ISTE Workshop
Introduction to Research Methodologies

How to Read a Research Paper

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Video: http://www.it.iitb.ac.in/nmeict/eVideos/IRM_Main/content/content.html, Session 11.
What type of papers are we discussing?

- Research Papers (not textbook chapters, opinion pieces)
- Engineering/ scientific research papers
- Published engineering research papers
  - In peer-reviewed “established” journals, conferences
  - Part of edited book on a research topic

- General guidelines – not specific to but reasonably applicable to CS, EE, MechE, ChemE, Physics, Chemistry, …

- These guidelines may not apply to survey / review papers
Assumption – you are familiar with topic

Pre-requisite to reading a technical research paper:
You are “somewhat” familiar with the broad idea
Assumption – you are familiar with topic

Pre-requisite to reading a technical research paper:

You are “somewhat” familiar with the broad idea

Else

Better to first become somewhat familiar

Read a textbook for fundamental concepts

Take a course

Go through tutorials

Read a survey / review paper
Pre-Homework

Read research paper:
“Design and deployment of clickers in distance education”
Uploaded on Moodle.

Have print-out of paper – one for every two participants.
3+ stage approach to reading a research paper

Stage 0
Get a “feel”

Stage 1
Get the big picture

Stage 2
Get the details

Stage 3
Evaluate the details

Stage 3+
Synthesize the details

Stage 0: Get a “feel” for the paper

• Read the title

• See how long the paper is (2 to 40+)
  – Conference research papers typically 4-8 pages
  – Journal research papers typically 6-15 pages
  – Review/survey papers much longer

• Where is the paper published?
  – (how to find this information?)

• Look at the figures

• Read the section / sub-section headings
The Scientific Research Paper is a Peculiar Piece of Writing

- Highly structured, almost predictable headings
- Every item in paper exists for a reason, nothing merely for cosmetic reasons
- Each part connected with other parts
  - sentence1 $\rightarrow$ sentence 2, paragraph1 $\rightarrow$ paragraph2, section1 $\rightarrow$ section2
  - Sequence is important
  - Figure $\leftrightarrow$ text
- Yet, space is highly constrained
The Scientific Research Paper is a Peculiar Piece of Writing

Novice researchers need time to become familiar
Structure of a scientific research paper

Title
Abstract

Introduction
Background / Motivation
Contribution of paper
Related work
Problem definition (research questions)
Solution approach or outline
Scope / Assumptions / Limitations
Details of solution - experiment / system / model
Findings
Evaluation
Take-away from paper

References
Mini-Activity – 1 minute

Locate the following parts in the uploaded paper. Mark on paper

Title
Abstract
Introduction
Background / Motivation
Contribution of paper
Related work
Problem definition (research questions)
Scope / Assumptions / Limitations
Solution approach
Details of solution - experiment / system / model
Findings
Evaluation
Take-away from paper
References

Discuss your answers with your neighbour
Mini-Activity Discussion
<table>
<thead>
<tr>
<th>What you are looking for</th>
<th>Where to find it</th>
</tr>
</thead>
<tbody>
<tr>
<td>What research area / sub-topic does the paper fall under?</td>
<td>Title, Abstract</td>
</tr>
<tr>
<td>What problem does the paper attempt to solve?</td>
<td>(Title), Abstract, Introduction, Problem definition</td>
</tr>
<tr>
<td>What is related work and why is it not sufficient, what are gaps</td>
<td>Introduction</td>
</tr>
<tr>
<td>What key contribution does the paper claim?</td>
<td>(Title), (Abstract), Introduction, Conclusion</td>
</tr>
<tr>
<td>Broadly, how does the paper solve the problem?</td>
<td>Introduction, figures</td>
</tr>
<tr>
<td>How do the authors defend the solution?</td>
<td>Introduction, figures</td>
</tr>
<tr>
<td>What category of paper is this?</td>
<td>Introduction, headings</td>
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</tbody>
</table>
How to get the big picture

Read:
- Title
- Abstract
- Introduction
- Conclusion

Go through
- Section and sub-section headings

Look at
- Figures
How to get the big picture

Write answer to the following questions:

• What research area / sub-topic does the paper fall under?
• What problem does the paper attempt to solve?
• What is the motivation for this problem?
• Why is this paper needed – i.e. what is related work and why is it not sufficient
• What key contribution does the paper claim?
• Broadly, how does the paper solve the problem?
• How do the authors defend the solution?
• What category of paper is this?

Make notes while reading paper

In margins
Using highlighter
In separate notebook / file
Pair Activity – 10 minutes

On the paper (print-out or soft-copy), make notes to answer the following questions. 1-3 lines for each question.

• What research area / sub-topic does the paper fall under?
• What problem does the paper attempt to solve?
• What is the motivation for this problem?
• What is related work and why is it not sufficient
• What key contribution does the paper claim?
• Broadly, how does the paper solve the problem?
• How do the authors defend the solution?

How to make notes while reading paper

Write in margins
Use underline (blue / red / green) or highlighter
Write in separate notebook / file
Pair Activity – Discussion

• What research area / sub-topic does the paper fall under? Engineering education.

• What problem does the paper attempt to solve? How to embrace the implementation and benefits of clickers for distance education?

• What is the motivation for this problem? Distance education lacks interactivity, ) Clickers shown to be highly effective in face to face classrooms

• What is related work and why is it not sufficient Very little work on use of clickers in distance education

• What key contribution does the paper claim? i) provide architecture of implementing a distributed student response system with 20+ remote locations ii) show proof of concept of implementation
Pair Activity – Discussion

• Broadly, how does the paper solve the problem?
  Instructor delivers lectures from a central location, which were transmitted to remote classrooms. RCs were equipped with receivers which communicate to a server located in the central classroom over the internet. Participants respond to questions presented by the instructor through clickers. (Block diagram of distributed system set up )

• How do the authors defend the solution?
  Data of clicker responses were recorded, for each question over 15 days from 500 participants.
  Instructor and participant feedback on distributed clicker system analyzed
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<td>Introduction, Problem definition</td>
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<tr>
<td>What is related work? What are gaps?</td>
<td>Introduction, Literature Survey or Related Work</td>
</tr>
<tr>
<td>What contribution does the paper claim – idea, technique, proof, surprising result etc?</td>
<td>Introduction, Conclusion</td>
</tr>
<tr>
<td>How does the paper solve the problem?</td>
<td>Solution, Experiment, figures</td>
</tr>
<tr>
<td>How do the authors defend the solution?</td>
<td>Methodology, Experiment, Results</td>
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## Stage 2: Get the details

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<th>What you are looking for</th>
<th>Where to find it</th>
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<tbody>
<tr>
<td>What is the precise research question addressed?</td>
<td>Introduction, Problem definition</td>
</tr>
<tr>
<td>Why is it believed that solution works, better than previous?</td>
<td>Solution approach, figures</td>
</tr>
<tr>
<td>What are assumptions, scope?</td>
<td>Problem defn, solution approach</td>
</tr>
<tr>
<td>What are details of proposed solution – argument, proof, implementation, experiment?</td>
<td>Solution, System details, Experiment, Methodology, figures</td>
</tr>
<tr>
<td>What evidence is provided?</td>
<td>Figures, Results</td>
</tr>
<tr>
<td>What is the take-away message from the paper?</td>
<td>Overall</td>
</tr>
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</table>
Stage 3: Evaluate the details

Is the research problem significant?
Is the problem novel?
Is the solution approach novel?
Are the contributions significant?
Is relevant related work surveyed “sufficiently” enough?
Have alternate approaches of solution been explored?
Are assumptions valid? Has paper violated assumptions?
Are the claims valid?
Are the different parts of the paper consistent?
Are the figures, graphs, diagrams precise?
Does the paper flow logically?

What is the paper trying to convince you of? Does it succeed
Stage 3+: Synthesize, Ask Creative Questions

• What are some alternative approaches to address the research problem?
• Could there be a different way to substantiate the claim?
• Are there counter-examples or arguments against the paper’s claims?
• Are all assumptions identified and validated?
• How can the research results be improved?
• How can the results be generalized?
• What are the new ideas and open problems suggested by this work?
Activity: Homework

Write a 2-3 page review of the paper. The review should have three parts:

1) Summary. Should address questions in Stage 2: Get details
2) Critically evaluate. Should address questions in Stage 3.
3) Creatively synthesize: Should address questions in Stage 3+

Use the questions as guidelines to develop your review as a coherent essay.
Frequently Asked Questions
How many times should I read the paper

Answer: Depends on your purpose.
How many times should I read the paper

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• Purpose: To decide if this paper is a valid research paper, broadly relevant to your work, interests you.

Go upto Stage 1. Get the big picture
How many times should I read the paper

Answer: Depends on your purpose.

• Purpose: To decide if this paper is a valid research paper, broadly relevant to your work, interests you.

Go upto Stage 1. Get the big picture

• Purpose: To grasp the content of the paper, to summarize the paper.

Go upto Stage 3. Get the details and evaluate them.
How many times should I read the paper

Answer: Depends on your purpose.

• Purpose: To decide if this paper is a valid research paper, broadly relevant to your work, interests you.

Go upto Stage 1. Get the big picture

• Purpose: To grasp the content of the paper, to summarize the paper.

Go upto Stage 3. Get the details and evaluate them.

• Purpose: To be able to re-create the paper, to base your research significant upon that paper.

Go upto Stage 3+. “Synthesize, ask and answer creative questions about paper.”
How much time should I spend?

Disclaimer: These are approximate times only!

• Get a feel - Beginner 5 minutes, Experienced 1-2 minutes

• Get the big picture – Beginner 1 hour, Experienced 5-10 mins

• Get the details

• Critically evaluate

• Creatively synthesize. Beginner 6 hours, few days. Experienced 1-2 hours.
What if I still don’t understand the paper

Possible reasons:
• New subject matter, unfamiliar terminology, acronyms.
• Don’t understand technical details of experiment methodology or proof
• You may be (mentally) tired. The paper is “heavy”.
• The paper is poorly written!

What to do:
• Nothing! (In case the paper is not important to you)
• Sleep, read again tomorrow with a fresh mind
• Discuss with colleague
• Read a textbook or survey article, then return to paper

A note about reading through the references

• The references won’t make sense unless you are familiar with the research area and the literature.

• The references are a great way to:
  – Understand the paper more clearly / deeply
  – Build upon the current paper
  – *Broaden your knowledge of the research area
References


