How to Write a Good Paper?

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Outline

- Introduction: The form and the contents
- Contents of a paper
  - The core content: What is research?
  - Structuring the core content for accessibility
- Detailed structure of a paper
- Elements of writing
- Conclusions
Focus of This Talk

- Significant distinction between
  - How to write a good paper?
  - How does a good paper look like?
- Process of writing Vs. Product of writing
Focus of This Talk

- Significant distinction between
  - How to write a good paper?
  - How does a good paper look like?
- Process of writing Vs. Product of writing
- We focus on the product rather than focus
- Assumptions:
  - Process is goal oriented. Once goals are clear, process is clear
  - Repeat: Write, read, review, refine, revise . . .
Part 1

Core Contents of a Research Paper
What is a Research Paper?

Does a research paper describe

- A software?
- Design of a software?
- A piece of hardware?
- A theorem?
- A proof?
- Empirical measurements?
- …
What is a Research Paper?

Does a research paper describe

- A software?
- Design of a software?
- A piece of hardware?
- A theorem?
- A proof?
- Empirical measurements?
- ...

A research paper describes an idea!
What is a Research Paper?

- Cannot be a complete description of work (process/product/modelling/reasoning/postulate/evidence)
  Must omit many details

- Should describe a logically complete idea
  Or a collection of logically complete related ideas

- Must embody a running theme that forms the essence of an idea

- This theme must be explicated in the paper
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Right choice of form and content is important
What is Research Paper?

Net information content of your paper

$$\Delta = \text{Information in your paper} - \text{Relevant Information in references}$$
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| \[ \Delta > 0 \] |  
| \[ \Delta = 0 \] |  
| \[ \Delta < 0 \] |  

Uday Khedker

IIT Bombay
What is Research Paper?

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| \( \Delta > 0 \) | Your paper makes research contributions |
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Ingredients of Good Research

- Innovation
Ingredients of Good Research

- Innovation
- Aesthetics
Ingredients of Good Research

• Innovation

• Aesthetics

• Other important aspects:
  ▶ Completeness
  ▶ Rigour
  ▶ Empirical demonstration
  ▶ Effective communication
Ingredients of Good Survey

- Have you identified all key ideas?
Ingredients of Good Survey

- Have you identified all key ideas?
- Have you distilled the essence of key ideas?
  - Why are they important?
  - Why should they be considered key ideas?
Ingredients of Good Survey

- Have you identified all key ideas?
- Have you distilled the essence of key ideas?
  - Why are they important?
  - Why should they be considered key ideas?
- Have you illustrated key ideas?
  - New examples
  - New pictures
  - New applications
  - Better explanations
Aesthetics

- Total is greater than the sum of the parts

“Scientists study science not because it is useful, but because it is beautiful. Here I do not talk about the beauty of appearance or beauty of qualities . . . Here I talk about that profound beauty which comes from a harmonious order of parts . . .”

– Henry Poincare.

- Example: Painting.
  Proportion of colours Vs. their arrangements
Part 2

Structuring the Core Contents for Accessibility
Intuition and Rigour in a Paper

- Ideas should be presented at two levels:
  - Intuition
    - Distilling the idea to its essence
    - Emphasizing the most important aspects (ignoring some details)
    - Using representative examples (even if all aspects are not illustrated)
  - Rigour
    - Plugging all the holes through formalism or reasoning
    - Presenting convincing empirical evidence
- Description of ideas at these two levels should be interleaved
Presenting Evolution of Ideas

• Evolution in discovery is different from evolution in presentation
• Evolution in presentation
  ▶ Perspective
  ▶ Problem Definition
  ▶ Key Ideas
  ▶ Key contributions
  ▶ Development of the key ideas
  ▶ Conclusions
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    Basis of the hope of a solution, Approach of the solution,
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    You have succeeded if readers reach here!
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    - Your claim to fame
  - **Development of the key ideas**
    - You have succeeded if readers reach here!
  - **Conclusions**
    - Honest analysis of work done, The Moral of the story
Part 3

The Structure of a Paper
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- Title
- Abstract
- Introduction, Motivation
- Background, Related work
- Main Contents
- Results, Conclusions
- Future Work
- References
How to Write a Good Title?

- Should be precise and inviting
How to Write a Good Title?

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• Examples of bad titles
  ▶ A Software
  ▶ A theorem and its proof
  ▶ Wireless networks
  ▶ Partial redundancy elimination in presence of critical edges for practical imperative programs with recursion and large number of functions and calls through function pointers
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- Possible good titles
  - A software based control system for …
  - On XYZ theorem
  - Reducing congestion in wireless networks
  - Partial redundancy elimination in extreme situations
How to Write a Good Abstract

- Should be a succinct and stand alone description
  - Reading the rest of the paper should not be necessary to get the gist
  - Self-containment only at a high level of description
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• A checklist: Motivation, problem statement, approach, results, conclusions
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- An abstract is neither a summary nor an outline of the paper
- A checklist: Motivation, problem statement, approach, results, conclusions
- Common mistakes
  - Too verbose
  - Too long
  - Too short
  - Omitting essential details
“We worked in Computer Science. We proved some theorems. Some were big, some were small. Big theorems had big proof, small theorems had small proofs. We tried to connect the proofs to the theorems. Sometimes we succeeded, sometimes we didn’t. By then, the time for submission had arrived, so we submitted the paper . . .”

M. Leunen and R. Lipton. “How to Have Your Abstract Rejected”. 
How to Write a Good Introduction?

What does a good introduction contain?
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What does a good introduction contain?

- More details of motivation and problem statement
  - From general to specific
  - Supported by concrete examples, puzzles, mysteries,
  - Contextualizing the problem
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- Importance of the problem
  - Significance of the outcome,
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Why would simple approaches not work?
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- Overview of proposed approach
  - A sketch of main proof, algorithm, key idea
  - Novelty of the proposed approach
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  Why would simple approaches not work?
- Overview of proposed approach
  - A sketch of main proof, algorithm, key idea
  - Novelty of the proposed approach
- Outline of the paper
How to Write a Good Introduction?

Why is a good introduction important?

• First chance of making first impression
  Writing style, overall quality, analytical skills, confidence in ideas
How to Write a Good Introduction?

Why is a good introduction important?

- First chance of making first impression
  Writing style, overall quality, analytical skills, confidence in ideas
- Last chance of making the reader want to read your paper in details
How to Describe Background and Related Work?

- Not just *what?* but also *why?, why not?, how?, how else?* etc.
  - Not just a list of summaries
  - Analysis, comparison, strengths, limitations
- Organized by ideas rather than by references
Important questions are answered

- Questions: Problem, Theorem, ...
- Answers: Algorithm/Protocol/Formulation, Proof, Counter example ...
- Type of contribution: Beauty, utility, or both
- Use formalism but don’t hide ideas behind notation
  Introduce notation, terminologies only where required
How to Write Conclusions?

- Not a just summary
How to Write Conclusions?

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- Different from abstract and introduction
How to Write Conclusions?

- Not a just summary
- Different from abstract and introduction
- Represents the moral of the story
  - A high level description of the significance of ideas, what they could further lead to
    - Last chance to highlight importance
  - Analysis of strength and limitations
  - What the readers should remember after they have forgotten the details
How to Write Conclusions?

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- Different from abstract and introduction
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  - What the readers should remember after they have forgotten the details
- Brings back the general level
  - Abstract $\rightarrow$ Introduction $\rightarrow$ Details: Journey from general to specific
  - Details $\rightarrow$ Conclusions: Return journey from specific to general
How to Write References?

• Reference or Bibliography?
  ▶ References: List of sources that you actually cite in your paper
  ▶ Bibliography: List of all related publications

• Each item in the list must have at least the following fields:
  Title, Author(s), Journal/Proceedings, Publisher, Year

• URLs don’t have a publication date, hence say when accessed it last

• Follow the style specified by the publisher
Part 4

Elements of Writing
Elements of Writing

- Be careful about the language: Grammar, sentence formations, spellings, punctuation etc.
- Each paragraph should represent a specific idea
- Smooth transition from
  - One paragraph to the next
  - One sentence to the next

Plenty of help available on Internet 😊
Writing a Good Sentence

• Write short sentences
Writing a Good Sentence

- Write short sentences
- Be precise

  “The problem stated above is difficult”
  Difficult for whom? NP-complete? Believed by you? Believed by others? Proved by someone?
Writing a Good Sentence

- Write short sentences
- Be precise
  - “The problem stated above is difficult”
    Difficult for whom? NP-complete? Believed by you? Believed by others? Proved by someone?
- Avoid unnecessary words in a sentence
  - “This is a subject which is liked by people”
    “This subject is liked by people”
  - “The logger program notes the fact that the event has happened”
    “The logger notes the event”
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  - “The logger program notes the fact that the event has happened”
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- Convert nouns to verbs
  - “His verticality changed to horizontality”
    “He fell down”
  - “This paragraph provides a conclusion of the description”
    “This paragraph concludes the description”
Part 5

Conclusions
Conclusions

Writing good papers is important for your research

- For your own understanding
- For communicating your ideas to others
- For getting feedback from others
Conclusions

On good writing

- Writing helps you understand your ideas better
- Write, read, revise. Repeat as long as you can
- Writing is a creative process and a big source of satisfaction
- Writing is an art
  - Rules are not absolute
    - Break rules if you must, but understand why it is necessary
- How to be a good writer? Read a lot
  - Best resource: “Elements of Style” by Strunk and White
  - Plenty of help available on Internet 😊
Acknowledgements

- Anonymous referees of our own papers
- Discussions with colleague
- Numerous tips available on Internet
- Talk by Abhiram Ranade
Last But Not the Least

Thank You!

Contacting me:

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- http://www.cse.iitb.ac.in/~uday