# Research Methods comp4809/7809

(Put booster rockets under your project)

Professor Janet Wiles (Weeks 1-6)

Professor Jane Hunter (Weeks 7-13)

# Announcements

- Course goal: to support project work
- Co-requisite requirement: To enrol in this course, students must be in the first semester of a two-semester project
- Webpage: http://www.itee.uq.edu.au/~comp4809/
- Profiles
- Assessment: 10 Deliverables (one per wk) + Lecture attendance
- Questions or feedback?

# Compatible Projects

## Projects commencing Sem. 1

- COMP6803,COMP7801 - Computer Science/IT Honours Project
- ENGG4801, METR4900, ENGG7803, ENGG7802 - Engineering Thesis
- IENV3801 - Information Environments Studio 5
- IENV6801 - Information Environments Honours
- MMDS3801 - Multimedia Project 1
- PhD and Research Masters students (first semester)

# INCOMPATIBLE PROJECTS

## Projects commencing Sem. 2

- COMP6804,COMP7802 - Computer Science/IT Honours Project (mid-year)
- ENGG4802,METR4901,ENGG7804 - Engineering Thesis (mid-year)

# Passing this course

- Attend the lectures
  - Must attend **10** lectures
  - Not attending lectures **will** cause you to fail
- Hand in all of the deliverables
  - Must submit **all** deliverables
  - Must get at least 50% (40 marks) total over all deliverables
- This isn’t difficult, it’s just a lot of work.

# Goals of Comp4809/7809

- Making your project happen
- Discussion Question:

  How do you get a 7 in a course?

  vs.

  How do you get a 7 in a project course?
- Projects are a different style of learning to traditional engineering and computing courses.

# Attendance sheet

# Lecture 1
# Introduction to Research Methods

- A tale of two projects
- What is science?
- What is research?
- What are research methods?

# A Tale of Two theses

Case A. Extraordinary vision. Grade 7. Mark 86.

- Anna (not her real name) looked for a project that was a little unusual and found a project building a software tool. She had great skills and research flair, though it wasn't obvious at first …

Case B. Gone to the dogs. Grade 4. Mark 55.

- Bob (not his real name) wanted to do a project in machine learning. It was out of the ordinary – he wanted to apply a neural network to predicting dog races …

# What grade do you want?

(not actually a trick question)

# What is science?

Available at:
http://www.itee.uq.edu.au/~comp4809/wiki/index.php/What_is_science%3F

Science has developed out of a history of philosophy that started with the ancient Greeks.

Philosophy was an attempt to describe the world around us, and has culminated in a system which is characterized by the Scientific Method.

# What is science?

- The scientific method is an ongoing process in four stages:
  - Observation
  - Hypothesis, to explain the observation
  - Prediction, based on the hypothesis
  - Experimentation, to test the prediction

- Experimentation leads back naturally to observation, where the process repeats

# What is good science?

- Peer review is an important aspect of modern science
  - It occurs at each stage of the process, and is vital for acceptance of the work
- “Experimentation” can be less obvious in IT than in other science, but it is an important step
- Having a hypothesis doesn’t make something scientific
  - Hypotheses must lead to predictions
  - Experiments must be reproducible

# What is research?

- It doesn’t have a simple definition, but I recognize it when I see it
  - use a checklist (Zobel’s Research list)
- Uncommon sense
  - Learning research by doing it
- What to do to achieve an excellent project?
  - Focus attention and action effectively

# Learning research by doing it

Outline

- Finding and defining a topic
- Presenting a seminar
- Demonstrating your work
- Completing a project report

# 1. Finding and defining a topic

- Topic, goal and relevance
- Review of background and relevant work
- Project plan and progress
- Presentation

| | Topic, goal and relevance (25%) | | Review of background and relevant work (25%) | | Project plan and progress (25%) | | Presentation (25%) | |
|---|---|---|---|---|---|---|---|---|
| | There is no doubt about the intended coverage and contribution of the thesis. Includes a project outline and clear statement of purpose. Evidence of initiative. | 25<br>23<br>21 | Clear and independently developed mastery of the material in the topic area. Most helpful in understanding the rest of the document. | 25<br>23<br>21 | A well justified, comprehensive and feasible list of project milestones (with resources and duration). Evidence of strong progress, strong problem-solving skills, initiative and self-reliance. | 25<br>23<br>21 | Excellent structure, so a pleasure to read. Neat, professional presentation – scientific/technical writing style. A correctly formatted bibliography appropriately referenced. | 25<br>23<br>21 |

# What do *you need to do* to achieve an excellent project?

- The mark sheets tell you what an excellent project is.
  - But they don't tell you what you need to do to create one.
- What you do and how you do it is up to you
  - You need to work out for yourself what your skills are in each of the areas required.
  - You need to create a plan that will enable you to work towards an excellent piece of work.
- One way to do create such a plan is to turn the mark sheet into a personal action checklist:
  - For each item, consider what actions need to be taken, if you have the skills already, or need to develop them.

# Sample Action and skills list for the project plan

| Topic, goal and relevance (25%) | | Review of background and relevant work (25%) | | Project plan and progress (25%) | | Presentation (25%) | |
|---|---|---|---|---|---|---|---|
| There is no doubt about the intended coverage and contribution of the thesis. Includes a project outline and clear statement of purpose. Evidence of initiative. | 25<br>23<br>21 | Clear and independently developed mastery of the material in the topic area. Most helpful in understanding the rest of the document. | 25<br>23<br>21 | A well justified, comprehensive and feasible list of project milestones (with resources and duration). Evidence of strong progress, strong problem-solving skills, initiative and self-reliance. | 25<br>23<br>21 | Excellent structure, so a pleasure to read. Neat, professional presentation – scientific/technical writing style. A correctly formatted bibliography appropriately referenced. | 25<br>23<br>21 |

| Desired result | Action | |
|---|---|---|
| Clear intended coverage<br>Project outline<br>Clear statement of purpose<br>Evidence of initiative | What's the scope?<br>How detailed is an outline?<br>What's the purpose?<br>What's the initiative in your project? | |
| Clear and independently developed mastery of the material in the area<br>Helpful in understanding the rest of the document | What constitutes mastery?<br>How much help constitutes independence?<br>How do you ensure that a review is helpful? | |
| … | | |

# 2. Presenting a Seminar

- Content and progress
- Structure
- Verbal Skills
- Visual Aids
- Timing

| Content and progress (50%) | | Structure (20%) | | Verbal Skills (10%) | | Visual Aids (10%) | | Timing (10%) | |
|---|---|---|---|---|---|---|---|---|---|
| Clear statement of thesis. Clear mastery of background material. Comprehensive and sound plan for research and development. Evidence of strong progress. | 50<br>47<br>44 | Clear development of thesis ideas. Presentation has logical flow. Easy for audience to navigate. Appropriate level of detail. | 20<br>18<br>17 | Confident, relaxed, natural, well rehearsed. Good eye contact, Clear, articulate and audible. Questions were very well answered. | 10<br>9 | Clear, interesting, uncluttered. Use enhances presentation. Diagrams where appropriate. Appropriate number of slides. | 10<br>9 | Time allocated appropriately to material. Adherence to set time frame. Correct pace throughout delivery. | 10<br>9 |

# 3. Poster and Demonstration

- Poster
- Presentation
- Excellence and innovation
- Completeness

| Poster (25%) | | Presentation (25%) | | Excellence, Innovation (25%) | | Completeness (25%) | |
|---|---|---|---|---|---|---|---|
| Accurate concise abstract completely captures topic and outcomes. Clearly defined topic and scope. Appropriate background material. Excellent structure, uncluttered, appropriate text, diagrams, pictures and tables best convey information. Creative presentation captures attention. | 25<br>23<br>21 | The verbal presentation is meaningful, interactive, tailored appropriately to a diverse audience. Confident, fluent, professional presentation. Able to strongly defend and justify work. Questions are handled masterfully. Effortlessly uses poster and/or demonstration as an aid. | 25<br>23<br>21 | Work is of the highest quality demonstrating best research and engineering practice and showing substantial creativity and innovation. | 25<br>23<br>21 | From the exposition of the work it should be self evident that the work is complete and functional or correct. | 25<br>23<br>21 |

# 4. Project Report

- Writing and presentation
- Background
- Thesis definition and scope
- Approach and execution
- Conclusion

| Writing and presentation (20%) | | Thesis definition and scope (20%) | | Background (20%) | |
|---|---|---|---|---|---|
| Excellent logical structure, physical layout and appropriate attention to detail. The work is presented in an accurate, concise and coherent fashion. Scientific and technical style. No spelling mistakes or grammar errors. Appropriate referencing to a correctly formatted bibliography. Appropriately acknowledges the work of others. | 20<br>18<br>17 | Excellent, clear definition of thesis topic, problem and/or hypothesis (including statement of purpose and relevance) and scope (including context, boundaries and assumptions). The abstract accurately yet concisely captures the thesis topic, methods and outcomes. | 20<br>18<br>17 | Extensive, relevant and logically organised review, analysis, discussion of background material, both specific research and general theory, helps the reader understand the rest of the document, and demonstrates clear mastery of the material in the topic area and ability to synthesize and abstract knowledge. | 20<br>18<br>17 |

| Approach and execution (20%) | | Conclusion (20%) | |
|---|---|---|---|
| A clearly set out plan with goals and methods systematically follows from the background research. The approach highlights your creativity and innovation and includes an evaluation of alternative approaches. The actual execution of work shows the application of knowledge gained from background research, possibly in different contexts leading to the generation of new knowledge. | 20<br>18<br>17 | The analysis of the work conducted highlights your comprehension and shows insight into the significance of the results. The thesis has a critical review of your performance against the stated plan. The thesis concludes with a clear concise summary of the outcomes – in context of specified thesis definitions and literature – and brings recommendations for continuation and improvement of the thesis. | 20<br>18<br>17 |

# Sample Action and skills list for Final Report: Writing and presentation

| Desired result | Action | Skills / resources |
|---|---|---|
| Excellent logical structure, | Use clear overviews and check paragraph by paragraph | Find out what "logical structure" means |
| Physical layout and | Use appropriate layout | Look at other reports to see their layout |
| Appropriate attention to detail. | Write descriptions when I do each piece of work | Look at level of detail in good reports |
| The work is presented in an accurate, concise and coherent fashion. | Be accurate<br>Write clear descriptions<br>Revise to be coherent & concise | Find out what makes a description clear |
| Scientific and technical style. | Write each section | Read past reports to see what this style is |
| No spelling mistakes or grammar errors. | Careful proofreading | Time management |
| Appropriate referencing to a correctly formatted bibliography. | Create reference list | Learn how to reference appropriately |
| Appropriately acknowledges the work of others. | Keep accurate notes of sources | Get a lab book to help being disciplined |

# “A Research Checklist” [1]

1. Are the ideas clear and consistent?
2. Is the problem worthy of investigation?
3. Does the project have appropriate scope?
4. What are the specific research questions?
5. Is there a hypothesis?
6. What would disprove the hypothesis? Does it have any improbable consequences?
7. Are the premises sensible?
8. Has the work been critically questioned? Have you satisfied yourself that it is sound science?

[1] Quoted from Zobel, J. (2004) *Writing for Computer Science*, Springer Verlag. Pp. 182-183

# “A Research Checklist” cont. [1]

9. How are the outcomes to be evaluated? Why are the chosen methods of evaluation appropriate or reasonable?
10. Are the roles of the participants clear? What are your responsibilities?
11. What activities will others undertake?
12. What are the likely weaknesses in your solution?
13. Is there a written research plan?
14. What forms of evidence are to be used?

[1] Quoted from Zobel, J. (2004) *Writing for Computer Science*, Springer Verlag. Pp. 182-183

# “A Research Checklist” cont. [1]

15. Have milestones, timelines, deadlines been identified?
16. Do the deadlines leave enough room for your advisor to provide feedback on your drafts, or for your colleagues to contribute to the material?
17. Has the literature been explored in appropriate depth? Once the work is largely done – and your perspective has changed – does it need to be explored again?

[1] Quoted from Zobel, J. (2004) *Writing for Computer Science*, Springer Verlag. Pp. 182-183

# What are research methods?

- Domain-specific research practices
  - Tools & techniques
  - Methodology
  - Analysis
  - Demos
- Generic research skills
  - Project planning
  - Reading, literature reviews
  - Writing
  - Seminars, posters, demos
  - Time management

> “There are as many scientific methods as there are individual scientists”
>
> Percy W. Bridgeman, On Scientific Method

# On writing

“The elements of good writing
– clarity, simplicity, accuracy, and organization –
are an essential part of success in science”

Justin Zobel

# Break

# Part 1. Action

- The Project Timeline
  - Significant stages and dates
  - Deliverables: Begin with the end in mind

- Getting Started
  - Find a project
  - Deliverable #1. Project title & project description
  - Deliverable #2. Annotated bibliography

# Timeline
# Make it concrete and personal

| COMP6803, COMP7801 | | Start: Semester 1 / 2006 | | | | |
|---|---|---|---|---|---|---|
| **Component** | **Deliverable** | **Deadline** | **Deadline Date** | **Assessor** | **Weight** | **Links** |
| **Progress Report** | Submit **Project Progress Report** (electronic submission and hard copy directly to supervisor) | **4pm Friday, Week 7** of first semester of the project | **14 / April / 2006** | Supervisor | 15% | •Submission page |
| **Half-time seminar** | Present seminar (day and time negotiated with supervisor), Attend 5 other seminars | **Week 11** of first semester of the project | **15-19 / May / 2006** | Supervisor | 15% | •Seminar attendance form<br>•Times available for seminars<br>•Current bookings |
| **Poster and Abstract submission** | Submit poster and 250 word Abstract (electronic submission*) | **4pm Friday, Week 10** of second semester of the project | **06 / Oct / 2006** | Assessed with Oral presentation | Assessed with Oral presentation | •Templates<br>•Submission page |
| **Thesis** | Submit thesis (electronic submission* and two printed and soft-bound copies to School Office) | **4pm Wednesday, Week 13** of second project semester | **25 / Oct / 2006** | Supervisor and examiner. | 50% | •Thesis information page<br>•Submission page |
| **Oral presentation (Demonstration)** | Present your work to your Examiner and Supervisor | **9am-12noon, Thursday, Week 13** of second semester of the project | **26 / Oct / 2006** | Examiner. | 20% | •Demo information page<br>•Templates<br>•Demo booking<br>•The demo schedule<br>•Submission page |

# COMP4809 / COMP7809 Deliverables assist time management

- How many hours should be spent on the project in total?
- How many per week in semester 1?
- How many per week in semester 2?

# Deliverable #1.
# Project title and project description

- Find a project
  - doing the right project
  - doing the project right

# What's in a name?
## Project titles from previous projects

1. Integration of heterogeneous sensors network for context aware pervasive computing.
2. Development of VRML metadata system for context relevant information
3. In-silico characterisation of functional sites of glutathione transferases: a machine learning approach.
4. A study of Language Evolution and adaptation using Robots
5. Digital Archaeology Library

What would each of these projects been about?

# Exercises for titles

1. Integration of heterogeneous sensors network for context aware pervasive computing.
2. Development of VRML metadata system for context relevant information
3. In-silico characterisation of functional sites of glutathione transferases: a machine learning approach.
4. A study of Language Evolution and adaptation using Robots
5. Digital Archaeology Library

If you were on a grants committee and could award 9 months of funding (say 50K with oncosts) to fund one of the following projects, ask yourself which you would choose, and why?

# "A title may be more important than you think"

- Some projects go for months with no title beyond “my project”
- For a project report an effective title:
  - captures the reader’s attention
  - prepares the reader for the focus of the project
- Components of a good title:
  - clear, concise, meaningful
  - not too broad, not too narrow
  - little to no jargon, and careful use of buzzwords

[1] This section is based on Friedland, A.J. and Folt, C.L. (2000). *Writing successful science proposals*. Yale University Press: London. Chapter 5. "A title may be more important than you think" pp53-61.
Retrieved from "http://www.itee.uq.edu.au/~comp4809/wiki/index.php/Writing"

# Project Titles

Swap titles with the person next to you. Ask yourself

1. What will this project be about?
2. Does the title capture the attention?
3. Does it prepare the reader for what the project will be about?

# Using the title to hone the scope

- List the main areas of your research, including both domain and methods (up to 6 areas)
- Choose three that make your research distinctive
- Write half a dozen titles using those concept terms
- For each title, ask yourself, "If I read a report with that title, what would it be about?"
- Ask yourself, "Is that what my project is about?"

# Exercises to refine your title

- Clarify
- Shorten
- Make it more precise
- Get feedback from others
- Exercise on analyzing titles

[1] This section is based on Friedland, A.J. and Folt, C.L. (2000). *Writing successful science proposals*. Yale University Press: London. Chapter 5. "A title may be more important than you think" pp53-61.
Retrieved from "http://www.itee.uq.edu.au/~comp4809/wiki/index.php/Writing"

# Deliverable #2: Annotated Bibliography

- Acceptable references
  - What counts as an acceptable reference?
  - Why are wikipedia articles not acceptable?
  - What does *provenance* of a document mean?

- Reference formats
  - Use a style sheet: endnote or bibtex
  - IEEE Computer Society style guide http://www.computer.org/author/style/refer.htm
  - APA style (for psychology formats) http://www.apastyle.org/

# Getting up to speed in a new area quickly

- Find relevant articles
  - Search
    - Google, Google scholar, Citeseer, Medline
  - Ask your supervisor
- Skim read them
  - Title, abstract, key terms, diagrams/methods
- Map them
  - Identify key ideas, make notes about anything you don’t understand

# Case study:
# The Sponge genome project

As a bioinformaticist you are invited to a meeting with Prof Degnan, the Director of the Sponge Genome project.

You don’t have long to prepare.

All you’re really sure about is that you know almost nothing about sponges!

# Mapping

1. Search Google for “sponge genome project” and Degnan
2. Search Google scholar for Bernard Degnan http://scholar.google.com/
3. Download a few recent papers (add the references in Endnote)
4. Use mapping software to find the major themes (e.g., Leximancer http://www.leximancer.com/)
5. Look up any terms online

30 mins!

# APA Reference formats

Examples are on the wiki
http://www.itee.uq.edu.au/~comp4809/wiki

…but the only true source is the APA style guide, which is not freely available.

…but the library has it.

# Journal articles

**Find the errors**

Rik Belew, (1990). Evolution, learning and culture: computational metaphors for adaptive search. *Complex Systems*, **4**(1):11-49.

Nishikimi, M., Fukuyama, R., Minoshoma, S., Shimizu, N., and Yagi, K. (1994). Cloning and chromosomal mapping of the human nonfunctional gene for L-gulono-gamma-lactone oxidase, the enzyme for L-ascorbic acid biosynthesis missing in man. *Journal of Biological Chemistry*.

# Books

**Find the errors**

Cohen, J. and Stewart, I. (1994). *The Collapse of Chaos*.

Mtichell, M. (1996). *An Introduction to Genetic Algorithms*. Cambridge, MA: MIT Press.

**Edited book**

Turney, P., Whitley, D., and Anderson, R. (1996). *Evolution, Learning and Instinct: 100 Years of the Baldwin Effect*, (Eds). Cambridge, MA: MIT Press.

# Conference Proceedings

French, R.M. and Messinger, A. (1994). Genes, Phenes and the Baldwin Effect: Learning and Evolution in a Simulated Population. In R. Brooks and P. Maes (Eds.), Artificial Life IV. Cambridge, MA: MIT Press.

Mayley, G. (1996). The evolutionary cost of learning. In (Eds) P. Maes, M. J. Mataric, Jean-Arcady Meyer, J. Pollack and S. W. Wilson, *From Animals to Animats 4: Proceedings of the Fourth International Conference on Simulation of Adaptive Behavior*. Cambridge, Ma: MIT Press, 458-467.

## Journals, books, edited book, book chapters, conference proceedings, reproduced articles

### Journal

Belew, R.K. (1990). Evolution, learning and culture: computational metaphors for adaptive search. *Complex Systems*, **4**(1):11-49.

Nishikimi, M., Fukuyama, R., Minoshoma, S., Shimizu, N., and Yagi, K. (1994) Cloning and chromosomal mapping of the human nonfunctional gene for L-gulono-gamma-lactone oxidase, the enzyme for L-ascorbic acid biosynthesis missing in man. *Journal of Biological Chemistry 269,* 13685-8.

### Book

Cohen, J. and Stewart, I. (1994). *The Collapse of Chaos*. London: Penguin.

Mitchell, M. (1996). *An Introduction to Genetic Algorithms*. Cambridge, MA: MIT Press.

### Edited book

Turney, P., Whitley, D., and Anderson, R. (1996). *Evolution, Learning and Instinct: 100 Years of the Baldwin Effect*, (Eds). Cambridge, MA: MIT Press.

### Book chapter

Deacon, T. W. (2003). Multilevel selection in a complex adaptive system: the problem of language origins. B. H. Weber & D. J. Depew (eds.) *Evolution and Learning: The Baldwin Effect Reconsidered.* Cambridge, MA: MIT Press.

### Reproduced article

Baldwin, J. M. (1896). A new factor in evolution. *American Naturalist* 30: 441 – 451. Reproduced in (eds.) Belew, R.K. & Mitchell, M., *Adaptive Individuals in Evolving Populations,* Proceedings Volume XXVI, Santa Fe Institute Studies in the Sciences of Complexity. 1996. Reading, MA: Addison-Wesley.

### Conference Proceedings

French, R.M. and Messinger, A. (1994). *Genes, Phenes and the Baldwin Effect: Learning and Evolution in a Simulated Population*. In R. Brooks and P. Maes (Eds.), Artificial Life IV. Cambridge, MA: MIT Press.

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# Deliverables

- On every submission
  - Name
  - Student number
  - Statement saying that you've emailed the deliverable to your supervisor
- Use PDF format
- **One** file per submission
  - Yes, even for deliverables that involve timelines, charts, diagrams, etc.

# Email

- Send email from your student account
- Dear “Professor Wiles” or “Hi Janet”
- Sign with your full name and student number

# Resources

- Your supervisor
- Other students
- UQ Library runs useful research-related sessions
  - Library orientation
  - Information skills (database use, etc.)
  - Endnote

# Resources

- Course home page
  http://www.itee.uq.edu.au/~comp4809/
- Course profile
  http://www.itee.uq.edu.au/~comp4809/profile.html
- Deliverables
  http://www.itee.uq.edu.au/~comp4809/Deliverables/
- Newsgroup
  uq.itee.comp4809
- Research wiki
  http://www.itee.uq.edu.au/~comp4809/wiki/

# Summary

- The project is a transition to research
  - Know what is expected (look at the marking criteria sheets)
  - Develop your research skills
- Plan the timeline for the YEAR
  - You set the agenda for yourself, schedule your weekly timetable, and manage the relationship with your supervisor

# Journal articles

**Find the errors**

**Belew, R.K.**

Rik Belew, (1990). Evolution, learning and culture: computational metaphors for adaptive search. *Complex Systems*, **4**(1):11-49.

Nishikimi, M., Fukuyama, R., Minoshoma, S., Shimizu, N., and Yagi, K. (1994). Cloning and chromosomal mapping of the human nonfunctional gene for L-gulono-gamma-lactone oxidase, the enzyme for L-ascorbic acid biosynthesis missing in man. *Journal of Biological Chemistry*. **269**: 13685-8

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***Artificial Life IV***

***Page numbers?***

Mayley, G. (1996). The evolutionary cost of learning. In (Eds) P. Maes, M. J. Mataric, Jean-Arcady Meyer, J. Pollack and S. W. Wilson, *From Animals to Animats 4: Proceedings of the Fourth International Conference on Simulation of Adaptive Behavior*. Cambridge, Ma: MIT Press, 458-467.