How To Do Research (Well)

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First Things First: Why?

SCENARIO ONE:
- Person A is a fool

SCENARIO TWO:
- Person A is extremely intelligent, has extremely good ideas and insights, but conducts research foolishly

SCENARIO THREE:
- Person A is extremely intelligent, has extremely good ideas and insights, conducts research brilliantly, but writes papers foolishly
A Good Algorithm

1. Answer question:
   
   **WHAT DO I WANT TO KNOW?**

2. Devise appropriate experiments

3. Gather data; stare at data; think

4. goto 1 unless satisfied

5. Write abstract; goto 1 unless satisfied

6. Write intro; goto 1 unless satisfied

7. Write remainder; goto 1 unless satisfied

8. Answer question:

   **DOES PAPER TELL THE STORY?**

   goto 5 unless satisfied
1. Answer Question

**What do I want to know?**

The hardest part of research is asking good questions

- Point of Advisor: Direction
- Point of Colleagues: Sounding boards
- Point of Research: PROVIDE INSIGHTS

What would be useful? influential? interesting? long-lived?

IN GENERAL: Be general. Compare things. Why do they differ? What causes behavior? What is unimportant to behavior?
2. Devise Experiments

CROSS-PRODUCTS are useful

Scenario 1:

Prefetch scheme A vs. scheme B;
fixed caches; fixed memory latency;
fixed memory bandwidth

Scenario 2:

Prefetch scheme A vs. scheme B;
cache sizes 1,2,4,8; memory latency 1,2,4,8;
memory bandwidth 1,2,4,8

Scenario 2 is MUCH, MUCH HARDER
but MUCH MORE USEFUL
3. Gather Data; Stare; Think

POINT:

DATA -> SYNTHESIS -> INFORMATION

Plot data every which way imaginable

Look for apparent connections

This is where advisor is useful …
4. goto 1 unless satisfied

Does the information synthesized tell you what you want to know? Does it answer the question? If not, start again …

Does the information raise more questions? **IF NOT, THERE IS LIKELY A PROBLEM**

Are the new questions within the scope? **Yes:** start again …  **No:** you have a new study to do next …
5. Write Abstract

Here is a topic, its importance, how it affects YOU (the reader)

Within that topic, here is an unsolved problem (unanswered question)

Here is how we solved the problem (answered the question)

Here are the most important results

PROVIDES FRAMEWORK FOR PAPER

Does it say what you intended? If not …
6. Write Intro

Here is a topic, its importance, how it affects YOU (the reader)

Within that topic, here is an unsolved problem (unanswered question)

Here is how we solved the problem (answered the question)

Here are the most important results

[ DOES THIS LOOK FAMILIAR? ]

Does it say what you intended? If not …
7. Write Remainder

Background: Be sophisticated (finer points as well as primer-level points)

Related Work: Pay homage to prior art; Distinguish present work

Experiments: Reproducible set-up

Discussion: PROVIDE INSIGHTS (those that require a few weeks of thinking)

References: Don’t miss important papers
8. Answer Question

Does the paper tell your story?

Hard to answer this. Get others to read it.

IN GENERAL:

• Have at least ONE MAIN POINT
• Don’t assume reader knows anything (but do assume reader is intelligent)
• Beware of prophecies/heresies/etc.
• Goal: the perfect sphere :)

If not “perfect,” rewrite abstract, perhaps run new experiments …
Summary

EXCELLENT RESEARCH ≠ COOL IDEA
EXCELLENT RESEARCH = ANY IDEA DONE WELL

Investigate all possibilities

Look at problem from all angles
(x is good, x is bad, x doesn’t matter ...)

Provide deep insights
(those not obvious at first or second glance)

Show connections between things
(x causes y causes z causes good/badness)