Research and Writing Tips for Graduate Students

Shou-de Lin (林守徳) Professor National Taiwan University sdlin@csie.ntu.edu.tw

Dept. of CSIE & GINM, NTU

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Machine Discovery and Social Network Mining Lab, CSIE, NTU

- PI: Shou-de Lin
 - B.S. in NTUEE
 - M.S. in EECS, UM
 - M.S. in Computational Linguistics, USC
 - Ph.D. in CS, USC (EELD project)
 - Postdoc in Los Alamos National Lab
- Courses:
 - Social network Analysis
 - Technical Writing and Research Method
 - Probabilistic Graphical Model
 - Machine Discovery
- Awards:
 - All-time ACM KDD Cup Champion (2008, 2010, 2011, 2012)
 - Best Paper Award WI2003, TAAI 2010, and ASONAM 2011
 - Google Research Award 2008
 - Microsoft Research Award 2009
 - IBM research award 2015
 - INTEL research Funding 2011~2015
 - US Areospace AROAD Research Grant Award 2011, 2013~2014, 2015~2016



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Agenda

- How to find good research topics
- How to do good research
- Improving your RQ
- How to write a good paper

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How to Find a Good Research Topic?

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What is a Good Research Topic

- Something that interests you, your advisor, and your research community.
- A real problem, not a toy problem (or even worse, not a well-defined problem).
- Have certain connection to the existing research (If not, you need to make sure people think it is interesting and worth doing.)
- There is a chance for you to have solid theoretical contribution or practical/empirical results (preferably both).
- Significant yet manageable, with extensions and additions that are successively riskier but will make the thesis more exciting (Chapman)

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A Good Research Topic Makes you Halfway to the Success

- A novel research topic is a big plus
 - You know people would appreciate your work even before starting working on it.
 - The topic itself is novel/interesting/challenging enough to have certain value.
 - Usually you need to hurry up since somebody else might come up with similar ideas.
 - Usually you need to do a lot of literature survey to make sure nobody does the same thing.
- If you cannot find a novel topic, then find a novel solution for an existing topic
 - Sometimes the problem is trivial, but the solution is not.
 - Novel solution is hard to come up with, so you don't need to worry that much about being stolen by others.

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What should I do if I cannot find a good research topic on my own

- Talk to your advisor and friends.
- Taking relevant courses.
- Read some papers.
- Don't just read papers, do something (join a group, implement a system).
- Read tech news.
- Open yourself to new/novel/interesting ideas, even it has nothing to do with your expertise.

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How to do Good Research?

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Foundation, Foundation, Foundation

- Algorithm: Dynamic Programming, Graph theory, Clustering, automata, logic, cryptography
- Search methods:
 - Optimization (e.g. heuristic search) : adjusting parameters of a system to optimize an explicit or implicit objection function (e.g. Maximum likelihood Estimation)
 - Learning (classification or regression): Given a set of input/output pairs, learning tells you how to predict the output given some unseen input. Proposed methods: SVM, NN, ME, DT, GE, EM...
- Math: probability and statistics, information theory, coding theory, queuing theory, linear algebra, discrete math...
- Programming Skills: C++, Java, design related tools, Python, Perl, MPI, database management...
- Background knowledge in other areas: biology, music...

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Finding your Own Hammers



- You need to identify your "secret weapon".
- For example, the hammers in MS lab:
 - Estimation-Maximization Algorithm.
 - Master in classifiers (e.g. ME, SVM, DT, GA).
 - Bayesian Inference Tools.
 - Reinforcement Learning Packages.
 - Probabilistic Graphical Model
 - Social Network Analysis Tools.
 - Using Clustering Machines.
 - Dealing with GigaWords of data

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Find New and Better Ideas (knight)

- Listen to the data (Herb Simon)
- Kick around ideas with senior students and your advisor
 - Reject mediocre ideas
 - Reject complex ideas
- Get animated by a giant goal
 - Narrow it down immediately what's the first experiment?
- Learn powerful techniques by implementing them
- Pick problems that will teach you something
- Obsess yourself with the research problem, and wait for the ideas to come.

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Getting feedbacks

- To be successful at research, it is essential that you learn to cope with criticism, and even that you actively seek it out.
- Talking to other people will help you realize
 - which aspects of your research are truly different and innovative
 - how your work fits into the current state of your field and where it's going
 - which aspects of your work are harder to sell (and, therefore, which aspects you need to think more about justifying).
- Give presentations at seminar series at your university, at conferences, and at other universities and research labs when you get the chance.
- Talk to people as much as they're willing to listen to. You should have 30-second, 2-minute, 5-minute and 10-minute summaries of your project ready at a moment's notice.

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Improving your RQ (Research Quotient)

Unfortunately, $IQ \uparrow + EQ \uparrow \neq RQ \uparrow$

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Mentality

- Initiative
- Tenacity
- Discipline
- Flexibility
- Awareness
- Selective
- Ambitious but practical
- Get your hands dirty (mind the details)

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Initiative

- Rather aggressive than passive
 - -your adviser is NOT going to hold your hands and tell you what to do every step of the way.
 - Your goal is to prove that you can do highquality research, not just to get a degree.







- "Let me tell you the secret that has led me to my goal. My strength lies solely in my tenacity." - Louis Pasteur
 - You don't need to be a genius to earn a degree, but very few finish a dissertation without being tenacious.
 - No one can tell you in advance exactly how long the dissertation will take, so it's hard to see where the "end of the road" lies.





Discipline

- Do research EVERYDAY, instead of doing it when you are in the mood.
- Try to find your own routine, and stick to it.
 - Know which time slots in a day are best/worst for you mentally and physically.
- Simplify your life.
 - Minimize distractions and detours.





Flexibility

- Working around problems if it is not possible to directly solve it
- Being willing to change plans if necessary
- Taking advantage of opportunities and synergies
- Accept the things you can't change (e.g. network broken).
 - Control the controllables.
 - Save the cursing time, it is YOU that should be responsible for how your time is spent.

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Awareness

- Pay attention to the rules, news, tips that benefit you.
- Be aware of the new opportunities (e.g. new research direction, new technology, new scholarship, etc.)
- Have a sense or urgency. It is YOUR future.
- keep in touch with the "real world," remind yourself that the graduate student population is not representative of humanity in general and keep your own perspectives.

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Selective

- Be aware that you have only limited amount of time (at most 24 hours a day).
- Don't spend too much of your time on subordinate things or tasks.

- Learn how to say no



Ambitious but Practical

- Everything is possible, unless you prove it impossible.
- Don't give up too early.
- Don't settle for mediocre.
- Be realistic (there are more research to be done after graduation).



Get your hands dirty

- Walk the talk (Talk the talk, walk the walk).
 - Smartness can be learned through experience.
- Have the determination to start working on a tough problem ASAP (Do it NOW!!)
- Knowing what is critical and what is minor (e.g. the speed is sometimes as important as the quality)
- The last 10% to perfection typically consumes 80% of the effort. The devil is always in the detail (Prof. *Tzicker Chiueh*)

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How to Write a Good Paper

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What's so important about publishing?

- To convey your research ideas and results *accurately, clearly and economically* to others.
- Presenting a coherent, written scientific argument is a learned skill – learn by doing!
- For application science, your works would not become applicable without first letting people know what it is.
- You'd be thrilled to realize that there are strangers reading your stuffs!
- To earn better understanding about your research
 - Writing down your method usually can reveal its pitfalls.
 - Sometimes it's difficult to define or formalize an idea well enough until you have written it down.

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The Peer-reviewing Era

- You cannot publish your papers at will.
- You need to get the approval from a bunch of (usually anonymous) judges
 – Good or bad?
- All of us have been reminded: a good writer should always consider the readers...
 - It turns out your papers have two different kinds of readers: the reviewers and the normal readers
 - The former determines whether your paper can be accepted, the later determines whether it will be cited
 - A good paper has to satisfy both types of readers

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Why My Papers are Accepted/Rejected





Research Quality: Meet Reviewers' Demand

Reviewers want



Things most likely to be criticized by reviewers

- Experiment (not enough, not convincing, not fair, no baseline, no confidence interval, etc)
- Methodology (too ad hoc, no complexity analysis, too complicated, too simple)
- Value (not important, not challenging, not applicable in the real world)
- References (too few, not citing somebody's work)

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Why My Papers are Accepted/Rejected





STechnical Writing Pyramid



3. Doing stage 1 and 2 efficiently (using as few space as possible).

 Presenting the methods and results in a convincing manner (that is, being able to persuade others that you are doing great work).

1. Conveying your research ideas clearly.

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How should one describe the idea

• The route you have come up with the idea.

• The way you implement your idea.

• The best logic you should present your idea.

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What makes a good piece of technical writing

- 1. Clear and forthright
- 2. Convincing (logically sound)
- 3. Precise and familiar
- 4. Concise and fluid (smooth)



Clarity: what to avoid?

- A sentence that is too long
- A sentence that contains too many pronouns
- A sentence that contains too many relative pronouns (e.g, who, which, that)
- A sentence that contains many prepositional phrases (e.g, before the class, behind the door)
- A sentence that contains more than one idea.





Composition

- Writing down the most important points in this paper first.
- Prepare the skeleton (logical sequence of sections). Writing down section and subsection titles first.
- Write the introduction draft first, and go back to revise it after finishing the whole paper.
- Writing the abstract in the very end.
- For novice writers, a good strategy is imitation: choose a well-written paper that is of a similar flavor, analyze its organization, and sketch an organization for your results based on the same pattern.

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Avoid grandiloquence

- Grandiloquence:
 - The use of extravagant language
 - The use of long pompous words
 - Creating a text that is difficult to read
 Example:
 - It may seem reasonable to suggest that the necrotic effect may possibly due to toxins
 →Necrosis may be caused by toxins

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Why My Papers are Accepted/Rejected







The Impression to the Reviewers

- Avoid providing the following impressions to the reviewers:
 - You are arrogant
 - You are a novice
 - You are not confident about your research
 - You are not working as hard as you can





Be Humble but Confident

- Avoiding arrogant/exaggerate statements such as:
 - We are the first team to ... → To our knowledge, our idea of ... is novel
- Be sure about your idea/proposal/results
 - It seems to me that ... → In my opinion, ...





Don't Feel Frustrated about Rejection

- Whether a paper gets accepted is sometimes a random process (i.e. the likelihood changes with time and environment)
- Sometimes the reviewers just cannot accept your submission, and it is easy to identify some flaws if they are determined to do so.



How to Improve Your Writing/language Skills?

- Writing English papers and reports
- Writing more English papers and reports.
- Reading well-written papers (not necessary the bestknown paper) from the writer's point of view, and pondering:
 - Why are they clear and easy to understand?
 - The usage of language
 - The structure and flow
- Analyzing other people's editing (why and how) on your write-ups.
- Don't give up: Never feel that your writing skills cannot be improved (and don't feel that it is all about English)

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