Department of Computer Science

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Computer Science

Honours Handbook

2012

Our Mission

As the Department of Computer Science, our mission is to develop and impart knowledge and skills in the field of Computer Science.

Our Vision

The Department of Computer Science strives to be a department of the first rank in both an international and an African context,

- Sustaining high respect for its research and post-graduate education
- Excellence in teaching in order to produce graduates who possess the skills that are needed whenever decision making or creative thinking takes place
- An influential role in industry and the Information Technology community

The University of Cape Town is committed to policies of equal opportunity and affirmative action which are essential to its mission of promoting critical inquiry and scholarship.

Contents

1   Welcome to Computer Science Honours

Congratulations on your results and your acceptance into the Honours Programme of the Department of Computer Science at the University of Cape Town. You have chosen one of the best Computer Science departments in the country for pursuing your graduate work. The honours course completes your qualification as a computer professional. It is an opportunity to undertake advanced courses given by enthusiastic lecturers on their own area of specialization, as well as to complete a major research and development project.

This booklet contains details of the structure of the Honours year (fourth year). The Honours year, in particular, is hard full-time work; we hope that you enjoy the course. The department wishes you every success for the year.

Note Well: As pointed out below (Section 2.3.1) you must be at the University *two weeks before the normal start of the (undergraduate) academic year* in order to fulfil certain compulsory parts of the honours course.

1.1 Professional Qualification

In Computer Science it takes four years to gain a professional qualification. It is only after four years that we sufficiently cover the ACM /IEEE Computer Science Curriculum[1]. It is also only after four years that you will have fulfilled the Requirements of the British Computer Society (BCS) for a professional Computer Science qualification — this only applies to students have also completed their undergraduate studies (BSc) in this department. The Department's honours course is recognized as providing full Chartered IT Professional (CITP) accreditation[2] as well as partially meeting the education requirement for Chartered Scientist (CSci) registration.

A professional qualification means that you can go into commerce and industry and practice with confidence in the field of Computer Science. It will certainly improve your career prospects locally and is an essential qualification for the global marketplace.

Our students have found employment in local companies such as Amazon.com Development Centre in Cape Town, local games and media companies such as Black Ginger and Wisdom Games and innovative businesses such as Wizzit Bank in Sandton. Our students also work for nVidia, Microsoft and Amazon in the USA.

1.2 Graduate Studies

We have built up a stable group of well-qualified researchers in this department and we believe we have brought together some of the best people in this country, with doctorates and experience from some of the world's leading Computer Science institutes.

A key aspect of the programme is to enable you to function both independently and in teams. By the end of the course you are able to read relevant literature and formulate research and development proposals. You will gain practical experience in team work by initiating and managing a major project. Emphasis is placed on the effective communication of ideas and results.

There is a significant, but subtle, difference between studies for an undergraduate and a graduate degree. It is assumed that if you register for the course, it is because you have an interest in your studies in general and Computer Science in particular.

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[1]   http://www.acm.org/education/curricula-recommendations
[2]   http://www.bcs.org/server.php?show=nav.7065

As a graduate student, you are expected to:

- Be responsible for identifying much of your study material yourself and managing your own study programme
- Work largely unsupervised and independently
- Display evidence of independent and original thought
- Be prepared to evaluate, criticise and justify
- Show an appreciation of concepts and principles
- Communicate ideas clearly and succinctly
- Learn together with staff members

1.3 Role of the Department

In general the role of the Department is to:

- Produce graduates with knowledge and skills relevant to both the International and the South African Information Technology community
- Carry out innovative research which adds to basic understanding
- Produce service courses and provide research assistance in the fields of science and engineering
- Provide services to Industry through technology transfer and applied research
- Take an active part in the academic and governance affairs of the University
- To provide opportunities and support for students from disadvantaged backgrounds to realise their potential
- To promote, support and advise schools in the teaching of Computer Science Technology

In our graduate programme our role is more specifically to produce individuals who are well read, articulate, and able to exercise critical judgement in the field of Information Technology. Its core function, therefore, is not that of providing vocational training, but to impart the fundamental skills that are needed whenever decision making or creative thinking takes place. These skills have to be nurtured in the special environment of the university, where orthodoxies can be challenged and ideas can be developed.

We therefore educate our students in the principles, theory and practice of Computer Science. We do not aim to train people how to use computers and become programmers, although you will learn those things as a matter of course. We want our students still to be useful scientists a decade from now, rather than be trained for the immediate demands of the marketplace.

1.4 Further Study

Students who successfully complete honours will be eligible to proceed to an MSc in Computer Science by dissertation provided they can find an approved supervisor for their intended course of study and research.

1.5 Programme Coordinator

The honours programme coordinator is Dr. Anne Kayem, Room 307, Computer Science Building (email: akayem@cs.uct.ac.za). There will also be class representatives to whom issues may be addressed. Apart from the issues mentioned above which must be resolved in consultation with the programme coordinator, any queries regarding the programme should first be addressed to the departmental administrative assistant; if the matter needs to be brought to the attention of the programme coordinator, she will do so.

1.6   Financial Assistance

Financial assistance is available for prospective Honours students. Please look at the University's Postgraduate Degree Funding web page3 or email pgfunding@uct.ac.za.   The South African National Research Foundation (NRF) provides a *limited* number of bursaries to South African citizens. The closing date for NRF bursaries is usually around the 30 September; the notification date is February of the next year. The University offers *UCT Council Honours Merit Scholarships* for students who achieve at least 65% in their undergraduate majors. A number of other bursaries are also available. You are advised to apply for all bursaries as early as possible.

The department's Advisory Board members are able to offer bursaries for Computer Science Honours at UCT; for 2012 there were 14 such bursaries on offer which covered tuition fees and some additional money. Please apply to the head of the department for these.

In addition to these bursaries, some members of the department have funds available for research purposes, which may be available to students involved in projects undertaken by these members of staff. Students with legitimate financial difficulties may also receive departmental support. Any queries in this regard should be addressed to the programme coordinator.

1.7   Facilities

Honours students are accommodated in a dedicated laboratory with 24-hour access, a small kitchen and coffee area, lockers and workstations. Our stated machine policy is to have at least two machines for every three students: in practice every student has in recent years had access to their own machine.

Computing resources include servers and workstations running BSD, Ubuntu Linux and other Linux distributions, Microsoft: Windows XP Professional, Windows 2003 Enterprise Server Edition.

Software resources for teaching and development are drawn from Public Domain offerings, third party releases (e.g. IBM Rational Suite) and the Microsoft Developer Network Academic Alliance software program.

For experiments in parallel computing we have an Apple cluster, comprising 9 quad-core Xeon Xserve machines as well as a 40 PC private enterprise cloud (based on the latest Ubuntu 9.10 w/Eucalyptus).

Access to the Centre for High-Performance Computing (CHPC) for use of their specialised cluster CPU cluster and GPU cluster computers when taking the specialised modules.

Computers are connected to 100Mb switched network, whilst servers are connected via 1Gb links. A wireless infrastructure provides connectivity wireless peripherals and notebook computers.

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3   http://www.uct.ac.za/apply/funding/postgraduate/applications/

2   Honours in Computer Science Programme

The honours programme in Computer Science, CSC4000W/CSC4003W/CSC4016W, is designed to provide students with the professional basis for a career path in the computer industry, and/or to embark upon a research programme at Masters level. CSC4000W is taken by students with a BSc with a major in Computer Science from UCT. Students in their final year of the Bachelor of Business Science (Computer Science) take CSC4003W. All other students take CSC4016W.

2.1 Admission Requirements

The number of places in the Honours programme is limited and students are selected on merit from the list of applicants each year. Criteria for selection are your Computer Science mark achieved in each of your three years of undergraduate studies and, to a lesser degree, the marks achieved in mathematics. Students who have not achieved at least a 65% average in their final year of Computer Science will only be admitted in exceptional circumstances.

2.2 Honours Module Credits

An honours coursework credit corresponds to 2.44 lectures worth of material. A 10 credit module would thus correspond to 24 lectures on the honours timetable. The practical assignments associated with a module can either be included in the course or can make up an additional 5 credits.   If the practical work is considered part of a module then proportionately fewer lectures are given and this will be stated in the entry for the module.

2.3 Structure

2.3.1   The Honours Year

The honours year commences two weeks before the undergraduate courses. Since the courses given in the initial period are compulsory, it is not possible to excuse any student from attendance during this period. The Professional Communication Unit (PCU) segment of the Research Methods module is completed during the first two weeks of honours. The New Venture Planning (NVP) module and the rest of the Research Methods (RM) modules also commence in this period.

The optional modules are given in three blocks: the first two blocks correspond roughly to the first two quarters of the first semester while the shorter third block is at the start of the second semester; after the third block students devote themselves exclusively to their full-time projects. The only exceptions to this structure are in the case of external modules taken by students.

All modules given in a block will be completed by the end of that block and no extensions will be granted to complete work after this period. The projects will be allocated by the start of the second quarter and various project related milestones have to be met from then on until the final report for the project is due in early November.

2.3.2   Course Credits

A total of 160 credits must be obtained during the course of the academic year. These credits are awarded as follows:

1.   Elective Modules (minimum 80 credits, maximum 100 credits) — in order to gain credit for a module, students have to obtain at least 40% for a module.

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[4]   The number was arrived at via a circuitous historical process.

2. The Major Project 60 credits — in order to pass CSC4000W & CSC4003W students have to obtain at least 50% for their project mark. CSC4016W students must obtain at least 40% for the project and an overall average of 50% for the course as a whole in order to pass.

3. Research Methods (RM) 10 credits — in order to pass honours students have to obtain at least 40% for this module.

4. New Venture Planning (NVP) 10 credits — in order to pass honours students have to obtain at least 40% for this module.

5. Apart from the subminima mentioned above students have to gain 50% overall average in order to pass honours.

Research Methods and New Venture Planning are compulsory modules that must be completed by every student. You may select any remaining modules as electives, subject to the credit limits cited in Section 2.5.

2.4 Work Load

This is an intensive full time course and may not be taken together with other courses or employment. Permission to deviate from this will only be given in exceptional circumstances by the Programme Coordinator. Your weekly workload will be between 40 and 48 hours per week.

For each lecture hour you should allocate at least two hours of extra work to review material and for the associated tutorials and practicals5.

Approximately eight weeks have been reserved in the final term to allow students to focus entirely on their honours project. All lectures and practicals will be concluded before this period commences. Before this final eight week block you should allocate at least 5 hours per week to supervisor meetings, planning your project, reading background material etc., during the second and third quarters.

You should also allocate one hour per week to attend departmental colloquia. Please note that attendance of at least 50% of the colloquia is mandatory. A register will be kept if necessary.

2.5 Course Work

The department offers sufficient modules at Honours level for you to fulfil your course work requirement. Subject to restrictions mentioned below you may take selected modules from other courses and Departments. You may take the Computer Graphics module from the Games Course for 10 credits. You may also take modules from other departments, provided they are of an appropriate level and have relevance to Computer Science. Unless such modules are listed in this document you have to obtain permission from the Honours Course Coordinator before they will be accepted.

As noted above (Section 2.3) you can only gain credit for a particular module if you obtain 40% in the final assessment for the module.

To fulfil the course work requirement the following rules apply:

1. You must complete the compulsory Research Methods for 10 credits successfully.
2. You must complete the compulsory New Venture Planning for 10 credits successfully.
3. You must obtain credit for at least 80 credits of elective material (you may take at most 100)

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5   These two hours could be allocated as one hour of theory review and one hour of practical work for a standard module or some other appropriate combination for a more practical or theoretical module.

4. The best 100 course work credits (including Research Methods and New Venture Planning) will count towards your final mark. Of these:
   a. At most 40 credits from Mathematics of Computer Honours (MOCS) courses will be taken into account.
   b. At most 20 credits from outside the department or MOCS will be taken into consideration; this *does not apply for Business Science* students[6].
   c. At most 10 credits may be practical credits.

Students are encouraged to take External Modules (given by other UCT departments) to broaden their education. Note, however, that any module you register for outside the department must be approved by the programme coordinator.

2.5.1 Lecture Periods

Most lectures are scheduled for periods 1–5; however Monday and Friday afternoons may also be used for lectures in periods 6–8. The timetable is drawn up in consultation with lecturers to best accommodate their lecture commitments and even out the work load. Computer Science colloquia are normally held during the lunch hour and normally on a Thursday.

2.5.2 Module Registration

A list of the modules available for the year will be handed at the start of the course. You will be asked to indicate your choice of modules within the first 2 weeks of the course. You may not register for more than 120 course credits all together. Only the registered modules will be considered in calculating your final mark.

Additional modules for credit may be offered during the year to take advantage of the expertise of visiting lecturers.

Apart from such additional modules you may only drop or add a module with the approval of the lecturer concerned and the programme coordinator. Such approval must be requested and given in writing and will not be granted if more than 1/6th of the lectures have already been given in the module concerned.

2.5.3 Examinations

Modules are usually examined after the completion of the block in which the module was given. External courses are usually examined in the University examination periods (May/June and October/November). However, the Department is free to schedule examinations at any sensible time after the completion of the relevant coursework. Examinations written outside the department are scheduled by the department in question. There is typically one two-hour examination per 10 credit module in Computer Science Honours. Open book and take-home examinations are preferred by some lecturers.

The examination timetable is the responsibility of the teaching assistant and lecturers concerned and is drawn up shortly before the examination period.

After the mid-year examinations, students may be given an indication of how they performed. Note that only a provisional symbol is released after the mid-year examination as it is University policy to release only a single mark for the whole Honours course and the exam papers will not have been seen by the external examiner at this stage.

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[6]   We regard the CSC4003W course for Business Science students as one with only 80 credits of coursework. A course in Business Strategy is taken and no courses outside of Computer Science or MOCS are counted. The average mark is therefore calculated as described on the best 80 credits.

2.6 The Major Project

Students are required to complete a major project under the supervision of a member of staff, possibly in conjunction with an outside supervisor. The project offers students the challenge of completing a substantial research or software development task in a professional way. Another objective of the project is to teach students to plan and work as a team.

Projects involving multiple students are required, but they are structured so that there are *readily identifiable components for each person to complete*. Your contribution to the overall project will be written up separately and so must constitute a piece of work that can be *independently assessed*.

2.6.1 Timing

The project topics are presented to the honours class towards the end of the first quarter and allocated to the teams by the start of the second quarter. You are expected to start work from the second quarter onwards and meet your project supervisor weekly. A final block of about eight weeks has been set aside in the last term, to allow you to work only on your project.

A great deal of importance is placed on making regular progress throughout the project period. A detailed list of milestones has been drawn up to help you plan your work. It contains deadlines and specifications of what has to be handed in or presented. The list is handed out when the projects are assigned.

2.6.2 Project Choice and Allocation

Normally academic staff will propose the projects, but you are welcome to submit your own project idea provided that the project has significant Computer Science content and that a staff member can be found to oversee the project. Contact the honours programme coordinator at the start of the year for the full requirements — the department does reserve the right to reject such proposals.

It is your responsibility to discuss the proposed projects with the supervisors concerned. You need to form a team of students with the right expertise to complete the task. You will then make a prioritised list of project preferences. You have about two weeks in which to make your choice after receiving the list of projects. As soon as possible thereafter the projects will be allocated. Every attempt will be made to accommodate your wishes while equalizing the workloads of staff.

Each project group is required to produce a formal project proposal which will be vetted by the staff. Guidelines for each of these will be distributed once the projects have been approved.

2.6.3 Deliverables

The final project report must be handed in to the Honours Coordinator no later than the specified due date. A maximum of three days beyond the official hand in time is permitted, but you will incur a penalty for such a delay. Extensions are only granted if the delays in completing the project are beyond the reasonable control of the student(s) concerned.

The project report should constitute a comprehensive description of your project. A document detailing what such a report should contain will be handed out when the projects are allocated. *No report may be submitted without the prior approval of the project supervisor*. The supervisor may require alterations and so the final draft must be available in good time for it to be read by your supervisor and revised by you.

The deliverables of the project may change from year to year but are likely to include:

- A formal project proposal and presentation
- A prototype deliverable

- A poster
- A project web page
- A self-reflection paper
- The (most important) project report

2.6.4 Award for Best Project

The department has instituted an award for the best project in each year. This goes to the team who has achieved the best overall result in their project in a particular year.

2008 *WiiRobot: Teleoperation of Rescue Robots in Urban Search and Rescue Tasks* by Jason Brownbridge and Graeme Smith.

2009 *Dynamic Content in Procedural Generation* by Richard Baxter and Zacharia Crumley.

2010 *Gesture-based Games with the iPad* by Pierre Benz, Nina Schiff and Daniel Wood.

2011 *A Sketch-based Interface for Modelling Trees and Plants* by Matthew Black, Mark Dahoner and Neil Goldberg.

2.7 Credit Requirements

2.7.1 Duly Performed Certificate

Students will only be allowed to proceed with the second semester if, by the end of the first semester, they have an overall average of 50% in their course work having gained credit for at least:

1. 60 credits of course work (this includes the compulsory modules) in CSC4000W and CSC4016W
6. 50 credits of course work in CSC4003W (business science course).

Students who do not meet these requirements will be listed as having been *Refused a Duly Performed Certificate* and their class record will show DPR. Such students will be entitled to a refund of 50% of their course fees and may apply to repeat the course as outlined in Section 2.8.

2.7.2 Computing the Final Mark

The final course mark will be computed as follows:

1. The project mark counts 3/8 of the total (60 credits out of 160)
7. The remaining 5/8 of the mark (100 credits) is calculated from the best courses taken. The modules which come into consideration for this mark are specified in Course Work. They must include Research Methods and New Venture Planning

2.7.3 Subminima

The following subminima are applied for the Honours in Computer Science programme:

1. At least 50% must be achieved in the *Project*.
8. At least 40% must be achieved in the Research Methods (RM) module, including full participation in the professional communications module and attendance at least half of the departmental colloquia and other research meetings for Honours students.
9. At least 40% must be achieved in the New Venture Planning (NVP) module.
10. An average mark of at least 50% must be attained in the modules making up the best 20 course credits.
11. No module will be considered for course credits unless a student has obtained at least 40% in that module.
12. The final mark, which will be calculated as explained in Section 2.7.2 above, must not be less than 50%.

A student who achieves each of the above subminima will pass the course.

2.8 Computer Science Department — Policy on Repeating Honours

Students have no automatic right to repeat honours if they failed to meet the requirements for awarding the degree. If a student wishes to repeat honours, a new internal honours application and a letter of motivation have to be addressed to the Honours Course Coordinator. Such applicants will be considered after all new students for the course who meet the criteria for admission have been accommodated. All applicants wishing to repeat the year as well as students who do not meet normal admission criteria will be considered together. All special applications for admission to honours have to be made by the end of last week of December.

3   Honours in Mathematics of Computer Science

The departments of Mathematics and Computer Science offer a joint Honours degree in the Mathematics of Computer Science in the School of Mathematics, course MAM4007W.   The Programme convener for this course is Prof Vasco Brattka, of the Mathematics Department.

This specialized programme provides the background for a further research career in theoretical Computer Science. A wide range of advanced modules are offered and by the end of the course you will be able to read the relevant literature and formulate further research proposals. Adequate experience and appreciation of the practice of Computer Science is provided by the project which all students have to complete. Emphasis is again placed on the effective communication of ideas and results.

The entrance requirements and available modules are listed in the Mathematics Department Prospectus.

3.1.1   Further Study

The Honours degree could lead to a Masters degree either in the Department of Computer Science or the Department of Mathematics.

3.1.2   Structure

The course structure is similar to the Computer Science Honours Degree. It is being revised for 2010 and may differ from this description. A 160 course credits were required: made up of course work from the two Departments (at least 60 credits from the Mathematics Department and at least 40 credits from the Computer Science Department) and a minor project from the Computer Science Department counting 35 credits. Students have to complete the Research Methods course from Computer Science which (in a slightly abbreviated form) for 5 credits.

For details see the Mathematics Department Prospectus.

3.2   Minor Project

The requirements for the minor project are essentially the same as that for the major project except that a reduced workload is envisaged.

Students are encouraged to team up with Computer Science Honours students to take a smaller role in a project team. However, in exceptional circumstances, if no appropriate team can be found permission may be given to do a single person project.

As with the major project it is a condition that the minor project has a significant Computer Science content and that a staff member from the Computer Science Department supervises the project, possibly in conjunction with an outside supervisor.

Unlike the major project at least 40% must be achieved in the minor project (subject to an overall average of 50% for the year).

4   Honours Modules

Modules offered at the Honours level vary from year to year depending on the interests of the staff. The following list of modules is provisional. An updated list will be placed on the honours web site if amendments are necessary. Additional modules offered by the Department of Mathematics and Applied Mathematics are listed in their departmental handbook.

4.1   Compulsory Modules

The Research Methods (RM) and New Venture Planning (NVP) modules are compulsory for all Computer Science honours students.

4.1.1   Research Methods (RM)

Prerequisites:

None

Course Objectives:

The research methods module forms part of your practical training as a researcher and computer professional. The course emphasizes communication skills and introduces basic research methodology.

Credits:

10 credits

Lecturer or Convener:

A/Prof. James Gain

Course Content:

The course covers the following topics:

1. Communication and presentation skills (PCU – see next section)
13. Project management
14. Scientific and technical writing
15. Experimental design and validation
16. The practical aspects of the work will be evaluated through an exam and the Professional Communications course.

Please note that you must obtain at least 40% for this module in order to continue with honours.

The final module mark will be composed of the PCU module mark (25%) and any examinable material (75%).

Prescribed Book: Notes will be distributed.

4.1.2   Professional Communication Unit (PCU)

Course Objectives:

The general aim of the course is to equip you with essential theory and practice in spoken, written and visual communication so that you can communicate more effectively at university and also in your chosen professional career. Your PCU course is run in the first two weeks of February in conjunction with other foundational courses such as Research Methods and the New Venture Planning (NVP) course. The communication modules will prepare you for other oral and written tasks you will be required to do later in the year.

Lecturer or Convener:

Terri Grant

Outcomes:

1. Select a topic and plan and present a business presentation. This presentation is expected to be of a professional standard in terms of:
    *   Format and organisation
    *   Appropriateness to audience
    *   Tone, language and style
    *   Visual aids

2. Function effectively in small-group activities. Team work is essential in university as well as professional life and you will be introduced to the following concepts:
    *   Interpersonal, non-verbal and intercultural communication
    *   Impromptu presentations
    *   Perception and listening
    *   Small-group communication
    *   Problem solving and decision-making

3. Gather information, plan and write selected documents according to acceptable standards. These documents are expected to:
    *   Conform to acceptable research methods, formats and referencing requirements
    *   Be suitable for target readers in content, style, tone and vocabulary
    *   Be well-planned, logically set out and argued
    *   Include appropriate, professionally executed and well integrated graphic materials.

Course Outline:

1. Written Communication Course Content:
    *   Selecting a document
    *   Gathering information
    *   Planning a document
    *   Selecting appropriate style, tone and vocabulary
    *   Writing logically and persuasively
    *   Evaluating formats (conventional and electronic) and layout (principles of readability)
    *   Integrating verbal and visual communication modes and practices
    *   Documenting/citing accurately
    *   Applying professional standards of presentation and delivery

2. Oral and Group Communication Course Content:
    *   Communicating effectively - a cyclical and negotiated process
    *   Listening actively
    *   Considering differences in perception, values and beliefs
    *   Assessing verbal and visual cues
    *   Planning an oral presentation
        *   Integrating visual modes
        *   Checking timing and balance
        *   Handling questions
        *   Handling stress/anxiety
    *   Introducing group dynamics

- Problem-solving and decision-making

Course Material:

Communicating @ Work is the prescribed text. This, together with exercise material, will be

handed out in the first session. You must provide your own writing and visual aid materials for

exercises/assignments/orals.

4.1.3 New Venture Planning (NVP)

This module is tailored to suit the needs of future Computer Science entrepreneurs. It provides the skills necessary to prepare a successful business plan to launch a new company. The topic is introduced and assessed by means of a project, in which student teams will develop a business idea. The learning experience will enable you to develop:

1. The discipline of thinking through all the various aspects of starting and operating a business or new innovation
17. The skill to identify areas in which a business or innovation has particular advantages or weaknesses
18. The skill to determine with a reasonable degree of certainty whether or not a business or innovation is viable - before investing (and potentially losing) money
19. The ability to know why and when you need to write a business plan and be able to produce a document which demonstrates to business associates - bankers, investors, and others - that you have carefully considered the options and the practicalities of starting or expanding a business
20. A greater understanding of the importance of the process of team formation and management in a multi-disciplinary project team

All Computer Science honours students have to obtain at least 40% for this module in order to continue with honours. This course is not compulsory for Mathematics of Computer Science honours.

4.2 Elective Modules

These modules may be taken as long as you satisfy any listed module prerequisites. The updated modules for a particular year can be found on the Department's website. Currently we are planning to offer the modules listed below.

4.2.1 Database Systems (DBS)

Prerequisites:

CSC2002S database module (or equivalent).

Course Objectives:

The aims of the course are to introduce new developments in database systems, to study how to use such technology effectively and to provide an understanding of established techniques as well as research issues in these areas.

Credits:

10 credits (16 lectures)

Lecturer or Convener:

Sonia Berman

Course Contents:

Object-Relational and object-oriented systems; Distributed databases; Data warehousing, OLAP and data mining; Spatial and temporal data management, Peer-to-peer systems, Web-based information systems.

Practical Assignments:

1 assignment and 1 group presentation

Assessment:

Exam + Prac work

Prescribed/Recommended Book:

There is no prescribed book.

4.2.2 Desktop High-Performance Computing: comparative parallel programming languages for multicore and accelerator architectures. (DHPC)

Prerequisites:

Reasonable proficiency with C or C++ (or Python!)

Course Objectives:

Single-core CPU clock speeds have flatlined at 70-100 GFLOPs and are no longer doubling every eighteen months. Multicore architectures are now ubiquitous and commodity Graphical Processing Units (GPUs), have overtaken CPUs in terms of processing power, with performance in the 900-1200 GFLOP range. This is the era of multicores and accelerators. As a result, parallel and multithreaded computing is becoming increasingly important for effective software development. However, knowledge and experience of both parallel algorithms and architectures is required in order to program a parallel computer effectively, particularly in the case of complex hybrid accelerator/multicore machines.

This course will consider the practical development of algorithms and associated coding in both the OpenMP and CUDA programming environment, for effective general purpose computing with multiple cores and GPUs.

Credits:

15 credits (A one week intensive course, with 5 days of lectures and workshops, followed by an assignment)

Lecturer or Convener:

James Gain, Michelle Kuttel and Patrick Marais

Course Contents:

This module covers the following areas:

- An overview of parallel computing, with a history of parallel computing in general, clusters, multicore and accelerators (1 lecture).
- Parallel architectures – clusters, multicore machines and accelerators. (1 lecture)
- General comparison of parallel programming models and methods, with focus on OpenMP and CUDA. (1 lecture)
- Thinking in parallel: Parallel algorithms and applications (N-body, finance, image processing) (2 lectures)
- The OpenMP approach to multithreaded computing (2 lectures)
- A motivation for general purpose computation on GPUs (GPGPU) (1 lecture)
- The CUDA approach to multithreaded computing (1 lecture)

- CUDA threading and memory models (2 lectures)
- CUDA performance optimization (1 lecture)
- Benchmarking, profiling and proving parallel performance (2 lectures)

Practical Assignments:

There will be in-class assignments to complete as part of the workshops and a single take-home assignment after the course.

Assessment:

Assignment (50%), Exam (50%)

Prescribed/Recommended Book:

There is no prescribed book, but notes will be provided.

4.2.3   Introduction to Image Processing and Computer Vision (ICV)

Prerequisites:

Basic Linear Algebra (matrices, vectors etc); familiarity with Fourier Analysis or functional analysis would be useful. For the prac, familiarity with a GUI toolkit would be very useful.

Course Objectives:

To introduce students to basic concepts in computer vision and image processing oriented towards solving real world, practical image analysis problems. The student will be introduced to basic concepts from digital signal processing, and a foundation built that will allow understanding of how more sophisticated schemes such as image analysis/segmentation which can be used to describe image and volumetric data at a higher, more useful, levels of abstraction. Case studies and papers will be examined which relate this to real-world problems.

Credits:

10 credits (10 lectures + 3 paper sessions + practical).

Lecturer or Convener:

Patrick Marais

Course Contents:

A number of lectures will be presented by the course convener, interspersed with paper/review sessions in which topical papers are discussed and followed up by review questions.

- Basic Signal processing   1
- Image Transforms   2
- Feature Detection   1-2
- Object Descriptions   1
- Segmentation   1-2
- Registration   1
- Genetic Algorithms in Computer Vision   1
- Case Study   1
- Paper Reviews   6

Practical Assignments:

Self-assessment exercises available (not for credit)

3 Paper Sessions (assessed by Review Questions)

2 week programming project.

Assessment:

Exam: Open Book; 2 hours

DP Requirement: 50% in class record (composed of prac and review questions)

Class Record: Practical 50%, Review Questions 50%

Final Mark: Exam 40%, Class Record 60%

Prescribed/Recommended Book:

There is no prescribed book: notes will be handed out.

Recommended Book: *Algorithms for Image Processing and Computer Vision*, J. R. Parker, Wiley Computer Publishing, 1997.

Useful Reference: *Image processing, Analysis and Machine Vision*, Milan Sonka et al, PWS Publishing, 1999.

4.2.4 Intelligent Systems Design (ISD)

Prerequisites:

Knowledge of a programming language: Java, Python or C++

Course Objectives:

The course intends to stimulate scientific curiosity through the introduction of key concepts of Intelligent Systems Design (ISD) by (1) presenting the architecture of some of the emergent intelligent systems (2) describing the main research challenges associated with these systems and (3) highlighting the main frameworks used to model these systems and the implementation strategies behind these systems.

Credits:

10 credits (12 lectures + project + presentation)

Lecturer or Convener:

Antoine Bagula

Course Contents:

The course will cover material in the following areas:

1. Introduction

   - Motivation
   - Mechanisms
   - Evaluation
   - Outcome
2. Intelligent Systems Modelling

   - Genetic optimization
   - Artificial Immune Systems
   - Bayesian Belief Networks
   - Fuzzy Sets and Logic
   - Neural Networks
   - Game Theory
   - Economic Models

- Markov Models
3. Intelligent systems Architectures

  - Sensor/Actuator systems
  - RF Identification Systems
  - Intelligent Radio Systems
  - Autonomous Robot systems
  - Speech Recognition systems
  - Computer Vision systems
4. Intelligent Systems Implementations

  - Anomaly Detection
  - Fraud Detection
  - Drought monitoring
  - Network planning
  - Water Management
  - Unmanned aerial vehicles

Assessment:

The assessment will be based on projects (40%), a selected research paper presentation (30%), and an oral exam (30%).

Prescribed/Recommended Book:

None; notes and pointers to relevant material will be available online.

4.2.5 Mobile Game Development (MGD)

Prerequisites:

CS2 Games Course. This can be waived if a student can demonstrate sufficient understanding and experience with games technology.

Course Objectives:

To develop a complete Mobile Game from the phases of Conceptual Design through to final Playtesting on the target device (Android Samsung touch-enabled Phone or Tablet) as part of a team.

Credits:

10 credits (5 meetings, with a strong practical component)

Lecturer or Convener:

James Gain and Patrick Marais

Course Contents:

This course is very practically oriented, with the intention of developing student's skills in game design and development. The course is broken into the following components, with each corresponding to roughly a week in the timetable:

1. The Essentials of iPhone Development (Introductory Lecture)
21. Conceptual Design
22. Paper Prototyping and the Game Design Document
23. Technical Design Document
24. Development (x 2)
25. Playtesting

There will be meetings on a weekly basis in which development artefacts will be presented and discussed.

Practical Assignments:

Each team will develop a complete Mobile Game.

Assessment:

Intermediate artefacts such as a Conceptual Design, Game Design Document, and Technical Design Document will be evaluated individually. The completed App will also be subject to assessment. There will be a final exam counting 30%.

Prescribed/Recommended Book:

There is no prescribed textbook. Web resources on Android development will be provided.

4.2.6 Mobile Interaction Design (MID)

Prerequisites:

None.

Course Objectives:

This course covers how to design and evaluate interactive systems with a particular focus on mobile applications.

Credits:

10 credits (16 lectures and an essay)

Lecturer or Convener:

Gary Marsden

Course Contents:

The outline is as follows.

The topics are the following:

1. Explaining Mobile Interaction Design
   - What are 'mobile' systems
   - How do we do Interaction Design
   - What is the commercial rationale
2. The practice of Interaction Design
   - Methodologies
   - Evaluation
3. Insight into Design
   - Basic Design Principles
   - Media case study
   - Developing world case study

Practical Assignments:

Essay mid-way through to check you are on track.

Assessment:

Exam 80%; Essay 20%

Prescribed/Recommended Book:

Matt Jones and I wrote a book on this called "Mobile Interaction Design" If you want, I can order it for you at a discount.

4.2.7 Network and Internetwork Security (NIS)

Prerequisites:

Assumed knowledge of Networks and Operating Systems from CS3.

Course Objectives:

The objective of this course is to introduce cryptographic techniques and protocols for secure exchange of information on networks and inter-networks, and to examine the deployment of these in emerging technologies.

Credits:

10 Credits (16 lectures + 1 practical)

Lecturer or Convener:

Andrew Hutchison

Course Contents:

The course covers risk concepts; security services; conventional encryption (classical encryption techniques, DES/AES, key distribution, key generation); public-key encryption (RSA algorithm, key management, certification hierarchies); authentication and digital signatures; LDAP directory services for authentication & authorisation; security protocol analysis; authentication and key exchange (Kerberos, Diffie-Hellman); electronic mail security (S-MIME/PGP); world-wide web authentication / security (S-HTTP, SSL, capabilities); secure electronic commerce (SET); web-services security (WS-Security, SAML); cloud computing security (public vs private clouds)

Practical Assignments:

A practical involving deployment of cryptographic algorithms will be conducted (in groups).

Assessment:

Exam – 50%, Practical – 50%

Prescribed/Recommended Book:

Papers and readings will be made available.

4.2.8 Speech and Language Technology (SALT)

Prerequisites:

Proficiency in programming languages and the ability to quickly pick up new languages as needed.

Course Objectives:

This course aims to provide students with an introduction to the field of speech and language processing and give them some practical, hands-on experience with the relevant tools and techniques.

Credits:

10 credits (16 lectures and 1 practical)

Lecturer or Convener:

Audrey Mbogho

Course Contents:

Techniques used in speech and language processing will be discussed. Issues relevant to the African context will be highlighted. Available tools will be presented. Current research will be explored.

The topics are the following:

1. Introduction
    - Overview of the field, its history and its current state
    - Challenges in speech and language technology
2. Applications
    - Speech-enabled user interfaces
    - Dictation
    - Transcription
    - Machine translation
3. Techniques
    - Acoustic modelling
    - Hidden Markov models
    - Pronunciation modelling
    - Language modelling
4. Tools
    - Sphinx
    - HTK

Practical Assignments:

Students will download one of the tools above. They will use it to build a simple ASR system, e.g. for isolated word recognition. They will carry out tests to evaluate the accuracy of the system. Generally such tools are complex and just to get them installed and working takes some doing. Part of the mark will be for accomplishing this feat.

Assessment:

Exam - 60%, Practical – 40%

Prescribed/Recommended Book:

There is no prescribed book; notes and pointers to online resources will be provided. Suggested Text: Speech and Language Processing (2nd Edition) by Daniel Jurafsky and James H. Martin, Prentice Hall, 2009.

4.2.9 Information Security: Models and Architectures (SECAI)

Prerequisites:

A basic understanding of discrete mathematics and formal methods will be helpful.

Course Objectives:

This course covers conventional and some unconventional methods of data protection. Topics include access control models, secure architectures, threat modelling, inference control, and information flow control.

Credits:

10 credits (16 lectures and one practical)

Lecturer or Convener:

Anne Kayem

Course Contents:

In this module is comprised of 10 lectures on the theoretical foundations and models of information security as well as 6 lectures on security experimentation.

The topics are the following:

1. Access Control Models
   - Selected Topics on Applied Cryptography
   - Cryptographic Access Control
   - Role-Based Access Control

2. Secure Architectures
   - Distributed Data Security
   - Privacy Enforcement

3. Threat Modelling
   - SQL Injection Attacks
   - Security Experimentation
   - Commercial Systems/ Prototypes

4. Inference and Information Flow Control

5. Unconventional Security Paradigms

Practical Assignments:

Implementation – 20%

Assessment:

Presentation – 20%; Review Paper – 20%; Exam – 40%

Prescribed/Recommended Book:

None, reference material and notes will be provided.

4.2.10 Visual Thinking and Visualization (VIS)

Prerequisites:

There are no specific prerequisites for this module.

Course Objectives:

It is increasingly important to pay careful attention to the design of software user interfaces. This fact is highlighted by the huge success of companies such as Apple and Google, who have prioritized intuitiveness and ease-of-use in their software interface designs. In this Honour's module, we aim to cover the field of visual thinking: outlining current understanding of how we think visually from a neurological perspective and demonstrating how we can use this knowledge to design more effective visual images. This knowledge will be applied to the design of user interfaces and data graphics to facilitate user queries.

Credits:

10 credits (15 lectures and one practical)

Lecturer or Convener:

Michelle Kuttel

Course Contents:

This module will cover the following topics:

- Visual queries and how the mind works to process visual information
- Structuring two dimensional space
- Colour
- Visual space and time: depth perception and motion
- Visual objects: how to design visual objects that are easy to identify
- Theory and best practice in the design of data graphics, interfaces and visualizations.

Practical Assignments:

The single major practical will involve multi-stage design and testing of a graphical display. Topics will be listed in the first week of the course and design stages will be presented to class for discussion. The practical is expected to involve about 30 hours of work.

Assessment:

Exam - 50%, Practical - 50%

Prescribed/Recommended Book:

Visual Thinking for Design by Colin Ware and The Visual Display of Quantitative Information by Edward R. Tufte (second edition). These recommended books are highly regarded internationally and will make wonderful additions to any Computer Scientist's library, but you don't have to buy them for this course.

4.2.11 Wireless Sensor Networks (WSN)

Prerequisites:

None.

Course Objectives:

Wireless Sensor Networks have become popular with wide and fastest growing applications in sensing environments using parameters such as: temperature, light, humidity, movement and even heart beats. The course introduces the key concepts behind networking and wireless sensor networks (WSNs). We present different types of networks and delve into WSN designing models, routing mechanisms and applications of WSNs to the real world.

Credits:

10 credits (12 lectures).

Lecturer or Convener:

Hanh Le

Course Contents:

The topics are as follows:

1. Introduction to Advanced Topics in Networks
   - Ad-hoc Network
   - Peer-to-Peer (P2P) network
   - Wireless Sensor Network (WSN)

2. Routing
   - Review on Routing basics (Distance vector and link state)
   - Routing for Ad-hoc network and P2P network
   - Routing for WSN (with geographical awareness)

3. Medium Access Control (MAC) for WSN

4. Applications using sensors
   - E-health applications
   - Smart home

Practical Assignments:

Students (in pairs) are asked to write software related to networking, sensors or WSNs. This could be in a form of a real implementation or a simulation.

Assessment:

Research Essay: 50%; Exam: 50%

Prescribed/Recommended Book:

There is no prescribed book, since this is research based.

4.2.12 World Wide Web Technology (WWW)

Prerequisites:

Understanding of XML/XSLT/XML Schema

Course Objectives:

This course is on the technology of the WWW. After the course you will be able to create Web applications and understand the possibilities and limitations of the WWW.

Credits:

10 credits (16 lectures and one practical)

Lecturer or Convener:

Hussein Suleman

Course Contents:

The topics are as follows:

1. Core technologies
   - DNS, HTTP, basic HTML, Web servers and clients
   - Web applications
   - Metadata and Searching

2. The Web 2.0 era
   - Wikis, CMSes and Repositories
   - Web Services, Interoperability and Mashups
   - Web components (e.g., Facebook apps)
   - AJAX and Comet (optional, time permitting)
   - Cloud computing (optional, time permitting)

Practical Assignments:

One – to develop a Web application

Assessment:

Exam – 60%, Paper review – 10%, Class participation – 10%, Assignment - 20%

Prescribed/Recommended Book:

There is no prescribed book – lots of information is available online.

4.3 External Modules

Students are encouraged to take external modules subject to the subminima for external courses (Section 2.5). These external courses have to be approved by the Honours Programme Coordinator. They will be weighted according to its relevance to computing in general. A critical aspect of undertaking such a module is your getting the permission from both the lecturer and the head of the relevant department to undertake the course. They have to provide a contact person who will be responsible for providing your final mark on time. Such arrangements obviously have to be confirmed in writing. Popular modules in the past have included Robotics and Agents offered by Mechanical Engineering.

4.3.1 Mathematics of Computer Science Modules

Modules within the Department of Mathematics and offered as part of the honours in Mathematics of Computer Science (Section 0) have been approved as external courses by the Department of Computer Science.

Additional information can be obtained from the Department of Mathematics. Only certain courses will be considered for credit, specifically those dealing with the foundational aspects of computing or other pertinent topics such as quantum computing. These courses are usually counted as 20 credits within the department (36 lectures + tutorials).

The following courses will be offered in 2012:

1. Computational Complexity
26. Cryptography
27. Graph Theory

Computational Complexity

Lecturer:

Dr. Holger Spakowski

Semester:

First

Course Description:

This course provides an introduction to major topics in computational complexity theory, which is one of the core areas of Theoretical Computer Science. In computational complexity, we investigate the power of efficient computation. That is, we try to distinguish between computational problems that can be solved efficiently in practice and those that, though theoretically solvable, are not solvable in practice because of prohibitively large time or space requirements. Topics covered include: Nondeterministic and deterministic Turing machines; basic time and space complexity classes; space and time hierarchies. NP and NP-completeness. The polynomial hierarchy. Oracle complexity classes; relativisation of the P versus NP problem. Space-bounded computation. Randomized computation. Circuits. Counting problems. Interactive proofs.

Cryptography

Lecturer:

Dr. Christine Swart

Semester:

Second

Course Description:

Cryptography is the mathematics of scrambling data to keep it secret. The course will be an overview of modern cryptology, including: block ciphers (and attacks), stream ciphers (and attacks), hash functions (and attacks), public key encryption and digital signatures (and attacks). We assume some basic familiarity with groups, but will cover all the number theory you need. Depending on time it might be possible to cover a special topic, for example elliptic curves and identity-based encryption.

Graph Theory

Lecturer:

Dr. David Erwin

Semester:

Second

Course Description:

A description of the course will be available in early 2012.

4.3.2 Business Strategy (BUS4050W)

This external course counts 20 credits and is typically taken by Business Science students. Please contact the School of Management Studies in the Faculty of Commerce for more details.