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
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.
• 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
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
• Provides a gentle introduction for the reader
• Illustrates why the research is done
• Also shows the bigger picture
“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
“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 $\lambda_1$ 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≠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
• 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)