Robotics Research Proposal

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(slides adapted from earlier versions by Alan Bundy, Alex Lascarides, Victor Lavrenko, Stratis Viglas, Mark van Rossum)

Two components of MSc

- Taught component (80 credits)
  - lectures, tutorials, coursework, exams
  - learn established techniques that work
- Research component (100 credits)
  - do something that's never been done before
    - study a new problem, develop a new method, etc.
    - probably the most exciting (and hardest) part of MSc
  - culminates in you writing a dissertation (~50 pages)
  - two courses prepare you:
    - RRR: literature review in area of interest
    - RRP: write a detailed plan for your MSc project

MSc project timeline

- Semester 1 RRR
  - learn about a relevant area: explore research papers
  - write a 3000-word summary of what you learned

- January:
  - faculty supervisors propose project topics
  - Or, propose your own
  - talk to supervisors, pick set of topics

- Semester 2 RRP
  - write a detailed plan for what you're going to do

- Summer (provided your exams went well)
  - work on your project (build, test, analyse results)
  - write a dissertation

Explaining research

Explaining research face-to-face is an important skill. It helps:

- improving the structure of your knowledge
- identifying weak points in your argument
- discovering new approaches to your problem
- getting a PhD or other research-related positions
  (a typical interview question is to explain your research)
- promoting your work at conferences/sponsor meetings etc.

- How often do you have/use an opportunity to talk about your research?
- What feedback do you give when being explained the other's project?
- What feedback do you expect?

RRP: Guidelines for Writing a Research Proposal

A good proposal will provide a convincing case for the high quality of the proposed research.

It will show an awareness of relevant prior work and include a clear statement of the problems and hypotheses to be addressed and why they are important.

It must also make clear exactly how the methods used to research those hypotheses will yield interesting results. There are many ways in which one might structure the material.

DRPS: RRP (IRP)

Assessment

The assessment will come from one piece of submitted work: a full research proposal, including background, motivation, and a description of the research methodology and expected outcomes. A good proposal might be organised as follows:

- Purpose: a statement of the problem to be addressed.
- Background: a short description of how previous work addresses (or fails to address) this problem.
- Methods: A description of the methods and techniques to be used to test the hypotheses, indicating that alternatives have been considered and ruled out on sound scientific grounds.
- Evaluation: Details of the metrics by which the outcomes will be evaluated.
- Workplan: A timetable detailing what will be done to complete the proposed project, and when these tasks will be completed.

As a guide, a good proposal might be organised as follows:

Purpose: a statement of the problem to be addressed. This should include arguments as to why solving the problem is important; e.g., because it will enable certain applications, or lead to interesting scientific discoveries.

Background: a short description of how previous work addresses (or fails to address) this problem, leading to a rationale for the hypotheses that you intend to test, and a convincing argument about how that hypotheses might solve the problem.

Methods: A description of the methods and techniques you intend to use to test your hypotheses (e.g., data analysis procedures, experimental design etc), indicating that alternatives have been considered and ruled out on sound scientific grounds.

Evaluation: Details of the metrics by which you will evaluate the outcomes of your research; e.g., by comparing the output of your system with some gold standard, or with the ways in which humans perform a task, etc.

Outputs: A description of what the outputs of the projects will be: e.g., these might include an extension or change to some existing theory or to some piece of software, some new data (e.g., annotated linguistic data), and so on.

Workplan: A timetable or research plan, detailing what will be done to complete the proposed project, and when these tasks will be completed by.

The proposal may also include material that would count as the Introduction to the MSc thesis itself, and/or the literature review.

1 - Critically evaluate research literature appropriate for their project subject

2 - Use existing research literature to justify experimental design choices.

3 - Develop a structured research proposal.

4 - Discuss research proposals with particular reference to key hypotheses and methodological approaches.

5 - Outline project/research management issues.

Hypotheses in Informatics / Robotics

- *Hypotheses/claims* often not stated

    - *except* in *theoretical* work

    - leads to confusion and misunderstanding

- If *claim not clear* then this should be *criticised*

    - same if claim is *strong* and is *not proven*

- *Evidence* may be *theoretical* or *experimental*

- *Objective* may be to *identify a hypothesis* for subsequent evaluation

Some considerations

- With the submission of the RRP you have finished work worth 40% of the project

- The more results have obtained before submitting the Proposal, the more realistic your plan will appear

- The more work you have done by the end of this term the better your project is going to be.

- The content of the proposal is basically the same content as the thesis with results replaced by plans (and alternative plans)

MSc thesis outline

1. Introduction
2. Related work
3. Methodology
4. Experiments
5. Discussion
6. Conclusions
7. Bibliography
8. Appendices

Introduction (M. v. Rossum)

- What problem are you working on?
- Why is this an important / interesting problem?
- What is the core idea of your solution?
- Which questions/hypotheses are you trying to answer with your work?
- What is novel/original about your solution?
- How are you going to test if it works?
- What are the main contributions / salient points in your thesis?
- Overview the rest of the dissertation

– cite all sources; if there is no paper, cite "Pers. comm."
– be very clear about which ideas are your own and which are not

Related work

Which fields of research are closely related to your work? (should be 2-3)
What are the most important (highly cited?) publications in those fields?
How are they related to each other?

How is your work similar to the work done in those publications?
– are you borrowing ideas / motivation / algorithms?
– are you using similar datasets?
– similar evaluation framework?
– what differentiates your work from the prior work?
– what motivated the difference in approach?
– what aspect of the problem are you hoping to do better?
– will you be comparing your performance to the prior work?
– summarise related work using a common vocabulary

Methodology: provide a high-level outline of your solution

– what are the major steps / phases: e.g. pre-process, extract features, measure similarities, ...
– describe each phase in a separate sub-section:
– be clear about the purpose of each step
– think in terms of what goes in and what comes out, but it is not necessarily the best way to describe it that way
– discuss design decisions and explain why you chose A over B
– describe possible variations on the approach / parameters that will affect performance
– use equations and diagrams to illustrate your ideas & assumptions
– use standard terminology and be consistent; don't use synonyms
– define all symbols and use them consistently in equations / diagrams / text
– include pseudo-code for complex algorithms, but keep it brief and high-level
– do not include class diagrams, robot construction plans etc. (if they are essential, put them into appendix and point to them in the text)
– devote a special sub-section to summarising the steps / phases

Experiments

Describe the datasets you will be using
– what experiment did the dataset come from?
– what are the summary statistics (number of instances, etc)
– what sort of pre-processing had to be done
Describe evaluation methodology
– what metrics will you be using and why?
– what does the ground truth look like and how was it generated?
For each hypothesis:
– describe the exact configuration of your system (refer to chapter 3)
– describe the baselines you will be comparing to (refer to chapter 2)
– state the hypothesis precisely: is your system expected to be faster? more accurate? under what conditions?
– describe the main experiments you carried out
– report the result in terms of tables and graphs
– where possible, test statistical significance of your results
– remember: graphs and tables are illustrations to your text, they are not meant to speak for themselves: guide the reader through what they are supposed to see in graphs / tables
– make sure all axes / headers are labeled and every figure has a descriptive caption
– analyse performance of alternatives / effect of parameters
– summarise the main outcome for this hypothesis
Use a special sub-section to summarise the results from all hypotheses

Discussion

Revisit the promises you gave the reader so far.

– Do your results meet expectations about the outcome that you have formulated in earlier chapters?
– What were the major surprises?
– Why did the numbers come out the way they did?

– What peculiarities did you encounter in working with the robots, algorithms etc.?

– What are the limitations of your approach? where would it fail?

– Critically compare your approach to prior work: should the reader use your system or the baseline?

Conclusions

Re-cap the hypotheses you tested and the main results (chapter 4)

– What are the major lessons learned? What should the reader take away from this thesis?

– What would be different in your approach if you were to do the project again?

– Future work: imagine you had a year to continue working on this project

– which questions would you focus on?

– what approaches would you consider?

– what resources would you need?

– having done the project, what do you see as the biggest challenges in the field?

Back matter

Bibliography: 20 - 50 citations is a reasonable number

Appendix: Bits of code, class diagrams, directory structures, study questionnaires, long tables and tables of graphs

Reminder: Common problems

- Hypothesis is unclear, ill-formed, or blatantly wrong
- Project attempts to solve a non-problem
- Assuming you will succeed where others have failed
- Insufficient detail to assess outcomes
- Unaware of related research
- Bad presentation, incomprehensible report
- KISS = Keep It Simple, Student (words to live by)

Simon Peyton Jones (Microsoft Research Cambridge)
with Alan Bundy and Jon Oberlander (University of Edinburgh)

RRP: legal, social, ethical and professional issues

Questions: Are you happy with all aspects of the work?
If you are happy, will everybody[*] else be happy too?

[*]this may exclude competitors

Are there aspects that deserve particular attention?

A number of legal, social, ethical & professional issues can occur: E.g.
- Privacy issues (Databases, learning from data, knowledge management)
- Ethics of human and animal experiments (HCI, HRI, Neuro- and cognitive science)
- Weaponry (Intelligent Robotics)
- Non-disclosure (Industry collaboration)
- Legal issues (Natural Language Processing, image processing)
- Best interests of client and providers (Computer Systems)
- Consistency with the public interest
- Integrity and independence in the professional judgement
- Fairness and support to colleagues

Assessment of RRP (IRP)

Your report will be marked (pass/fail at UoE) by your supervisor and RRP coordinator

Assessment will be based on:

- How well project is motivated
- Quality of research plan
- Demonstrated understanding of area
- Clarity of expression and presentation

IRP: Basic criteria (you need these!)

Clear explanation and justification of each of the following

- Project aims and hypothesis
- Project deliverables
- Research plan, with timetable of dependencies
- Plans for evaluating work
- Relation to previous work

Additional criteria
(it would be nice to have these)

- Convincing arguments about each of the following
- Timeliness and significance of research
- Potential commercial or academic impact
- Backup plan if original plan fails

Robotics Research Proposal (RRP)

- Submission last week of term (Fr 3/4/15, 4pm)
- Marked by the same criteria and procedure as RRR
- Mark recorded at HWU, pass/fail at UoE

- Pace yourself
  - Leave time for feedback and correction
  - Self-assessment against marking criteria

- Meet with your supervisor regularly
  - If they say no, keep contacting them
  - If problem persists, contact me:
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