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)*

Goals/Requirements of Thesis

Aims of the 4th-year thesis:

- give you exposure to research/implementation topics
- give you experience in tackling a sizeable project
- allow you to "put together" what you've learned

Requirements:

- *seminar* (project overview + plan) (in 06s2, week 12) (5%)
- *report* (literature review + plan) (due 06s2, week 12) (5%)
- *thesis* (project + evaluation) (due 07s1, week 14) (90%)

Goals/Requirements of Thesis (cont.)

For definitive description of Thesis requirements:

- CSE Thesis web site[1]
- 4th-year Thesis Coordinator ... John Potter[2]

If any of these slides disagree with the above,

the above takes precedence (i.e. they are correct)

FAQ

Q: How long should X be? ($X \in$ chapter,Report,Seminar,Thesis)

A: As long as is necessary to make it convincing.

Q: When is Y due? ($Y \in$ Report,Seminar,Thesis)

A: Check www.cse.unsw.edu.au/thesis

Q: What happens if I can't finish?

A: You get less marks than you would if you finished.

Q: Can I get an extension?

A: No ... if Thesis A is late/missing, you get AF.
If Thesis B is late, you suffer heavy *late penalties*.

FAQ (cont.)

Q: What must I do to get good marks?

A: Depends on whether you're asking supervisor or assessor

Supervisor:

- knows everything you did (or ought to)
- can assess based on continuous performance

Assessor:

- (most likely) sees only Seminar, Demo, Thesis
- can assess based on what she/he observes in S/D/T

To be safe: ask what they're looking for.

Why a Thesis is not an Assignment

A thesis is significantly different from an assignment:

- it is, typically, *open-ended*
  - there is not an obvious single “correct” answer
  - you have more say in the direction the work takes
- it has a much longer time-frame
  - you need more *self-discipline* to get things done
  - you have more responsibility to *plan* your progress

If you’re still in “assignment mode”, break the task into 2-week-long steps and treat each one as an assignment (but, alas, no late penalty).

Different Types of Theses

Theses have been classified into:

RES carry out a small focussed piece of research

DEV build a software and/or hardware system

R&D combination of the above two ...
build a system, but needs research to get it done

Expectations for each type are slightly different (see later)

What is Research?

Activity that advances the store of human knowledge, e.g.

- explaining a previously unexplained phenomenon
- developing techniques to do things better
- proposing a new viewpoint on a cultural system
- proving a theorem

Scientific/engineering research follows the “scientific method”:

- Observe ... Hypothesize ... Test ... (repeat)

What is Research? (cont.)

Example: astronomer discovering rotating star pairs

Observation:

- individual stars that appear to pulsate/change
  (changing brightness, different spectra at different times, ...)

Hypothesis:

- such "stars" are actually rotating pairs (intuition)

Test:

- examine stars using different instruments
  (e.g. very powerful optical observation to reveal individual stars)

Computing Research

Writing a piece of software, no matter how complex, isn't generally regarded as research in itself.

However, it would be considered research if

- it uses a new method/algorithm/data structure
  (the new method must be *demonstrably* better than earlier approaches)

- it solves a problem not previously solved by computer
  (will typically involve development of new methods, anyway)

Computing Research (cont.)

Example: devising a new database indexing method

Observation:

- queries of type Y are not efficient with existing methods
- try to figure out what it is about Y queries that makes them slow

Hypothesis:

- my new method (X-trees) will handle Y queries *better*

Test:

- analyse computational complexity of X-trees for Y queries
- build an X-trees indexing library, test on a variety of data

Computing Research (cont.)

Evaluation of computing research:

- solves existing problem more effectively than before
- solves a wider range of problems than before (generalises)

Demonstrations of effectiveness follow two tracks ...

Theoretical, e.g.

- analyse complexity, prove upper/lower bounds, ...

Experimental, e.g.

- build prototype; measure performance on range of data

What is Development?

Construction of artefacts/systems to solve problems.

Implicit notion that new systems are *better* than existing.

There is still a (minor) research aspect:

- you must demonstrate effectiveness
- you must analyse and describe limitations

A very important requirement for a DEV project:

- follow a well-defined project development methodology
- document the development process in the thesis

(cf. research projects: the result is paramount, method matters less)

Computing Development

Aim: build a system to meet a demand or solve a problem.

May involve developing software, hardware, or a combination.

The goal is clearly to build the system, but you must also:

- follow a (software) engineering methodology (+ document it)
- provide a demonstration that the system *works effectively*
- note any unsolved problems and limitations

Computing Development (cont.)

Characteristics of effectiveness are problem-dependent, e.g.

- time and space, for most computing projects
- bandwidth utilisation, for networks
- usability, if there's a user interface
- accuracy (precision/recall), for web search engines

Must use *appropriate* evaluation instrument for project.

Must be honest about effectiveness (even negative results are useful).

Doing Research

The process is an elaboration of “observe/hypothesis/test”:

- understand the broad topic area
- establish an evaluation framework (issues, metrics)
- look at what others have done and evaluate
- find an area of “weakness” in existing work
- devise a (better) solution
- evaluate the effectiveness of the solution

Hint: document all parts of this process **as they are done**.

Reporting Research

Reporting follows, more or less, the steps in the process:

Introduction	sell the topic, summarise aims
Background	set the context, review literature
Own Work	what have you done, exactly
Evaluation	convince us that it's good
Conlusion	summarise achievments (and failures)

Reporting Research (cont.)

Introduction:

- outline the topic area, significance, originality, ...
- give overall aims of your work, summarise contribution

Background:

- describe the problem you are trying to solve in detail
- establish evaluation framework (what makes a *good* solution?)
- describe *and analyse* what others have done already

Reporting Research (cont.)

Own Work:

- describe your proposed method/approach in detail

Evaluation: (experimental)

- describe evaluation process (what are you measuring, how, why)
- report *and discuss* results of evaluation

Conclusion:

- summarise what you achieved
- *and* what you didn't achieve ... and suggest how to fix it

Doing Development

Has similarities to research ... but like “observe/build/test”:

- understand/refine the requirements
- establish an evaluation framework
- look at what others have done and evaluate
- look at what methods are available, and choose
- devise a solution (implement system)
- evaluate the effectiveness of the solution

Hint: document all parts of this process **as they are done**.

Reporting Development

Reporting follows, more or less, the steps in the process:

Introduction	sell the topic, summarise aims
Background	set context, evaluate approaches
Own Work	what have you done, exactly
Evaluation	convince us that it's good
Conlusion	summarise achievments (and failures)

Reporting Development (cont.)

Introduction:

- outline the topic area, significance, benefits ...
- give overall aims of the project

Background:

- describe the problem you are trying to solve in detail
- establish evaluation framework (how to recognise a good solution)
- describe *and analyse* what others have done already (maybe no-one has attempted this before?)
- evaluate possible implementation methods/approaches

Reporting Development (cont.)

Own Work:

- describe implementation process (SE) and final product
- if it has a user interface, give a tour of this

Evaluation:

- describe evaluation process (what are you measuring, how, why)
- report *and discuss* results of evaluation

Conclusion:

- summarise what you achieved
- *and* what you didn't achieve ... and suggest how to fix it

Getting Started

Getting Started

What you should be doing as soon as you have a topic:

- *think* about the topic ... understand all aspects, etc.
- find out what others have done before (reading required)
(Google[3] ... Citeseer[4] ... DBLP[5])
- consider what's need to evaluate your work
(don't bother considering evaluation-by-bluff ... it doesn't work)
- make notes on everything that you look at/think about
- set up a thesis web site? (for holding the notes)
- meet your supervisor and find out what they expect
- establish a consistent Thesis working pattern (weekly meeting?)

Do all of this before week 6 and assignments get heavy.

Getting Started (cont.)

Things you should do **today** ...

- create a directory called *thesis* (or *4910* or ...)
- create subdirectories: *report*, *seminar*, *thesis*
- if doing implementation, create a directory called *system*
- create subdirectories:
  - *notes*: where you type up ideas *as you think of them*
  - *papers*: to keep electronic copies of reference material
- if keen, set up a web site (e.g. Wiki) for your thesis work

You should do this *today* because you have no asssignments to do yet.

Thesis A

Thesis A aims for you to demonstrate that ...

- you have a thorough understanding of the topic
- you have identified an aspect 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
(5-6 minutes)

Background set context, evaluate previous work
(12-15 minutes)

Proposal/Plan how do you plan to tackle the problem
(2-3 minutes)

Bibliography give references for all work cited
(as you go)

Seminar = summary of Report, publicity for project, chance for 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).

URLs

1. `www.cse.unsw.edu.au/thesis/`
2. `www.cse.unsw.edu.au/info/potter.html`
3. `www.google.com.au/`
4. `citeseer.csail.mit.edu/`
5. `www.informatik.uni-trier.de/~ley/db/`