Some Discussion on Computer Science Research

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Acknowledgements

These slides are created from these reference books and reports,

📄 J. Zobel, *Writing for computer science.*
Springer, 3rd ed., 2015.

📄 W. C. Booth, G. G. Colomb, G. G. Colomb, J. M. Williams, and J. M. Williams, *The craft of research.*
University of Chicago press, 3rd ed., 2007.

📄 B. Gastel and R. A. Day, *How to write and publish a scientific paper.*
ABC-CLIO, 2016.

📄 D. Patterson, L. Snyder, and J. Ullman, "Evaluating computer scientists and engineers for promotion and tenure," 1999.

Perspectives of Research Process

▶ Research process leads to papers and theses;
▶ Research process leads to impact on the society

Shaping a Research

Zobel [1] indicates broadly steps involved in a research as follows,

1. Formation of a precise question, the answer to which will satisfy the aim of the research.
2. Development of a detailed understanding, through reading and critical analysis of scientific literature and other resources.
3. Gathering of evidence that relates to the question, through experiment, analysis, or theory. These are intended to supportor disprovethe hypothesis underlying the question.
4. Linking of the question and evidence with an argument, that is, a chain of reasoning.
5. Description of the work in a publication.

Shaping a Research

Booth et al. [2] postulate the following,

- ▶ From an interest to a topic
- ▶ From a broad topic to a focused one
- ▶ From a focused topic to questions
- ▶ From questions to a problem
- ▶ From problems to source

Structure of the Field of Computer Science and Engineering

- ▶ Computation is synthetic.
  - ▶ Different from natural sciences, such as, biology and physics
  - ▶ We create and study artifacts – must show the artifacts are "better"
- ▶ Two paradigms: theory and experimentation
  - ▶ Theory: Similar to mathematics of an abstract phenomena
  - ▶ Experimentation: Property of artifacts

"Better" Property

Examples:

- ▶ "solves a problem in less time"
- ▶ "solves a larger class of problems"
- ▶ "is more efficient of resources"
- ▶ "is more expressive by some criterion"
- ▶ "is more visually appealing in the case of graphics"
- ▶ "presents a totally new capability"

What Makes it Better?

- ▶ The "better" property is not simply an observation
- ▶ More about postulating that a new idea that something fundamental leads to the better result
- ▶ Examples
    - ▶ Data structure, algorithm, language, mechanism, process, representation, protocol, methodology, optimization or simplification, and model

One Research and Many Topics

A research may be examined from many different angles and can have many different topics, e.g.,

- ▶ Statistical. Identify properties ofWeb pages that are useful in determining whether they are good answers to queries.
- ▶ Mathematical. Prove that the efficiency of index construction has reached a lower bound in terms of asymptotic cost.
- ▶ Analytical. Quantify bottlenecks in query processing, and relate them to properties of computers and networks.
- ▶ Algorithmic. Develop and demonstrate the benefit of a new index structure.
- ▶ Representational. Propose and evaluate a formal language for capturing properties of image, video, or audio to be used in search.
- ▶ Behavioural. Quantify the effect on searchers of varying the interface.
- ▶ Social. Link changes in search technology to changes in queries and user demographics.

Critical Reading

Zobel [1]
suggests to ask critical questions (when carefully reading a paper),

- ▶ Is there a contribution? Is it significant?
- ▶ Is the contribution of interest?
- ▶ Are the results correct?
- ▶ Is the appropriate literature discussed?
- ▶ Does the methodology actually answer the initial question?
- ▶ Are the proposals and results critically analyzed?
- ▶ Are appropriate conclusions drawn from the results, or are there other possible interpretations?
- ▶ Are all the technical details correct? Are they sensible?
- ▶ Could the results be verified?
- ▶ Are there any serious ambiguities or inconsistencies?

Literature Review

- ▶ Develop it progressively.
- ▶ Group papers by topics and contributions.
- ▶ Add notes indicating how the papers related to each other.
- ▶ summarize each papers contribution and the evidence used to support the claims.
- ▶ Note any shortcomings or features that are of interest.
- ▶ Document your insight, such as, how the work might have been done better