestige Pyramid



Award-winning Publications

Journal Publications

Conference Publications

Workshop Publications

Journals and Proceedings

- Academic Journals
  - Standardised Peer Review Process
  - Who is the publisher? (May have other relevant journals)
  - Detailed and Specific (might be tough when new to an area)
  - Rather recent results available
- Conference Proceedings
  - Quality varies between conferences
    - Check acceptance ratio
  - No standardised way of reviewing
    - Established conferences have good quality
  - Typically very recent work
- Workshops
  - Unfinished ideas, as well as research results.
  - May have a reviewing process in place
  - Some workshops are well established and rank higher than conferences – check for references to the workshop

Books and Theses

- Books
  - Often comprehensive
  - Might be outdated
  - Less standardised reviewing
  - Are there references to the book?
- Theses (dissertations)
  - In some way reviewed
  - Varies in Quality
  - Often a good starting point for research in a new area

Other Sources

- Manuals (of software)
  - Often not (scientifically) reviewed. May contain many errors.
- Others (company reports, RFCs, white papers, newspaper articles, etc.)
  - Purpose is to sell – not to critically review.
- Wikipedia
  - Purpose is to spread ideas – not to critically review.

Peer Reviewing for (most) Research Journals

- Anyone can submit an article/paper to a research journal (or conference or workshop).
- Each journal has a specification of what types of research papers it is intended for.
- A chief editor or an editorial board decides whether to accept the papers for publication or not.
- To assist the board they “employ” a number of referees (normally 2-3) for each submitted article.

Peer Reviewing for Journals

- Referees are typically “known names”, and/or previously published in the journal.
- Referees are anonymous!
  - Sometimes the authors are anonymous too.
- Referees give detailed comments and recommendation of acceptance or rejection
- It can be regarded as a form of voting system on what is high quality research
- Potentially problematic for new areas of research and interdisciplinary research?
- What if you catch the referee on a bad day?

Reviewers: Assessing the Quality

- Clearly stated purpose?
- Appropriate for the journal?
- Significant/useful goal?
  - Relevancy
- Valid method / approach?
- Correct execution of approach?
- Correct conclusions?
- Presentation (understandable)?
- Anything to learn for the reader?
- Other Instructions from Journal

A.J. Smith: The Task of the Referee.

Example: Instructions to Referee

- Review Criteria
  - Originality
  - Structure
    - Title and Abstract
    - Introduction
    - Method
    - Results
    - Conclusion/Discussion
  - Language
  - Previous Research
  - Ethical Issues: Plagiarism, Fraud

IST Reviewer Guidelines, http://www.elsevier.com/wps/find/reviewershome.reviewers/reviewersguidelines.

Using a Publication I

- Assess Quality
  - Be your own referee

- From above (J.S. Smith):
  - Purpose
  - Appropriateness
  - Significant goal
  - Valid method / approach
  - correct execution of approach
  - correct conclusions
  - presentation
  - anything to learn for the reader

Using a Publication II

- Assess Relevance

- What kind of article?
  - review, theoretical, case study, experiment etc.
- What can you gain?
  - ideas, techniques, etc.
- What is the contribution?
  - Can it support your work?
- Does it fit within the context?
  - Context of itself and your work
- Are the conclusions supported by logic reasoning, the results, and the discussion?

Using a Publication III

- Assess Degree of Validity

- Are there contradictions with the work of others (in method and/or conclusions)?
- Can you distinguish opinions from facts?
- Do you agree? Does it make sense?
- What references are used?
- Can you use the results, methods, ideas, etc. in your research?

Using a Publication IV

- Assess Implications

- Does it motivate your work by pointing out where further research is needed?
- Does it contain interesting shortcomings or problems that you can “fix” in your project?
- How does it present research questions and hypotheses? Can you learn from that?
- Are there techniques that you can use?
  - Algorithms, statistical analysis, etc.

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