MSci and Third Year Projects – 2009/10

Some Advice

Hopefully by now you have made a good start on your project (unless you are planning on doing most of your project work in semester B because of your timetable for other modules). I would have expected everyone to have had several meetings with their supervisor, to have identified (guided by their supervisor) some suitable textbooks and/or research papers, to have started reading them, and to have a rough idea of what will go into their project. If you are behind on this then you need to take action. If you are at all worried about how the project is going then speak to your supervisor or to me.
In this document I have tried to give a few pieces of advice. I am writing this now because much of it is more relevant to the later stages of the project work and because it is loosely based round things students have asked me since starting their projects. Not all of this will be relevant for everyone but hopefully some of it will be useful to you. Some of the advice on content and style is subjective and is more slanted toward the pure maths side so if your supervisor suggests differently (particularly for applied or statistics projects) then you should probably go with them. However, the discussion of supervision arrangements and referencing other people's work applies to all.

1 What is Exposition?

The project is an expository piece of writing. This means that it should contain an account of some existing maths rather than new results. The originality comes from how you present the material. One typical sort of project is to take a few sources (perhaps a few chapters from a graduate level textbook and 2 or 3 research papers) and give a coherent account of some of the material in them. It may be for instance that the papers you read are confusingly written, contain a large number of technical results, and don't put results in context. Your job would be to improve the writing, select what to include, and to provide some context.
By now you will have been exposed to many pieces of mathematical exposition: lectures, lecturers handouts, textbooks etc. What are the features of the good ones? If you look back at your lecture notes and any textbooks you have used you will find some easier to understand than others. What is it about the good ones that make them easy to follow? What is it about the less good ones that you find confusing? Who are your role models for explaining mathematics? Identifying what you think the features of good and bad exposition are will help you to write clearly yourself.

2 Structure

Having read your sources and taken in a lot of material you are ready to think about how your project will look. One way of doing this is to imagine you were giving a section of a lecture course on the material. How will you motivate the material and relate it to other parts of maths? What are the most important results which must go in and what order

should they go in? What can you afford to leave out? Perhaps for some results you can get away with proving just a special case without losing too many of the ideas. This point is a particular difference between a research paper and a project or lecture course. In a paper the authors are usually trying to present the strongest result they can prove. In a project it may well be clearer to prove a slightly weaker result which contains most of the important ideas but is technically less fiddly to present.
Having done this write a brief skeleton in the style of the syllabuses in the back of the undergraduate handbook. For example if your topic was extremal graph theory you might end up with the following (taken from the Extremal Combinatorics module syllabus):

"Introduction (what is an extremal problem/result, some simple examples). Cycles (Dirac's theorem). Complete Graphs (Turán's theorem). Zarankiewicz problem (bipartite analogue of Turan). Erdős-Stone theorem."

Now flesh out each of these points with a few words describing what will go in each section. Having done all this you are ready to write each section but the overall structure will be clearly in your mind when you do this.
Similarly, before starting to write a section think about the structure of it. Will you split a long proof into several lemmas for instance.

3 Writing

The Mathematical Writing module notes contain lots of good advice which I won't repeat here. You can find these notes on the web at:
`http://www.maths.qmul.ac.uk/~fv/books/mw/mwbook.pdf`
The golden rule is to make things easy for the reader. A way to do this is to include lots of helpful remarks particularly in the course of a long proof. For instance:

- "this is the only place in the argument where we use that G is bipartite",
- "the key point of the argument is ...",
- " this completes the proof of the first assertion",
- "we could strengthen this but the bound given suffices for our purposes".

In a long proof comments like this can make a huge difference in readability. Remember that your readers are less immersed in the topic than you are.

4 Adding value

One thing that the markers take great note of is the extent to which you have added value. In other words what I get out of reading your project that I would not get from reading the original sources. There are many ways you can add value. Here is a list of suggestions. Which of these are appropriate to your project? What other ways could you add value?

- after giving a definition consider
  - what is the simplest example
  - what are some more complicated examples
  - does it generalise something else
  - is it analogous to anything else
- after stating a theorem consider
  - what are analogous results
  - is there an easy argument which gives a special case of it (perhaps a weaker conclusion or using some extra conditions)
  - how does it relate to other results in your project or beyond
  - why are all the conditions needed (or perhaps it is unknown whether they are needed)
  - if the result was a previously open problem, what is the new idea in the proof
  - does it have some applications which you can describe or allude to
- after stating a conjecture or open problem consider
  - what consequences would it have
  - what goes wrong if you try to solve it with existing techniques
  - what special cases are known

5 Supervision

I would expect you to see your supervisor relatively frequently (between once a week and once a month would be normal). Make sure you have a clear arrangement with your supervisor which both of you are happy with. They may want to arrange a fixed time weekly or they may prefer you to make each appointment as you require it. Your supervisor will provide general guidance. For instance they will probably suggest an initial textbook or papers to read but after that it may be up to you to follow up references in these or track down further material. The mathematics resources page on the library website is a good place to start:
`http://www.library.qmul.ac.uk/eng/infopages/mathwww.htm`.
In particular: `http://www.ams.org/mathscinet/` and `http://arxiv.org/` are useful resources.
Your supervisor should be willing to read a draft of your project and comment on what sections need work and how you could improve things. They will not suggest specific corrections or rewrite things for you.
If you are unhappy about any issue concerning supervision and do not feel able to raise with your supervisor then speak to me (unless I am your supervisor in which case I suggest you contact the second examiner Thomas Prellberg).

6 Referencing

You will need to refer to the sources in which the material you present first appeared (both for reasons of academic etiquette and to help a reader who wants to know more). Knowing what you need to reference is slightly subjective. Any relatively recent results must be attributed to the person who first published them. For more classical results a general reference (see ... for background on ...) is appropriate. Some parts of mathematics are established enough that no reference is required. This is a delicate area and one that many students get wrong so do ask your supervisor. If possible avoid referencing web pages and unpublished lecture notes.

If giving a simple definition (for example defining a prime number) it is quite likely that you will use exactly the same form of words as a textbook. This is fine and needs no comment. However, if you copy a chatty sentence from anywhere (including web pages) you must give the source and author. Failure to do this for a couple of sentences counts as bad academic practice (this could lose you marks) while failure to do it for a paragraph or more is plagiarism (this could count as an exam offence).

For the technicalities of how to refer to other peoples work see the Mathematical Writing module notes.

7 The Presentation

You are expected to give a short presentation on your project towards the end of Semester B. This will be to an audience of fellow students and a few staff (in particular your supervisor will probably be there). The presentation will be assessed and will contribute to your final mark. However, provided a moderate attempt is made, the presentation will only increase your mark.

When deciding on the content of your presentation, resist the temptation to include too much material. It is fine to give an overview of the area of maths you have studied and go into detail only on some part of it. On the other hand your talk should have some serious mathematical content (I would, for instance, be suspicious of a talk containing no proofs). Remember that your audience has a range of backgrounds and will be much less knowledgeable about your area that you are. Don't assume that they know more than they do and don't go too fast. As a rough guide you should pitch your talk at a level that you would have understood before you started your final year (so you may assume background from relevant courses in previous years but not anything you learnt while working on your project).

You may choose to present your talk with a blackboard/whiteboard, OHP/visualiser, or a computer (if you use a computer then you will probably want to use the LaTeX Beamer package to produce your slides). By now you will have sat through many hours of lectures using a variety of methods and you will have a good idea of the advantages and disadvantages of each. Hopefully you will also have realised the importance of a speaker being engaging and enthusiastic. Again it is worth deciding who your role models as lecturers are and following their lead.

8 Finally

Reading, writing, and speaking about advanced mathematics are difficult things to do make sure you take your project seriously and don't leave it all to the last minute. However, almost all students produce a good piece of work and learn some nice maths along the way. I hope you enjoy the experience!

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(updated 12 March 2010)