How to Read a Research Paper

Why read papers?

- So you know what's happening
- Avoid reinventing the wheel
  - does happen commonly, too many wheels already
- Find interesting research topics

Why bother ourselves?

- Journal papers are current
  - Textbooks are often years out of date.
- Journals are generally the most accessible means of obtaining the information that you need.
- You can get a good explanation for your data and enough details to replicate what you read about.
- To find out exactly what the latest developments are in a field.
- To find out how a certain piece of research was done.
- Because one day soon you could be writing papers too!

Why not to read papers?

- Cannot read everything
- Should not read everything
- Can suppress innovation
  - once you see solutions using a particular theme, often hard to think differently

Read or not to read, that is the question

- Read, of course
- Know what’s important
- Know what can be ignored without significant loss of information

What to read?

- Major conferences
  - Journals are a few years behind, but still can be useful
- Tech reports from active research groups
  - need to know which groups to look up
- Survey / overview papers
  - ACM Computing Surveys
  - CACM, IEEE Computer, Spectrum
  - more technical - IEEE Personal Communications, …
  - newsletters - ACM SIGCOMM, ACM SIGMOBILE, ...

Two Types of Scientific Papers Containing Two Types of Information

There are two types of scientific papers:

Review articles: give an overview of the scientific field or topic by summarizing the data and conclusions from many studies.

Primary research articles: contain the original data and conclusions of the researchers who were involved in the experiments and how the experiments were done.

Few easy ways to distinguish between Review & Primary research

1. Many reviews will be labeled as "review“ on the first page of the article.
2. Reviews don't have a "methods" section.
3. In a review article, graphs, tables, or figures containing actual data will contain citations in the figure legend to the primary research papers that originally reported the findings.

Research Papers

- Primary form in which research results are disseminated in computer science
- Conference papers (shorter)
- Journal papers (longer)
  - Often the complete version of a conference paper
  - May come out several years after the conference paper

What’s in a paper?

- Abstract
- Introduction
- Motivation
- Problem description
- Solution
- Performance Analysis
- Conclusions
- Future Work

How to read a paper?

Know why you want to read the paper

- To know what's going on (e.g., scanning proceedings)
  - title, authors, abstract
- Papers in your broad research area
  - introduction, motivation, solution description, summary, conclusions
  - sometimes reading more details useful, but not always
- Papers you may want to improve on
  - read entire paper carefully

What to note?

- Authors and research group
  - Need to know where to look for a paper on particular topic
- Theme of the solution
  - Should be able to go back to the paper if you need more info
- Approach to performance evaluation
- Note any shortcomings

Reading a Paper Critically

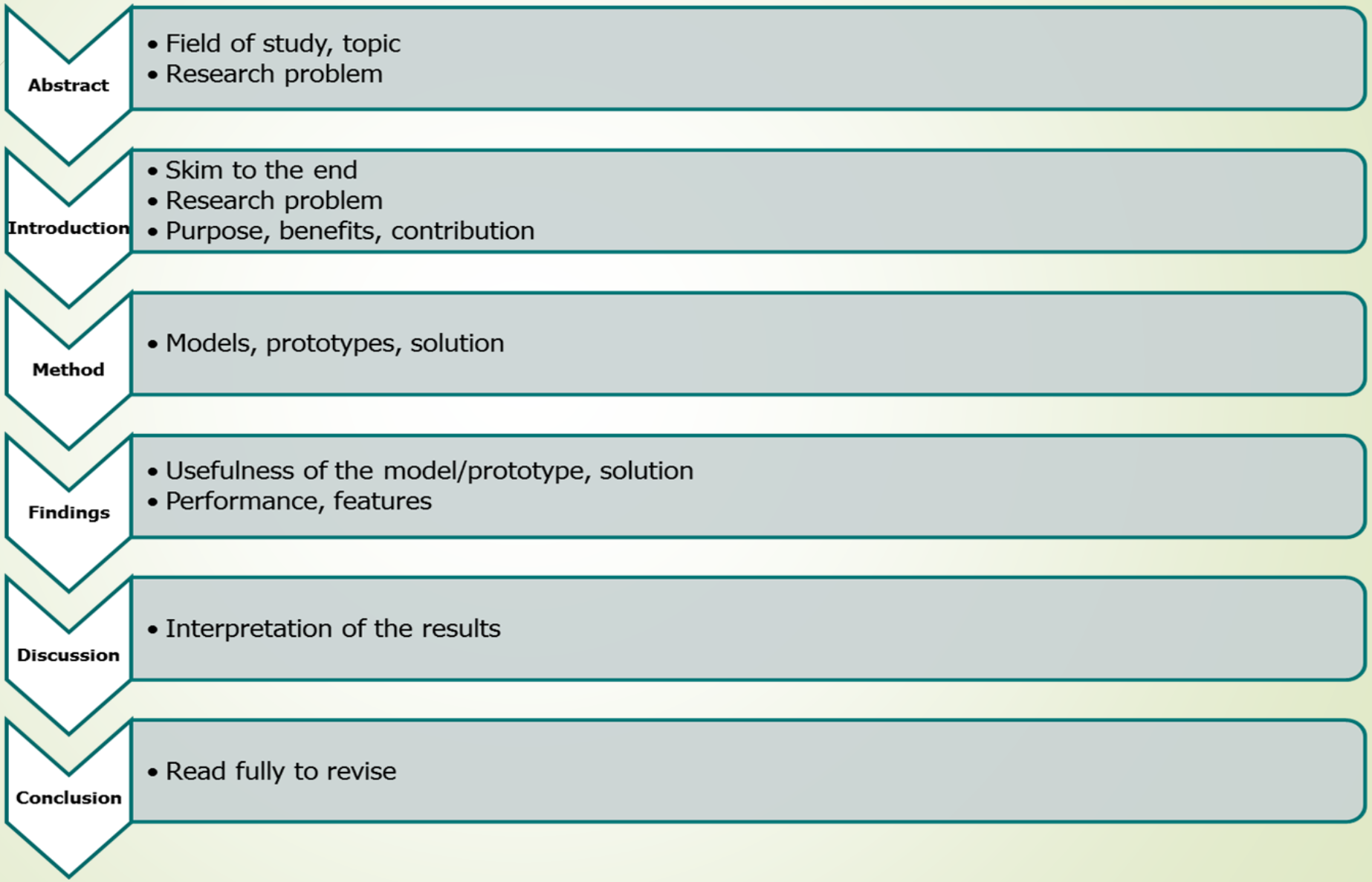
- Understand the problem
- Understand the proposed solution
- Understand competing approaches / designs
- Evaluate the paper

- Peer review is the cornerstone of the scientific publishing process

Why?

- Learn to do research
- Learn to think critically about quality of research papers
  - Someone will be thinking critically about your own work!
  - In any discipline, there are fads and there are lasting ideas… learn to tell the difference!
- Gain perspective
- Key issue: what are the questions to ask?

Anatomy of a Research Article



Evaluating a Paper

- What is the problem being solved?
  - Is it important? Relevant? Why?
  - What is the prior work in this area?
- Is the proposed solution clever?
  - Cleverness is orthogonal to importance!
- Are the assumptions and model reasonable?
- Impact
  - Easier to evaluate for older papers
  - Does other work build on it? Do other papers use techniques and solutions proposed in this paper?

Evaluation Process

- Read slowly, take notes as you read
  - Question assumptions, importance of the problem
  - Write questions to track what you don’t understand
- Sometimes what is not in the paper is more important than what is in it
  - Is there something the authors have overlooked?
- Don’t let ideas or design details pass until you understand them!
- Do not assume the paper is correct, even if published in a prestigious peer-reviewed venue

Title and authors

- Title is very descriptive (often states the main finding) and is not about being creative and “catchy”!
- Order of authors is important. What can you tell from it?

Computation on Stochastic Bit Streams Digital Image Processing Case Studies

Peng Li ; David J. Lilja ; Weikang Qian ; Kia Bazargan ; Marc D. Riedel

Abstract/Summary

- Brief background of subject
- Purpose for the study
- Major findings of the study
- Relationship between these findings and the field

- *This is what you see when you do a google search. You can decide if the paper is worth reading based upon this.*

Introduction

- Presents the background information for a fellow scientist (possibly in another field) to understand why the findings of this paper are significant.

- Structure is usually:

  - Accepted state of knowledge in the field
  - Focus on a particular aspect of the field, often the set(s) of data that led directly to the work of this paper
  - Hypothesis being tested
  - Conclusions (scientists don’t really like surprise endings!)

How to approach the introduction

- **Grab a blank piece of paper:**
  - Take notes
  - Draw mini figures
  - Define vocabulary

    (wikipedia is a quick reference)

- **Answer these questions:**
  - What is the accepted state of knowledge?
  - What data led directly to the work of this paper?
  - What is the hypothesis being tested?
  - What are the basic conclusions? (Scientists don’t really like surprise endings and this is usually stated in the last paragraph.)

Materials and Methods

- Should be detailed enough for another scientist to replicate the work (volumes, times, company material was purchased from etc.)
- In reality, often compressed and you may need to look up another paper that is referenced for more detail.

Should you read the materials and methods?

- Often you can skim over them before the results.
- However, when you get to the results, you will need to flip back to them often to clarify how experiment was done.
  - Sample number? (*Did they do this more than once?)*
  - Conditions?

Results

- While the introduction poses the questions being asked, the results describes the outcome of the experiments that were done to answer the questions.
- Results are often simply stated with *interpretation* of them coming later in the discussion.
- Figures and tables allow the reader to see the outcomes of the experiments for themselves!

How to read the results:

- Read the text straight through, but as a figure is referred to, examine the figure.
- Take notes, giving yourself a place to refer to about each figure.
- With each experiment/figure you should be able to explain :
  - **1) the basic procedure**
  - **2) the question it sought to answer**
  - **3) the results**
  - **4) the conclusion**
  - **5) criticisms**

Discussion

- Data is analyzed to show what the authors believe the data show. (You don’t have to agree with their interpretations!)
- Findings are related to other findings in the field (contribute to knowledge, correct errors, etc.)– How is this work significant?

How to read a discussion

Take notes and answer these questions:

- What conclusions do the authors draw? Be sure to separate fact from their opinion/interpretation?
- Describe for yourself why these data significant. (Does it contribute to knowledge or correct errors?)

Question: How should we READ a scientific paper?

- Step 1: Skim the entire paper
- Step 2:Vocabulary
- Step 3: Read for comprehension, section by section
- Step 4: Reflection and criticism

Step 4: Reflection and criticism

- Do you agree with the authors' rationale for setting up the experiments as they did?
- Did they perform the experiments appropriately? (Repeated a number of times, used correct control groups, used appropriate measurements etc)
- Were there enough experiments to support the one major finding they are claiming?
- Do you see patterns/trends in their data that are problems that were not mentioned?
- Do you agree with the authors' conclusions from these data? Are they over-generalized or too grand? Or are there other factors that they neglect that could have accounted for their data?
- What further questions do you have? What might you suggest they do next?

Template for Taking Notes on Research Articles

1. Complete Citation: Author(s), Date of Publication, Title, Journal, Volume, Issue, Pages
2. Key words
3. General subject
4. Specific subject
5. Hypothesis / Question
6. Methodology
7. Result(s)
8. Summary of Key Points
9. Context (how this article relates to other work in the field; how it ties in with key issues findings by others, including yourself)
10. Significance (to the field; in relation to your own work):
11. Important Figures and/or Tables (brief description; page number):