

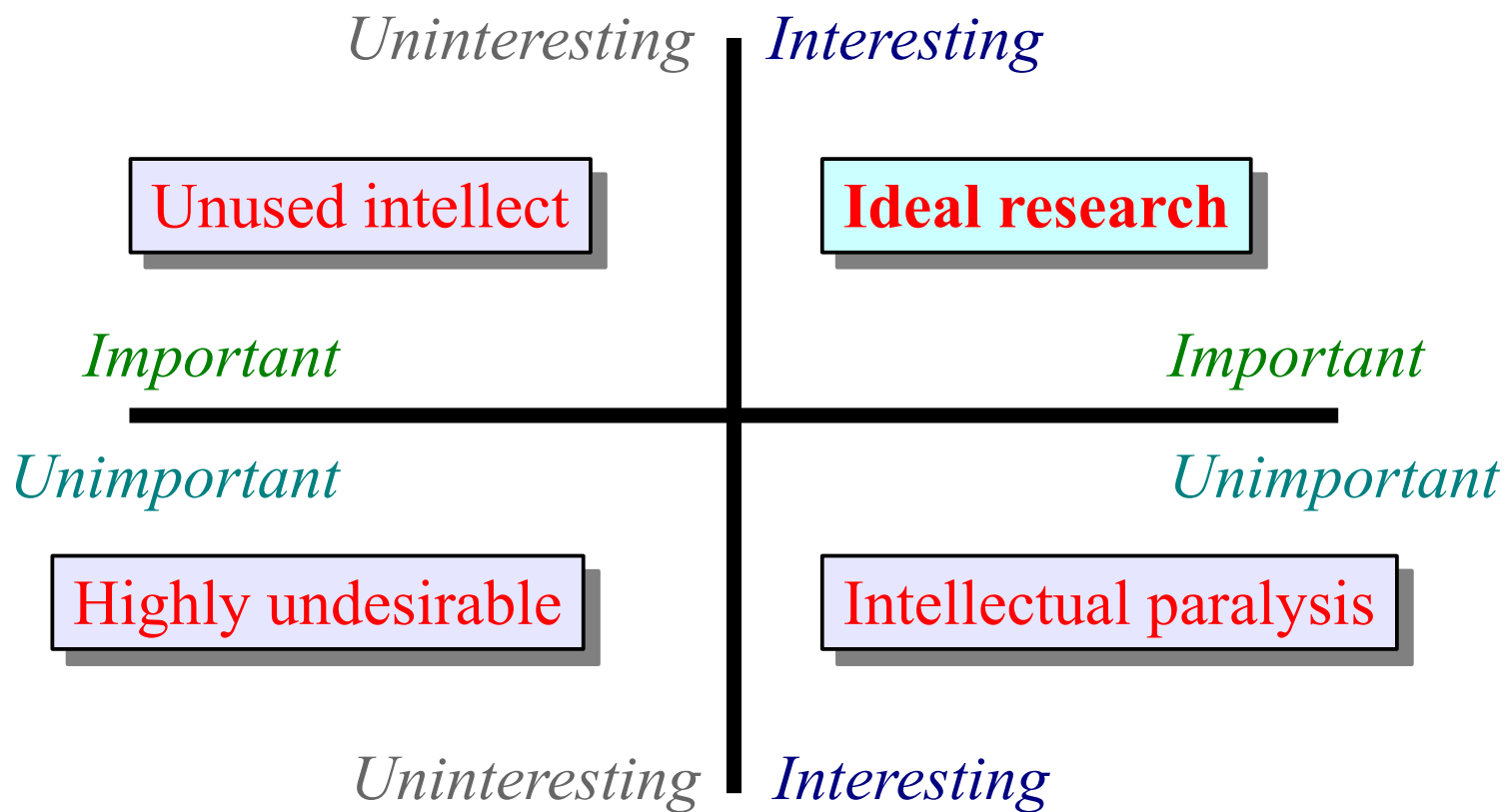
**"I love nuclear energy. I just want to make sure it stays where God put it -- 93 million miles away, in the sun."
-- William McDonough**



How to do Quality Research

A Tutorial
WISARD/COMSNETS 2011
Bangalore, India

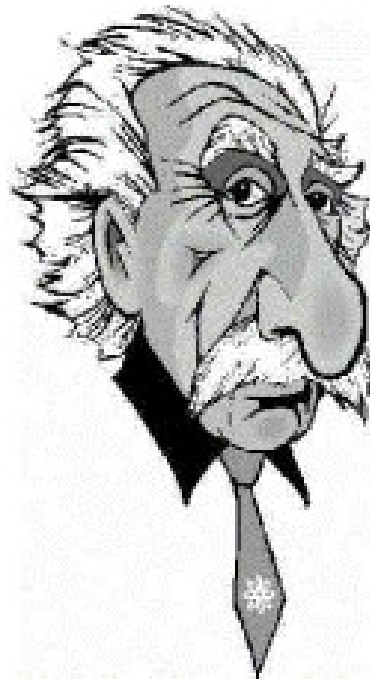
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Research classification

Thanks to: Pravin Bhagwat

*"And somewhere there are engineers
 Helping others fly faster than sound.
 But, where are the engineers
 Helping those who must live on the ground?"
 --- Unknown author*



**"If we knew what it was we were
doing, it would not be called
research, would it?"
-- Albert Einstein**

This Tutorial: Ingredients of Research



- Read literature

- *Understand (unsolved) problem, innovate*



- Write papers/reports

- Make presentations



- Review others' papers/reports



- Time management



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Structure of This Tutorial

- Introduction: 5 min
- How to read a paper? 20 min
- How to write a good paper/report? 20 min
- How to make a good presentation? 20 min
- How to review a paper? 10 min
- Time management (Prof. Anurag Kumar) 20 min
- Q&A: 20-25 min

Papers Used in Examples

- “Practical Network Support for **IP Traceback**”, SIGCOMM 2000
- “Link-level Measurements from an 802.11b Mesh Network”, SIGCOMM 2004 (best paper award, **Roofnet**)
- “Long-Distance 802.11b Links: Performance Measurements and Experience”, MobiCom 2006 (Testbed: **DGP**)
- “**PPR**: Partial Packet Recovery for Wireless Networks”, SIGCOMM 2007
- “**Flush**: A Reliable Bulk Transport Protocol for Multihop Wireless Networks”, SenSys 2007
- “**PIP**: A Connection-Oriented, Multi-Hop, Multi-Channel TDMA-based MAC for High Throughput Bulk Transfer”, SenSys 2010

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Reference

- "How to read a paper?", S. Keshav, ACM SIGCOMM Computer Communication Review, Volume 37 , Issue 3, July 2007
<http://portal.acm.org/citation.cfm?id=1273458>
- 2-page paper: neat and crisp, but invaluable!

The Three-Pass Approach

- How not to read: start-to-end
- Increasing levels of depth:
 - **First pass, filter pass:** general understanding, context
 - **Second pass, overview pass:** high level idea of contents, but not details
 - **Third pass, detailed pass:** all details

The First Pass, Filter Pass

- Read:
 - Title, abstract, introduction, conclusion
 - Section and sub-section headings (only)
 - Advanced reader: glance over references
- **Purpose** of first pass:
 - Category & context
 - Problem statement, solution contributions
 - Correctness & clarity
 - Use these as filter
- Approximate time: **5-10 min**
- **Note:** when you write a paper, most readers will make only one pass!

The Second Pass, Overview Pass

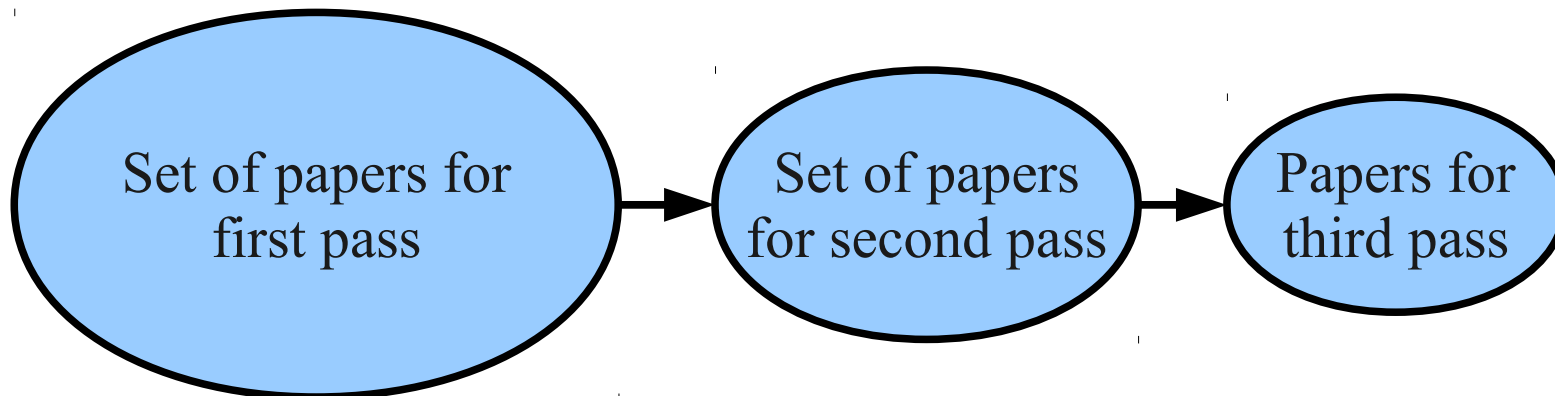
- Read:
 - Paper more carefully
 - But ignore details: proof, experimental setup, details of idea/architecture
 - **Figures, tables, graphs**
 - Advanced: mark relevant unread references
- Purpose of second pass; should be able to:
 - **Summarize** paper to someone else: idea, main results, contributions, assumptions, weaknesses
 - Have a **discussion** with someone else
 - Perhaps **compare** with related work at a high level
- Approximate time: **1-2 hours**

The Third Pass, Detailed Pass

- Understand all details
- Virtually **re-implement** the paper
 - How would you have done it? Assumptions, proofs, experiments, results
 - Usually done if paper is closely related to your work
 - Or when doing a review
- Should be able to point out strengths, flaws, missing citations, implicit assumptions, etc.
- Approximate time: **2-6 hours**

Doing a Literature Survey

- **Keywords** on an academic search engine
- Filter pass (first pass) on each paper, read related work section if interesting
- Recent survey paper? Done!
- Browse prominent authors' **webpages**, where they publish: **conferences/journals**
- Three passes on decreasing subsets of papers



- Summary of literature survey: comparison table

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Overall Goal, Approach

- Paper: written *to be read*
- Overall approach
 - Top-down
 - Continual *refinement*
 - Don't wait for stars to align: put down *whatever* comes to mind

Writing in Multiple Passes

- First pass, **outline** pass:
 - Title (tentative), abstract (tentative)
 - Forces you to think of high level *contributions*
 - Section-level outline, subsection-level outline, paragraph level outline
 - Think of figures, tables, graphs
- Second pass, **rough-draft** pass:
 - Introduction (tentative)
 - Forces you to think of *main contributions*
 - Individual sections: generate text, figures, tables, graphs
- Further passes: **refinements**

Structure of a Paper/Report: Guidelines, not Rules

- Title, abstract
- Introduction: includes motivation
- Background: optional
- Related work: can be toward the end
- Technical sections
- Evaluation/results
- Discussion: optional
- Future work: optional
- Conclusion

“Title”, “Abstract”

- Title, abstract: important to write carefully
 - Most read parts of a paper
 - Many search engines index on title/abstract
 - Carefully ==> multiple refinements, not continuous hours
- Title: convey **key idea/contribution**
- Abstract:
 - Essence of paper
 - **Succinctly state:** context, contribution, key idea, related work, methodology, eye-catching result
 - 1-3 paragraphs ~ 250 words
- Some examples: IP-traceback, PPR, PIP, Roofnet

“Introduction”

- Also read in first pass, typically
- “Introduction” should typically address most of:
 - What is the context, **problem** statement?
 - Why is the problem **important**? (motivation)
 - Is the problem still **unsolved**? (related work)
 - Why is the problem **interesting**? (challenges)
 - **How** have you solved the problem? (approach)
 - Conditions of solution applicability (assumptions)
 - What are the **main results**? (highlight performance)
 - Summary of **contributions** (sometimes implicit)
 - Organization of the rest of the report (overview/flow)
- “Introduction” ~ shorter version of paper ~ extended abstract
- Some examples: IP-traceback, PIP, DGP

“Background”

- Optional section
- If paper requires reader to know about:
 - Specific past work
 - Typically your own specific past work
- Even otherwise, it sometimes helps in laying out terminology/context

“Related Work”

- Level of detail of comparison: context specific
- Highly recommended: *table of comparison*
 - Succinctly conveys positioning, contribution of your work
 - Also note: **table** catches attention in 2nd pass reading
 - Ability to draw this table:
 - Conveys your understanding of existing literature
 - Conveys confidence
- Some examples: IP-traceback, LiT presentation

Technical Sections

- Several sections: depends on paper content
- Section **outline**: appropriate for “large” sections
- **Flow** sentences: glue between sections
- Use of *figures, tables*
 - “A picture is worth a thousand words”
 - Quality of figures ~ quality of paper
 - Also: readers catch these in 2nd pass
- Develop, use intuitive *terminology*
- Some examples: PIP, IP-traceback

“Evaluation”, “Results”

- What are you trying to evaluate and why?
- What are the **comparison** points?
 - Past work, some alternative design, optimal
- What are the comparison **metrics**?
- **Parameters** of comparison
- How are you evaluating?
 - Setup: provide all details, explain parameters
- What are the results?
- What are the implications?

Presenting Experimental Results

- Graph:
 - Title, label, axes, units
 - Should be legible in **gray-scale print**
 - **Explain** *all* aspects of graph
 - Also point out *unexplainable* aspects
 - Consider log-scale
- Table: explain rows, columns
- *Seriously consider*: summary of results in a table
 - Example: PPR

“Discussion”, “Future Work”, “Conclusion”

- Discussion: additional aspects of your work
 - See example papers...
- Future work: can be merged with conclusion
- Conclusion: read in 1st pass
 - How has your paper changed the world?

Refinements

- Near **perfect paper** \implies underwent **more revisions!**
- Typically, for MTech/PhD students:
 - First two revisions: read yourself and revise
 - At least 2 weeks; comes down with experience
 - Colleagues, fellow students
 - Advisor
 - Outsider: friend in another university/research-lab
- Overall: 2-3 weeks for writing a 12-15 page paper
 - More revisions required for top-rated conferences/journals

Key Things to Remember

- Title, abstract, intro: 1st pass reading
- Figures, tables, graphs: 2nd pass reading
- Refine, refine, refine
 - Until point of diminishing returns

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Overall Goal, Non-Goal

- Goal of presentation:
 - Convey that you have done interesting/useful work
 - **Motivate** audience to read report/paper
 - **Impress** audience!
- Important **non-goal**:
 - Present *everything* you have done
 - Not possible to convey everything!
 - If you try, you will lose audience

Overall Structure

- Flow: similar to report, barring details
- *Figures, figures, figures*
- Presenting **graphs**:
 - Full slide
 - Take-away point
 - Regenerate graphs (jpg/png export from gnuplot)
- Examples: LiT, PIP

Do's and Don'ts: Slide Contents

- **Bullets**, not full sentences
- Text/font, highlight/colours for **keywords**
- Animation: use sparingly
- Meaningful slide titles
- Spelling, grammar, bullet space, capitalization, punctuation
- **Talk outline**: for talks > 20-25 min
- Use equations sparingly; explain intuition
- Backup slides

Do's and Don'ts: Presentation Style

- Don't read off slides
- Gauge audience mood, background
- **Talk length:** skip slides/sections if necessary, never exceed time
- Face the audience, don't block screen
- Don't go back and forth: repeat slides if necessary

Other Guidelines

- *Practice, practice, practice*
- Enthusiasm, energy: don't over-practice
- Understand question and answer
 - But don't give complete control to audience

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Review Guidelines

- Give the paper its due:
 - Read it unhurriedly, mostly 3 passes
 - Write a detailed review
- Identify good ideas: look for reasons to accept paper
- Review papers, not ideas
- Justify your score! And comments too
- Provide adequate references
- Be constructive in your comments

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Resources, References

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- "How to read a paper?", S. Keshav, ACM SIGCOMM Computer Communication Review, Volume 37 , Issue 3, July 2007
<http://portal.acm.org/citation.cfm?id=1273458>
- “How to give a bad talk”, Rold Riedi,
<http://www.stat.rice.edu/~riedi/Publ/bad-talk.ppt>
- “How to give a good talk”, Arnaud Legout,
<http://cel.archives-ouvertes.fr/docs/00/52/95/05/ANNEX/HowToGiveATalk.ppt>
- Several papers on how to write a review