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Research Methodology
Contribution and Result

Lecture, 21. September 2007

Structure of Paper

- Title: "Catchy summary of paper content"
- Abstract: "Why should you read our paper"
- Introduction: "What we will tell you"
- **Contribution (Main Part): "What we did"**
  - **Hypothesis, method, evaluation, results**
- Related Work: "The context and why new"
- Conclusion: "What we told you"
  - Somtimes also: Discussion, future work
- References: "Where to find context, etc"

Purpose of Main Part

- Describe your contribution (duh!)
- But, wait, there is more:
  - Background information
  - Describing underpinnings of contribution
  - Describing contribution (finally!)
  - Evaluating contribution
  - Convincing reader contribution is good

Background information

- Primary purpose
  - Define problem in question
  - Identify focus of your work
  - Identify objective of your work
- Depth and level depends on audience
  - General audience requires more
  - Expert audience requires less

Underpinnings

- Hypothesis to be examined
  - "Expect algorithms using recursion to do better on small problems"
- Formalism and definitions
  - Material needed to understand contribution
  - Use, when possible, standard definitions
- Insights
  - What is behind your contribution

Organization of main section

- Technical background
- Development of contribution
  - Usually in sections
  - Clear indication of contribution
  - Anticipatory answers to questions
- Supporting data and results

Anticipating questions

- Made-up paragraph
  - If all elements in array A are unique, then the foobarsort takes time O(n log n) to order the array.
- Expected question:
  - Why do the elements need to be unique?
- Added remark:
  - Note that if there are O(n) copies of the same element, then foobarsort takes $O(n^2)$ to identify they are all the same, thus taking $O(n^2)$ time.

Organization is key

- As noted before:
  - "The preparation of a scientific paper has almost nothing to do with literary skill. It is a question of **organization**."
- Organize material logically
  - Big things: Keep a logical flow
  - Small things: Introduce terms and acronyms before using them

Traditional presentation

- Use of tense
  - Active “I” or “We” to present own results
  - Passive “has been done” for other work
  - Alternatively, “Jonsson showed that…”
- Baseline
  - Problem definition
  - New method
  - Statistical or theoretical results

Many types of papers

- **Primary paper types**
  - **Theoretical contribution**
  - **Experimentally proven contribution**
- Other types
  - Interesting idea contribution
  - Summary of existing work
  - Challenge paper

Lots of good material, but

- Much of science is “simpler” than CS
  - Specify problem
  - Specify mechanism of study
  - Specify methods or procedures
  - Describe results
  - Draw conclusions
- CS is sometimes a bit more complex

Experimental CS main section

- Definition of problem (often formal)
- Definition of algorithm or approach
- Implementation of approach
- Experimental results on data
- Discussion of results

- Example paper: Hoffmann & Nebel

Theoretical CS main section

- Definition of formal problem
- Definition of new structures (maybe)
- Techniques for working with structure
- Theoretical results about structure
- Discussion of results (sometimes)

- Example paper: Aceto et.al

Interesting idea in CS

- Discussion of an issue
- Proposal of new approach
- Non-formal evaluation of appraoch
- Typically not in primary publications
  - But very appropriate in workshops etc.

- Example paper: Joslin et.al

Summary paper in CS

- Specification of problem class
- Overview of work done
- Introduction of structure to tie together
- Mapping of earlier work to structure
- Conclusions about earlier work

- Example paper: Smith et.al

Challenge paper in CS

- Overview of problem (often informal)
- Overview of existing work
- New problem or problem class
- Discussion of existing work failing

- Example paper: Smith

Source of experimental data

- Good sources
  - Real-life data, e.g., DNA data
  - Realistic simulation data, e.g., networking
- Trickier sources
  - Randomly generated data
  - Specifically set up data
- An example of a data problem
  - Randomly generated SAT problems
  - Turn out to be very easy on average

Presenting experimental results

- Starting points
  - What results do we have
  - What do we believe the are saying
- Objective
  - Present results so others understand
  - Make sure others take from them what we intend to say

Presenting experimental results

- Common methods
  - Graphs of various kinds
  - Tables with data
- Common problems
  - Misusing graphs for “non-scalar” x-axis
  - Unlabelled or mislabeled axes
  - Incorrect implications of “comparables”

Interesting links

- Writer's handbook
  - http://www.wisc.edu/writing/Handbook/ScienceReport.html