

Goals

The goals of these lectures:

- *describe the general research/development process*
- *discuss the specific requirements for a CSE thesis*
- show how to go about achieving these effectively

At the end, you should ...

- understand precisely what's required of you
- produce a better result (project/report/seminar)
- use your time more effectively

Topics

In these lectures, we'll talk about:

- *goals/requirements of 4th-year thesis*
- *the process of doing research/development*
- *getting started on a project*
- preparing/delivering the seminar
- writing the literature review (Thesis A Report)
- doing and evaluating the work
- writing the final thesis (Thesis B Report)

Outline

In this lecture:

- structure and preparation of Thesis A seminar
- structure and preparation of Thesis A report
- carrying out the project

- structure and preparation of Thesis B thesis

Some of this material is based on ideas from:

- *Thesis Web Site*, <http://www.cse.unsw.edu.au/db/thesis/>
- *Introduction to Thesis Writing - Structures and Processes*
Pam Mort, The Learning Centre, UNSW
- *How Theses Get Written: Some Cool Tips*
Steve Easterbrook, Dept. Computer Science, University of Toronto

Thesis A

Thesis A aims for you to demonstrate that ...

- you have a thorough understanding of the topic
- you have identified an area that requires work
- you have an approach for solving the problem
(and you can argue the likely effectiveness of this approach)
- you have a plan for carrying out the work
(including time-frames for tasks, knowing how to evaluate, ...)

Thesis A Seminar

Seminar Structure

Introduction	sell the topic, summarise aims <i>(5-6 minutes)</i>
Background	set context, evaluate previous work <i>(12-15 minutes)</i>
Proposal/Plan	how do you plan to tackle the problem <i>(2-3 minutes)</i>
Bibliography	give references for all work cited <i>(as you go)</i>

seminar = summary of Report, publicity for project, chance to get feedback

Seminar

The seminar aims to:

- give you a chance to practice your presentation skills
- let you show that you have met the goals of Thesis A
 - convince others that you're studying an important/interesting problem
 - demonstrate that you've done some research/thinking about it already
 - have a plan for the rest of the year to solve the problem

If you already have some results to show, that's a bonus.

Target your seminar at fellow thesis students *except* target the hard-core technical stuff at your supervisor and assessor.

Seminar (cont.)

Suggested structure for presentation:

1. Title slide (name of project, your name, ...)
2. Example to illustrate the problem (1-3 slides)
3. Introduction to problem; statement of goal (1 slide)
4. More detailed problem description (3-4 slides)
5. Survey/critique of existing approaches (3-4 slides)
6. Outline your approach to solve it (1-3 slides)
7. Plan for your work for the rest of the year (1 slide)

Use max 15 slides; you cannot cover more in 25 mins.

(The most difficult part of preparing a presentation is deciding what to leave out)

Practice the talk to a friend (for timing and explanation clarity).

Seminar (cont.)

Some rules for making slides:

- at least 20-point font, preferably sans serif font
- no more than 10 lines of text per slide
- no more than 2 main points per slide
- use pictures/diagrams to illustrate ideas
- strip the text down to the bare essentials

The *content* is the most important thing.

Nobody cares about colours, background, fancy transitions.

Presentation Tools: PowerPoint, S5 (HTML-based), LaTeX/PDF (e.g. Beamer)

The Seminar

Take it seriously ... you're being assessed.

Speak clearly ... *tell a story* ... practice.

Don't just read the slides ...

- if you can *ad lib* talk around the slides
- if you prefer, write a script and read from that

The Seminar (cont.)

Question time is important (hopefully)

- you will get unexpected questions
(this is where the assessor double-checks whether you know the material)
- you will get *very useful* feedback
(others will notice things that you (and your supervisor) may have missed)

Attend seminars by others, especially on related topics

(you may get a whole lot of useful ideas by seeing a different viewpoint)

The Seminar (cont.)

Suggested timetable for seminar preparation:

Weeks	Task
1-5	Work out precisely what your project is
2-12	Prepare your Thesis A report
10-11	Prepare the presentation
11	Show the slides to your supervisor
12	Revise the slides and practice

Thesis A Report

Thesis A Report Structure

Introduction	sell the topic, summarise aims <i>(1-2 pages)</i>
Background	set context, evaluate previous work <i>(4-6 pages)</i>
Proposal/Plan	how do you plan to tackle the problem (with justification based on ideas in Background) <i>(3-5 pages)</i>
Bibliography	give references for all work cited <i>(1-2 pages)</i>

“set context” = define/examine problem in detail, set out evaluation framework

Chapter Structure

Thesis/report have overall structure:

- Introduction ... what the thesis is about
- Main Part ... the details of the work
- Conclusion ... what the thesis achieved

Individual chapters should follow a similar structure:

- Introduction ... what this chapter is about
- Main Part ... the details of the chapter
- Summary ... what the chapter achieved

May sound repetitive but it provides linkage and rationale for the reader.

Chapter Structure (cont.)

The main part of each chapter ...

- must present a coherent, logical progression of ideas
(think of it as telling a story or trying to explain some idea to a friend)
- each new idea must be based on what was said before
- the reason for the progression must be made clear
(don't pull conclusions out of the air; everything must be justified)

Simple example:

Previous experimental studies of M-tree indexing show that when the data has a non-uniform distribution, the tree may become severely unbalanced. If the tree can be constructed so that it adapts to the distribution of the data, it can be made balanced. The X-tree method that we propose uses the data distribution to compute a weighting vector that is used to place data in the tree in such a way as to keep it balanced.

Introduction

Write a draft of the introduction *now*, containing ...

- what are you trying to achieve? why is it important?

Leave it while you write the rest.

After you finish the rest, come back and re-write it ...

- significance/importance of the general topic area
- brief review of current state-of-the-art in the area
- the aim of your study and what are its implications
- summary of the main results and implications
- structure of rest of thesis; what does each chapter give

Background

This chapter aims to show:

- that you understand what the problem is
- that you are aware of the current state-of-the-art
- that you can analyse and critique others' work
- that there is an unsolved problem to be investigated

The chapter structure follows roughly these goals

- describe the problem in detail, all issues/aspects
- develop an approach for determining a “good” solution
- describe and analyse previous work (using this approach)
- conclude that some aspect of the problem is not yet solved

Background (cont.)

For DEV thesis, you might conclude that previous systems ...

- did not exist (nobody has ever built a system to do this)
- were too inefficient
- had usability problems

For RES thesis, you might conclude that previous methods ...

- did not work for a certain class of data
- were inefficient for a certain class of data
- were not elegant

Ultimately, you must show that your approach effectively addresses the problem.

Doing the Literature Review

Goals:

- collect a comprehensive set of publications on the topic
- build a picture of the nature and scope of the problem
- develop a framework for evaluating possible solutions
- *analyse* the specific work described in the publications

How comprehensive? (a.k.a. how many references is enough?)

- until *you* are convinced that you have all relevant material
- some topics may require: one main ref + one general ref
- other topics may have dozens of relevant publications
- use your judgement when to stop (and ask supervisor)

Doing the Literature Review (cont.)

How to find references?

- your supervisor may give you some papers/references
- if not, try using Google with terms from the topic title
- once you have an initial set of references ...
 - use their bibliographies to find *prior* work
 - use Citation Index to find *subsequent* work (e.g. citeseer)
- try to identify seminal papers on the topic

Doing the Literature Review (cont.)

Maintaining your bibliography:

- maintain a database using a bibliography tool (e.g. BibTeX)
- keep all printed copies of papers in a labelled folder
- keep all electronic copies under your “thesis” directory*
- make electronic notes on all papers, as you read them

For word processing, I strongly recommend LaTeX, because it ...

- produces better looking output, especially mathematical formulae
- has good facilities for bibliography, cross-referencing, table of contents
- encourages you to concentrate on *content*, not *appearance*

Doing the Literature Review (cont.)

How to “get a handle” on the topic?

- read and *think* about the references
- determine how they relate to each other
- work out common themes and differences
- note what assumptions they make (are they reasonable?)
- think about you might assess the “goodness” of each

Keep (electronic) notes:

- write a description of the topic, in your own words
- keep a list of important issues and unresolved problems

Using References

What you should **NOT** do with references:

- copy/paste large pieces of text from them into your report**
- if you do this, it's **plagiarism** and you *fail*

Every statement in your thesis which is based on others' work

- must be attributed to them (via a reference)
- even if you make the statement entirely in your own words
- but especially if you are “quoting” them (minimise this)

** One exception is where the quote is an indented paragraph and well-attributed

Using References (cont.)

Examples of acceptable use of others' material:

and Smith [8] noted “M-trees do not assist Z queries”.

and (Smith, 1998) noted “M-trees do not assist Z queries”.

... and as was pointed out by Smith [8]:

M-trees do not assist Z queries. Even if the Z queries conform to the normal pattern of querying expected in this context, the algorithmic complexity is still too high.

The Bibliography

The bibliography

- consists of a list of all of references used in the report
- with enough detail that a reader could find each reference

Examples:

1. Mehregan Mahdavi and John Shepherd. Caching dynamic data in portal applications. In *Proceedings of the 14th International Workshop on Research Issues on Data Engineering: Web Services for E-Commerce and E-Government Applications, Boston, USA , March 28-29, 2004*, pages 30-38. IEEE Computer Society, 2004.
2. Anne Ngu, Banchong Harangsri, and John Shepherd. Query size estimation for joins using systematic sampling. *Distributed and Parallel Databases: An International Journal*, 15(3):237-275, 2004.
3. Albert Nymeyer. Advice on research. <http://www.cse.unsw.edu.au/thesis/a/a-advice.html> Accessed: 18-03-2004.

Proposal/Plan

This chapter aims to show:

- what you plan to do
 - state what methods/approaches you will use to solve the problem
- why you think it will work (well)
 - justify your choices ... there *must* be a reason why you chose them
- when you plan to do it
 - estimating how long research/development will take it always difficult
 - be generous with time allocations; assume that things *will* go wrong

Thesis A Report

Suggested timetable for report preparation:

Weeks	Task
1-5	Meet your supervisor, and discuss what your project is
2-12	Collect and read relevant literature
2-12	Make notes on your reading
6-12	Prepare your method and plan
8-12	Write the report

Thesis B Report

Thesis B Report (The Thesis)

The final thesis aims for you to demonstrate that ...

- you can identify and solve(?) a significant problem
- you can discover and evaluate literature on a topic
- you are capable of evaluating the work that you do
- you have developed some useful skills in your time here

The thesis project ...

- should be a useful talking point at job interviews
- may be a stepping-stone to a research degree/career

Thesis Structure

Introduction	sell the topic, summarise aims (2-5 pages)
Background	set context, evaluate previous work (15-30 pages)
Own Work	what have you done, exactly (10-20 pages)
Evaluation	convince us that it's good (10-20 pages)
Conclusion	summarise achievements (<i>and failures</i>) (2-5 pages)
Bibliography	give references for all work cited
Appendices	present tedious details of data/programs

Chapter Titles

Introduction	no choice
Background	or “Literature Review”, or name it after the general topic area (e.g. “Database Indexing”, “e-Learning Systems”, ...)
Own Work	should be named after your approach or system (e.g. “X-Trees”, “WebCMS”, ...)
Evaluation	or “Experimental Results”
Conclusion	no choice
Bibliography	or “References”
Appendices	no choice

Doing the Work

Each thesis is different, so no specific advice on how to do it.

Some general advice, to ensure that you keep on track ...

- try to stick to the plan that you made in Thesis A
- always work towards a specific short-term goal/milestone
- meet your supervisor regularly (force them to meet)

If you leave the implementation too late ...

- you will be busy with assignments, marking, etc.
- you won't have time to properly evaluate your work

Doing the Work (cont.)

To plan milestones, work backwards:

- *thesis must be completed by week 14*
- will take 1 week to write up evaluation alone, so ...
- *evaluation must be completed by week 13*
- will take 4 weeks to do the evaluation, so ...
- *system must be completed by week 9*
- will take 8 weeks to implement the system, so ...
- *must start implementing system in week 1*
- etc. etc.

Doing the Work (cont.)

The above planning assumes that you are writing other parts of the thesis as you go:

- you can write Introduction/Background/Conclusion anytime
- you can write description of system before you build it
(but will most likely need minor adjustments as you go)

If you're doing usability testing on a system you built ...

- you need usability testers (typically other thesis students)
- you will probably need to modify system after testing

Conclusion: you need a working system *early* in semester 2.

Doing the Work (cont.)

What to do if you find that your *approach* was “wrong”?

- you tried an approach; it didn't work; it will never work
 - present it as a negative result ... useful for others
 - ultimately, not intellectually satisfying for you
- you tried an approach; it didn't work; it can be fixed
 - fix it! ... will require you to change your plans
 - include the first attempt in your write-up ... to warn others

Doing the Work (cont.)

What to do if you find that your *plan* was “wrong”?

- the most likely cause: you tried to do too much
- reduce the scope of the work; discuss with supervisor
 - e.g. build a system with less functionality (omit some functions)
 - e.g. devise a method that solves a subset of cases
- do not reduce the evaluation of your work

Introduction and Background

Use material from these chapters in Thesis A report.

Introduction:

- will definitely need to change if scope/methods change
- re-write to better reflect the final outcomes of project

Background:

- change description of problem if necessary
- add any additional material discovered since thesis A
- elaborate framework and literature review in more detail
- add any missing material on how to evaluate your work

Your Own Work

Contents of this chapter depend on whether RES or DEV thesis.

Either way, should still follow Intro/MainPart/Summary chapter structure.

If you have solved several distinct problems:

- use several chapters of the form (Problem_{*i*}, Evaluation_{*i*})
- if this leads to too much repetition, try:

(Common Material) (Problem₁,Eval₁) (Problem₂,Eval₂) ...

Your Own Work (cont.)

For a RES thesis:

- state the precise research question (including assumptions/limits)
- describe the approach (what exactly did you do?)
- justify your choice of methods (why did you do it this way?)
- outline alternatives that were rejected

Your Own Work (cont.)

For a DEV thesis:

- summarize the system requirements (cf. Background)
- describe the design/implementation (what exactly did you do?)
- justify your choice of methods (why did you do it this way?)
 - platform, architecture, algorithms, data structures, ...
- outline alternatives that were rejected

In all of the above, follow an established software engineering methodology.

For an interactive system, adding a tour of the interface is very useful to give readers a feeling for what you've done.

Evaluation

Aim of evaluation:

- to convince the reader that you have a good solution
- to show that you can analyse and interpret results

To conduct the evaluation:

- refer back to evaluation framework in Background
- for each evaluation dimension, develop an instrument to measure/assess it
 - must explain how instrument assesses dimension
- apply the instrument and present and *analyse* the results

Evaluation (cont.)

Examples of dimensions and instruments:

Satisfies functionality

- apply a standard software engineering testing strategy

Usability of interactive system ...

- conduct task-based usability analysis on range of people

Efficiency of database indexing ...

- measure performance over a wide range of query types
- measure over a large range of database sizes

Will typically need to apply tests across several dimensions.

Evaluation (cont.)

Presentation of results:

- summarise results in Eval chapter; give full details in appendix
- learn a graphing program (e.g. gnuplot)

Analysis/interpretation of results

- essential that you say precisely what the results *mean*

Conclusion

The conclusion should ...

- re-state the goal from the introduction
- summarize what parts of it you have achieved
- summarize what you have **not** achieved
- for any limitations/deficiencies, ...
 - outline how you might approach them (don't need solution)

Typical structure for this chapter:

- main conclusions, subsection on Future Work

Future work is aimed at students who might do this thesis in the future.

Other Resources

Most online resources talk about PhD theses, but many of the basic ideas are also relevant here.

"Writing and Presenting your Thesis or Dissertation" ,
S. Joseph Levine, Michigan State University
<http://www.learnerassociates.net/dissthes/>

"How to write a PhD Thesis" ,
Joe Wolfe, Physics, UNSW
<http://www.phys.unsw.edu.au/jw/thesis.html>

"How to Write a Dissertation" ,
Douglas Comer, Computer Science, Purdue University
<http://www.cs.purdue.edu/homes/dec/essay.dissertation.html>

"How to Write a Master's Thesis in Computer Science" ,
William D. Shoaf, Computer Science, Florida Inst. Technology
<http://www.cs.fit.edu/wds/guides/howto/howto.html>

Other Resources (cont.)

Pages with collections of other resources:

<http://www-2.cs.cmu.edu/afs/cs.cmu.edu/user/mleone/web/how-to.html>

<http://www.cs.iastate.edu/~honavar/research-methods-workshop.html>