Evaluation – The Crucial Part of Research (and Your Ph.D. Dissertation, too)

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What Is Research about?

• Answering questions that nobody has already answered satisfactorily
  – Note: “satisfactorily” allows for new interpretations

• Solving problems that nobody has already solved satisfactorily
  – Note: “satisfactorily” allows for improvements

Not All Answers/Solutions Are Equal

• How do you know that your answer/solution is “better” than the alternatives?

Evaluation

• “systematic determination of merit, worth, and significance of something or someone using criteria against a set of standards”

• Related terms (special cases): testing, verification, validation, ....

Evaluation Methods/Techniques

• There are many

• They differ across disciplines and even sub-disciplines

• Appropriateness also depends on the purpose of the research
  – E.g., the need for “crush test dummies” to evaluate safety
How Will You Know Which to Use?

- Discuss with your supervisors (!!!) and other researchers in your sub-discipline
- Read peer-reviewed papers and successful Ph.D. dissertations in your sub-discipline

Some Examples of Evaluation Criteria

- Correctness
- Feasibility
- Usefulness
- Performance
- Overhead

Some Examples of Evaluation Methods

- Correctness: math. proofs, formal methods
- Feasibility: prototypes/demonstrators
- Usefulness: examples, case studies, surveys
- Performance: mathematical models, simulations, measurements (e.g., experiments)
- Overhead: calculations, measurements

Combination of Evaluation Methods

- All evaluation methods have strengths/advantages and weaknesses/disadvantages
  - E.g., math is only an abstraction of reality and its assumptions might disregard something relevant in practice
- Combination can give a more precise picture

Not Only Evaluation of Research Results

- You could/should also evaluate research methodology and used evaluation methods
  - E.g., evaluation of appropriateness
- Evaluation is about critical thinking

When Should You Do the Evaluation?

- Think about evaluation early – during research design
  - A “great idea” that you cannot evaluate (in available time) is not a good research topic!
- Have evaluation checkpoints/milestones throughout the research process
  - The “analysis – synthesis – evaluation” loop
  - Evaluation could require significant time!
Good Researchers Are Honest!

- Clearly state both benefits/advantages and limitations/disadvantages of your answers/solutions
  - “Evaluation” has broader meaning than “validation”
- Your research does not have to be “perfect” to be good research

What If Your Results Are Not “Better”?

- Do not fit the result data to your hypotheses!
- Check and recheck your research methodology and procedures
- If no errors, you might have come across useful new insights (contribution to knowledge)

Evaluation in Ph.D. Research

- Ph.D. is awarded for an …
  - original significant contribution to knowledge

How To Argue Originality?

- Primarily through literature search/analysis
- academic literature
- patent databases
- documentation of commercial products
- other literature (e.g., on the Web)
- Expert testimonies might also be useful
- You do evaluation of the past achievements

How to Argue Significance?

- Illustrative examples
- Quotes from literature and experts
- Market analysis
- Usually, research is not about a singular question/problem, but a class of questions/problems with broader applicability
- Not evaluating different aspects of the answer/solution can lead to insignificant research

How To Argue Contribution to Knowledge?

- The hardest to argue
- What is known after your research that was not known before it?
  - Knowledge that other people can apply/use
- You need thorough evaluation of your research results (and research methodology)
Conclusions

• You have to critically evaluate your research
• Think about evaluation early in your research and practice it throughout
• Be honest! This will get your career further