WATERLOO?

Where is that?
RIM/Blackberry
Sybase/SAP
Maplesoft
Google, Square,
Clearpath, Vidyard, Thalmic + 1200 more startups
Perimeter Institute for Theoretical Physics
AGENDA

1. Hints for doing GREAT research
2. How to read a paper
3. How to do a literature survey
4. How to give a talk
5. Q&A
HINTS FOR DOING GREAT RESEARCH
GREAT RESEARCH

Grounded
Risky
Ethical
Absorbing
Thorough
 Look for gap between hype and reality

Use appropriate theory

Assumptions are critical
- Be the harshest critic of your own work
- Prepare to move on
RISKY

Bridge of research

Known

Chasm of uncertainty

Envision your goal

How will it change the world?
RISKY
ETHICAL
ABSORBING

- Unexpected results
- Read widely
- Share your ideas
- Collaborate

Talks
ABSORBING

Be passionate
Read widely
Attend diverse talks
Share your ideas
  • Maintain a research site
THOROUGH
BEING THOROUGH

Always begin with a literature survey
Start with the simplest non-trivial instance
Learn as you go
Prepare to change
Crystallize solutions
Keep an eye open for the unexpected
Carry a notebook
ON WRITING PAPERS

Publish, but not at any cost
- Quality trumps quantity

Avoid gratuitous math

Fuzzy writing indicates fuzzy thinking

Use the one week rule

Hone your writing and thoughts

Rejection strengthens your work
ON ATTENDING TALKS

Take detailed notes

Ask questions
  • It keeps you from sleeping
THE BOTTOM LINE

Have fun doing research!
- You’re not going to make any money anyway
HOW TO READ A PAPER
KEY IDEA

Don’t read linearly. Instead, make three passes:

• Pass 1: General idea
• Pass 2: Basic content, but not details
• Pass 3: In-depth understanding
FIRST PASS

- **Bird’s eye view**: 5-10 minutes

1. Title, abstract, introduction
2. Section and subsection headings
3. Conclusions
4. Glance over references
AFTER THE FIRST PASS...

You should be able to answer the “five Cs”:

1. **Category**: What type of paper?
2. **Context**: What other papers is it related to?
3. **Correctness**: Do assumptions seem valid?
4. **Contributions**: Main contributions?
5. **Clarity**: Well-written?
SECOND PASS

- Read carefully, but ignore details
  - proofs, for example

- ~ 1 hour

- Figures, diagrams, illustrations, graphs.
  - Properly labeled? Error bars? Etc...

- Mark relevant unread references

- After, should be able to summarize main thrust
“Virtually re-implement” the paper
- Identify and challenge assumptions
- ~ 1 – 5 hours

Jot down ideas for future work

After, be able to:
- Reconstruct entire structure of paper from memory
- Identify strong and weak points
- Pinpoint implicit assumptions, missing citations to related work, issues with experimental or analytical technique
HOW TO DO A LITERATURE SURVEY
Use **Microsoft Academic** or **Google Scholar** and well-chosen keywords to find **3-5 recent papers**

- Do first pass read of each
- Read related work section of each
- Find a good survey in related work?
PHASE 2

- If you didn’t find a good survey already:
  - Find shared citations, repeated author names
  - Download key papers, set aside
  - Go to websites of key researchers
    - Where have they published recently?
    - What are the top conferences?
PHASE 3

Go to web sites of top conferences
- Look through recent proceedings
- Identify recent, high-quality related work

Make 2\textsuperscript{nd} pass through papers from these phases …

3\textsuperscript{rd} pass on most promising
ITERATE ...
HOW TO GIVE A RESEARCH TALK
OUTLINE

Preparation

Presentation
RULE 1: TELL A STORY

Background
- “Once upon a time, …”

Problem
- “The ogre ate all the apples, so the children went without…”

Solution
- “The anti-ogre fence…”

Evaluation
- “Ogre infestations declined 58% over 5 years…”

Conclusions
- “We recommend anti-ogre fences”
RULE 2: 1-2-3 RULE

One idea per slide
**Microbenchmarks**

Traffic Model: Batched Poisson

\[
\text{load} = \frac{\text{mean batch size}}{\text{mean batch interval}}
\]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>0.45</td>
</tr>
<tr>
<td>Allowed Rate</td>
<td>0.5</td>
</tr>
<tr>
<td>Frequency</td>
<td>12 / day</td>
</tr>
<tr>
<td>Transit Delay</td>
<td>60 min</td>
</tr>
<tr>
<td>(\Delta \phi)</td>
<td>180°</td>
</tr>
</tbody>
</table>
RULE 2: 1-2-3 RULE

Two minutes per slide

30 minute talk: no more than 15 body slides

- unless very sparse
- like this talk!
RULE 2: 1-2-3 RULE

At most three topics
- figure them out first
- depends on the nature of the audience
- work backwards
RULE 3: USE OUTLINES

Outlines show connections
- as important as the details

Start with an outline

Repeat the outline or section title for each section
- ‘roadmap’
RULE 4: USE FEW WORDS

"Words on presentation slides are a very good idea, but only when the audience is deaf."

- Prof. W. Cowan, University of Waterloo
FOR EXAMPLE...

A lush green valley in the Himalayas, looking down a thousand meters to stepped rice fields by a rushing river.
RULE 5: USE FRIENDLY THEMES, FONTS AND COLOURS

KioskNet Architecture

Downlink Scheduling
- Problem Definition
- Existing Approaches
- Our Solution
- Simulation

Implementing the KioskNet System

Especially for graphs
RULE 6: NEVER SHOW TABLES WHEN YOU CAN SHOW GRAPHS
Table 4. Cases of meningococcal disease in Dublin 1998 by area of residence

<table>
<thead>
<tr>
<th>Area</th>
<th>Cases</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>37</td>
<td>100</td>
</tr>
</tbody>
</table>
RULE 7: TYPOS RELFECT PORELY ON YURE COMPTENCE
RULE 8: USE EXAMPLES

As in this talk!
RULE 9: AVOID COLLOQUIALISMS

It's like, duh
RULE 10: DESCRIBE RELATED AND PAST WORK

“If I have seen further it is only by standing on the shoulders of Giants.”

Isaac Newton
RULE 4 & 10: DESCRIBE RELATED AND PAST WORK

“If I have seen further it is only by standing on the shoulders of Giants.”

Isaac Newton
RULE 11: TALK ABOUT YOUR CONTRIBUTIONS

Don’t make the audience guess what they are.
RULE 12: HIGHLIGHT INSIGHTS

The story behind the work is what audiences come to talks for
- What didn’t work? Why?
- What would you do differently next time?
Rule 13: End with a summary slide

Leave it up on the screen when you stop for questions
OUTLINE

Preparation

Presentation
RULE 1: TALK TO THE AUDIENCE, NOT THE SCREEN

Scan the audience, see if they are understanding

Pace your talk
RULE 2: NEVER READ FROM NOTES

Expand from ‘headlines’
RULE 3: WALK AUDIENCES THROUGH FORMULAE

\[ \log N^*(t) = \log \left( \prod_{i=1}^{n} N^*(t_i) \right) = \sum_{i=1}^{n} \log \left( N^*(t_i) \right) = \sum_{i=1}^{n} \log \left( 1 + \frac{(\sigma_i)^2}{2} \frac{(t_i)^2}{\sigma^2} \right) \]  

(EQ 14)

It is easily shown by the Taylor series expansion that when \( h \) is small (so that \( h^2 \) and higher powers of \( h \) can be ignored) \( \log(1+h) \) can be approximated by \( h \). So, when \( n \) is large, and \( \sigma \) is large, we can further approximate

\[ \sum_{i=1}^{n} \log \left( 1 + \frac{(\sigma_i)^2}{2} \frac{(t_i)^2}{\sigma^2} \right) \approx \sum_{i=1}^{n} \frac{(\sigma_i)^2}{2} \frac{(t_i)^2}{\sigma^2} = \frac{1}{2} \frac{(t_i)^2}{\sigma^2} \sum_{i=1}^{n} (\sigma_i)^2 = \frac{1}{2} t^2 \]

(EQ 15)

where, for the last simplification, we used Equation 10. Thus, \( \log N^*(t) \) is approximately \( 1/2 \ t^2 \), which means that

\[ N^*(t) \approx \sigma^2 \]

(EQ 16)
RULE 4: ALWAYS INTRODUCE GRAPH AXES
RULE 5: SPEAK SLOWLY AND CLEARLY

Especially if you are not a native English speaker

and even if you are!
RULE 6: RESPECT QUESTIONERS

Hear questions fully
Defer them if needed
Remember the cry of distress: “Let’s take it offline”
RULE 7: PRACTICE MAKES PERFECT

Practice a talk at least three times
Talk in front of a mirror
Have it recorded, if possible
RULE 8: ARRIVE EARLY

Test your laptop or better yet, borrow one
Bring a memory stick
Do the talk on a white/black board if necessary
RULE 9: BRING A POINTER

Laser, stick, or pen
RULE 10: A LITTLE HUMOUR GOES A LONG WAY

“I think you should be more explicit here in step two.”

From The New Yorker
RULE 11: END ON TIME

Keep track of the time
SUMMARY

Rule 1: Tell a story
Rule 2: 1-2-3 rule
Rule 3: Use outlines
Rule 4: Use few words
Rule 5: Use friendly themes, fonts and colours
Rule 6: Never show tables when you can show graphs
Rule 7: Typos reflect poorly on your competence
Rule 8: Use examples
Rule 9: Avoid colloquialisms
Rule 10: Describe related and past work
Rule 11: Talk about your contributions
Rule 12: Highlight insights
Rule 13: End with a summary slide

Rule 1: Talk to the audience, not the screen
Rule 2: Never read from notes
Rule 3: Walk audiences through formulae
Rule 4: Always introduce graph axes
Rule 5: Speak slowly and clearly
Rule 6: Respect questioners
Rule 7: Practice makes perfect
Rule 8: Arrive early
Rule 9: Bring a pointer
Rule 10: A little humour goes a long way
Rule 11: End on time