HOW TO CONDUCT RESEARCH 101

By Cen CHEN, Sep 30, 2021

THE NATURE OF RESEARCH

- Scientific research is the research performed by applying systematic and constructed scientific methods to obtain, analyze, and interpret the data/problem/or the world.
  - Challenging yet tedious, may require patience
- **My point of view**:
  - Identify problem
  - Formulate problem
  - Explore possible solutions (trails & errors)
  - Solve the problem
  - It's a matter of course to write paper

HOW TO FIND RELATED PAPERS

- Start with **survey paper** to get an overview of the research area
  - **Google scholar**: search keywords，filter by citation & venue
  - Follow **CCF list**, analyse the top conference accepted paper list:
    - Genreal top conference: NIPS, ICML, ICLR, WWW, AAAI, IJCAI
    - ML & data mining: KDD, CIKM, SIGIR, WSDM
    - Federated Learning: CCS, S&P, NIPS, ICML, SysML
    - NLP: ACL, EMNLP, NAACL, COLING
- Start with classical papers, then find related ones
- Follow senior researchers, wechat, zhihu, and other sources

HOW TO READ A PAPER

- **Common practice for graduate students is to read at least 2-3 papers a week**
  - Abstract, introduction, related work, methods, experiments…
  - **Thumb of rules:**
    - Remember title/ author names/ main ideas
    - Contribution? Weakness v.s. Strengths?
    - Related papers and technical details
    - Is the experiment valid and sound? Learn to judge the experiments.
    - How the method proposed by the paper can be applied?

DIFFERENT PARADIGM FOR POTENTIAL RESEARCH

- **Paradigm 1: filling the gaps**
  - Systematically review the related work
  - Write down the differences in these papers:
    - Premises, assumptions, proof support/characteristics, etc. provided by these papers in terms of systems, methods, technologies, data sets, etc..
    - Compare and analyse
- Then draw a table in terms of these “dimensions”, not necessarily two-dimensional.
- Find the "blanks", that is, the parts that have not been considered or involved.

DIFFERENT PARADIGM FOR POTENTIAL RESEARCH

- **Paradigm 2: expansion and extension**
  - This is the natural progression of the "fill in the gaps" paradigm.
  - If you already have some research ideas in a certain direction
    - for example, you have published one or two papers
- You can see the “dimensions” that are not easy for others to find from your own special perspective.

DIFFERENT PARADIGM FOR POTENTIAL RESEARCH

- **Paradigm 3: building a hammer and finding nails**

- The general idea is that if you have unique expertise, technology, systems, and even data sets (that other people cannot easily get), you can make full use of them to find interesting problems

- It can be very time-consuming to build expertise or systems until it starts to be profitable.

- This type of plan sometimes requires the entire team to conceive, plan, and organise.

  - Usually beyond the ability of the individual students, need collaborative effort.

- If you can find what many people need, but there is no good solution yet, then it may be worth considering.

DIFFERENT PARADIGM FOR POTENTIAL RESEARCH

- **Paradigm 4: find the big picture from the small discoveries**
  - A research idea usually starts with some small or accidental discoveries, and you need to study this idea in depth to determine whether it is enough to support an paper
    - It takes skill to determine whether in-depth research is required or how much time to invest in in-depth research.
- The following signals indicate that this idea may be worthy of further study:
  - When you first discovered a interesting phenomenon (no matter how subtle)
  - When you dig deeper, you find that there is a deep explanation behind this phenomenon
  - You can find similar phenomenon in your problem.

DIFFERENT PARADIGM FOR POTENTIAL RESEARCH

- **Paradigm 5: revisit the existing idea (reproduction is important!)**
  - The results you reproduced may not be the same as shown in the paper. Analyse the reason:
    - Mistakes made unintentionally by the author;
    - The result itself is not 100% reproducible
    - The benchmark of the method proposed in the paper is biased or the data set is relatively one-sided. Learn to be critical thinking!
- Even if you manage to reproduce 100% of the same results as expected in the paper, you may get new inspirations in the reproduction.
  - The limitations of previous work meant room for improvement.

DIFFERENT PARADIGM FOR POTENTIAL RESEARCH

- **Paradigm 6: Draw inspiration from external sources, e.g., industry**
  - Keep connections with industry and understand their needs & pain points may bring new ideas
  - The focus of industry and academia is different.
    - Industry: more resources, effective, reliable, practical…
    - Academic: elegant, exploratory, idealistic
  - If you solve a certain problem, you can even define your own "solving" criteria in a sense.
  - If you are studying a problem that needs to be solved in industry, & there is no perfect solution, thus the threshold of "success" (relative to other more mature fields) will be reduced.
- I personally often benefit from inspiration from external sources.

A FEW TIPS

- **Develop a good habit of thinking about research ideas**
  - Read papers! Read papers! Read papers!
  - Keep curious and open minded about papers in different fields
  - Participate more in reading groups, discussions, and ask questions!
  - Discuss with your lab mates and collaborator
  - Be patient, resilience and optimistic!

ONE MORE THING…

- **Zero tolerance for plagiarism!**
- Please follow the **basic ethics**.

"Stay foolish, stay hungry"

虚心若愚，求知若渴

–Steve Jobs