How to Write a Research Plan

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Why write a research plan?

- We make you do it. . .
- Helps you in developing as a researcher
- Can be part of a research grant
- Other reasons

What Does It Look Like?

- Short answer: it depends
  - What is the context?
  - Who is going to read it?
- Luckily, in your case you know that
  - it is part of your PhD
  - it is read by supervisor/second reader
- Unfortunately, there is no simple recipe

RSP: Official Version

- The research plan must:
  - briefly describe the area of research of the PhD work,
  - specify the research questions to investigate,
  - contain a literature study (mandatory) proving the work related to the student's research questions,
  - suggest what would be the expected results to answer those questions,
  - specify the kind of the expected results:algorithms, theory, system architecture, etc.,
  - make evident the extent to which the expected results will be novel and/or an improvement with respect to the related work.

RSP: Official Version (2)

- The study plan should:
  - identify subjects that require deepening of expertise and suitable means of study,
  - describe a set of events by which the student plans to obtain credits,
  - provide plans of publications, travel, and stays with partner institutions.

Time Line

- After six months:
  - Submission of an initial research and study plan
- After twelve and twenty-four months
  - Submission of an updated version which reports on
    - the progress made
    - changes in the research questions and the approach taken
    - the steps planned to complete the research work

Not Necessarily That Helpful. . .

Common parts of research plans:

- set context/background, motivate research
- formulate concrete research question
- (briefly) survey related work
- sketch planned work and methods, can be
  - theoretical analysis
  - developing algorithms
  - building systems
  - social/business research
- define milestones/deliverables/outcomes

Context, Background, Motivation

- Provides a gentle introduction for the reader
- Illustrates why the research is done
- Also shows the bigger picture

How Not to Do It

"Let G be an Abelian group and H be a subgroup of G. Let $\mathcal{F}$ be the complex field $\mathcal{C}$ of the real field $\mathcal{R}$, and let $\mathcal{F}_{m\times n}$ be the linear space of all $m \times n$ matrices over $\mathcal{F}$. If $A \in \mathcal{F}_{m\times n}$ we use A^* to denote the conjugate transpose of A. . . "

Examples taken from: Nicholas J. Higham, Handbook of Writing for the Mathematical Sciences, SIAM, 1998

Formality is not the Problem

"Let A be a positive definite matrix of order n with eigenvalues $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_n > 0$ corresponding to the orthonormal system of eigenvectors $x_1, x_2, \ldots, x_n$. In some applications, one must obtain an estimate of λ_1 without going to the expense of computing the complete eigensystem of A. A simple technique that is applicable to a variety of problems is the power method."

Research Question

- The more concrete the research question. . .
- . . . the easier it is to write the plan
- Nobody expects you to
  - find a cure for cancer
  - establish world peace
  - prove P$\neq$NP

Related Work

- Research rarely starts from scratch
- You have to look at the state of the art
- The hardest part is getting started
  - Once you have some sources, they'll point you to others

Getting Started

- Web search engines:
  - `http://scholar.google.com/`
  - `http://academic.research.microsoft.com/`
- In general, web sites of organizations/ companies may provide
  - technical reports
  - white papers
  - descriptions/documentation
- Online libraries
  - Your local university library
  - ACM/IEEE web sites

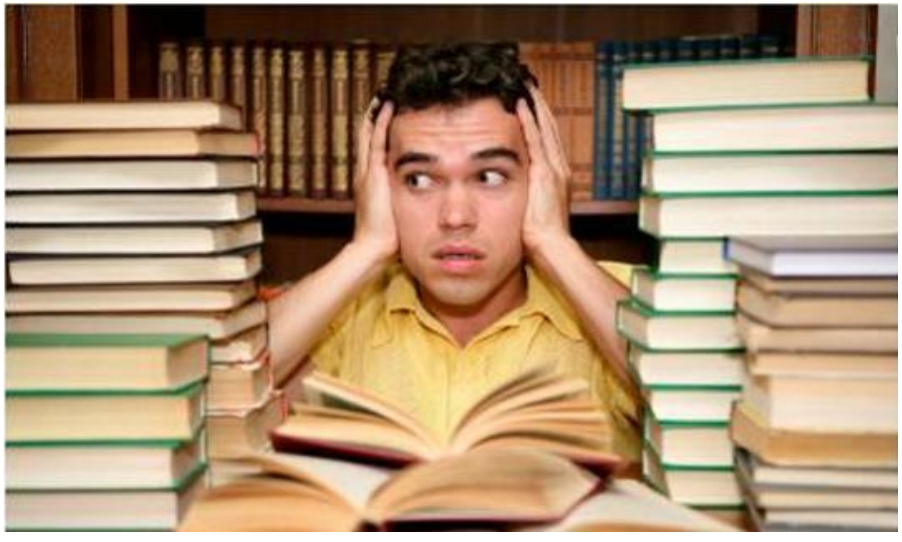
Going Further

- Once you have a few publications, you can
  - go through their related work/references section
  - look up who referenced the publications (e.g. “cited by” on acm.org)

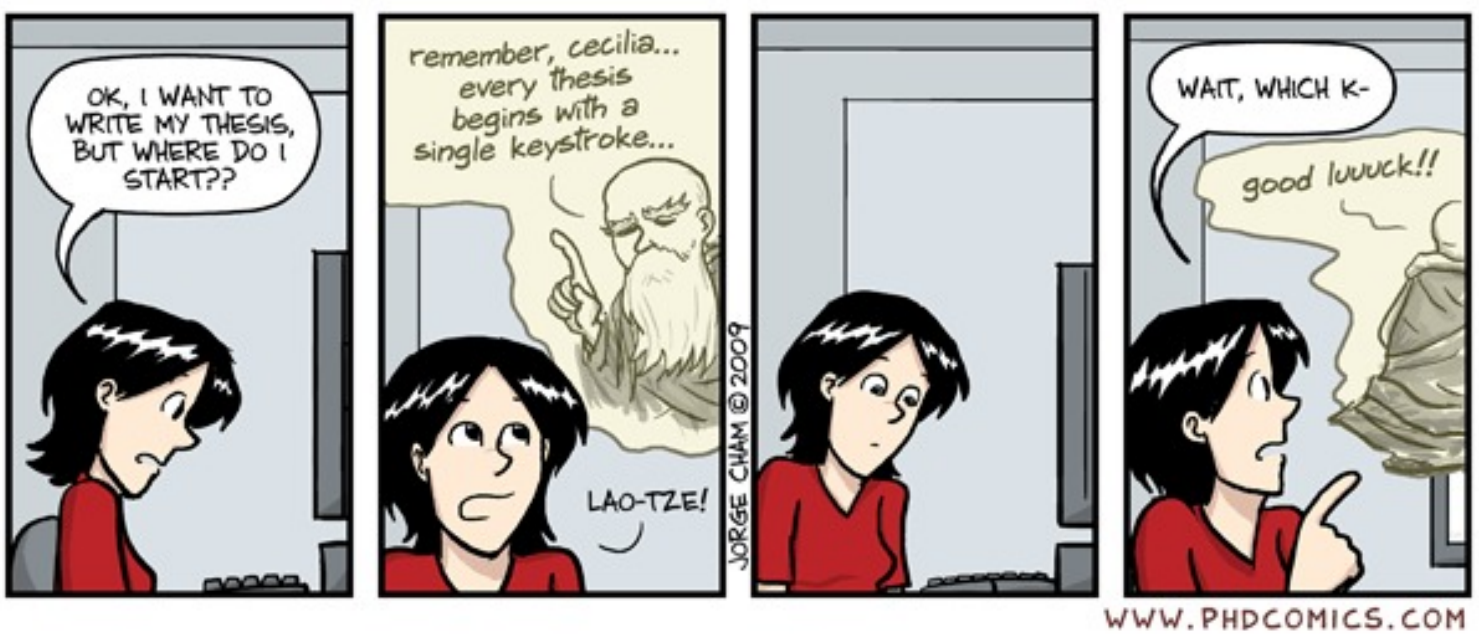
  - look for similar papers in the same publication venue

Further Suggestions

- Often no need to read complete articles
- Don’t overdo the literature research
  - There is a huge number of publications out there
  - You could keep reading for years
  - At some point you have to get on with your work!



Writing Related Work Up



- Cram every citation into your report
  - Usually not a good idea
- Select papers most important to your work
  - Allows you to write more than a half-sentence about each

Making the Writing Easier

- When reading papers
  - underline important bits
  - scribble comments on margin
- Maybe even write your own short summary
- Categorize papers according to different aspects
- Automatize the bibliography, e.g. with BibTeX

Methods and Work Packages

- This is where the actual plan comes into play
- Break down work into manageable chunks
- What we don’t want:
  - Single work package: do PhD
  - 156 different work packages with detailed description
- What we want:
  - Break-down showing you’ve put some thought into this

What happens next?

- “No plan survives contact with the enemy.”
  (Moltke the Elder)
- We are doing research after all
- But you still need to make a plan
- Sketch some alternatives/branches

Methodology

- There are countless different methodologies
- Which one to choose depends on your research
- Can’t cover all of them in half an hour
- Covered in other parts of the seminar . . .
- . . . and/or talk to your supervisor

Milestones and Deliverables

- Can take many different forms:
  - Algorithm with experimental evaluation
  - Theorems and proofs
  - Implementation of a working system
  - Questionnaire and statistical evaluation
  - Survey of the state of the art
  - Writing a paper
  - Wrapping up the PhD thesis

Milestones and Deliverables (2)

- Gives you a concrete goal to work towards
- Keep long-term goals more general
- Break down milestones while working on them:
  - Short-term goals
  - Mid-term goals

Some General Remarks

- Writing helps you to learn
  - Brings out gaps in your understanding
  - Forces you to focus on *all* steps

Also taken from: Nicholas J. Higham, Handbook of Writing for the Mathematical Sciences, SIAM, 1998

Some General Remarks (2)

- Good writing reflects clear thinking
  - Clear thinking leads to good organization
  - Difficulty in writing may indicate an inappropriate structure

Some General Remarks (3)

- Writing is difficult
  - It is often difficult to get started
  - Sometimes it’s best to just start writing
  - Modifying can be easier than writing from scratch

Some General Remarks (4)

- Keep it simple
  - Much of written English is unnecessarily complicated
  - For many readers/writers English is not the first language

Some General Remarks (5)

- Feedback
  - An important step in improving is getting feedback
  - Sometimes hard to take, but very valuable

Conclusion

- There is no cookie-cutter recipe
- However, practice certainly helps
- “Everybody has a million bad words in them, and the sooner we get through that first million, the better.”

(Ray Bradbury)