Computer Science Honours Handbook 2017 (version 4)

UCT Computer Science

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DEPARTMENT OF COMPUTER SCIENCE

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Our Mission

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

Our Vision

The Department of Computer Science strives to be of the first rank, maintaining excellence in both research and teaching and producing high-quality graduates skilled in problem solving, in order to play an influential role in the development of Information Technology, both within the continent of Africa and internationally.

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.

1. Honours in Computer Science at UCT

The Honours programme in Computer Science – course codes CSC4000W, CSC4003W or CSC4016W - is designed to provide students with the professional basis for a career path in the computer industry, and/or to enable them to embark upon a research programme at Masters level.

The Honours year is an opportunity to undertake advanced courses given by enthusiastic lecturers in their areas of specialization, as well as to complete a major research- and development project. Honours is an enriching and challenging year which will require your firm commitment to full-time, hard work.

1.1. Course codes

The CSC4000W course code is assigned to students with a major in Computer Science from UCT. CSC4003W is assigned to students in their final year of the Bachelor of Business Science (Computer Science). All other students are assigned the code CSC4016W.

1.2. Professional Qualification

In Computer Science, four years of study are required for a professional qualification: it is only after four years that you will have covered the ACM/IEEE Computer Science Curriculum[1] in sufficient breadth to practice with confidence in the field of Computer Science. It is also only after four years that you will have fulfilled the academic requirements of the British Computer Society (BCS) for a professional Computer Science qualification   (degree accreditation only applies to students have also completed their undergraduate studies in our department). The UCT CS Honours course is accredited as meeting the academic requirements for Chartered IT Professional (CITP) certification[2] and partially meeting the requirements for Chartered Scientist (CSci) registration.

Your Honours degree will improve your career prospects locally and is an essential qualification for the global marketplace. Our Honours students from 2015 found employment in international companies in the USA (Asana); in local branches of international companies (Amazon, Oracle, MWR infosecurity);), in large South African corporations (BSG, Investec, Old Mutual and Standard Bank); in smaller local software companies or startups (Smyte, Nomanini, Praekelt Foundation, Thought Express) and in local animation and visual effects studios (Sea Monster and Black Ginger). Some graduates are creating their own startup companies. Many of our alumni work internationally, for software giants such as nVidia, Facebook, Microsoft and Amazon.

1.3. The role of the student: Graduate Studies

There are significant differences between an undergraduate and a graduate degree. Graduate students are expected to be interested in deepening their knowledge and experience, particularly in Computer Science, but also in related fields.

Many of you will appreciate the additional freedom you have in the Honours course to choose coursework modules in specific fields that interest you. However, the additional freedom comes with additional expectations. As a graduate student, we expect you to:

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

- Work hard and go beyond the basic requirements. This is your year to stretch yourself!
- Behave as a professional; arriving punctually for all classes, meetings and seminars and submitting all assignments by the posted deadline (assignment deadline extensions are not allowed in Honours).
- Take responsibility for your own study programme.
- Work largely unsupervised and independently.
- Approach problem solving independently and creatively and show an appreciation for concepts and principles.
- Evaluate, criticise and justify your own work - and others' work.
- Respond to criticism by improving your work.
- Communicate ideas clearly and succinctly.

Our Honours programme produces skilled graduates: graduates who understand the process of research and development, who are critical thinkers and who can work productively, both independently and as part of a team.   During the course, you will learn to read relevant academic literature, to formulate research and and write development proposals. You will also gain practical experience in team work, through initiating and managing a major project. You will learn to communicate your ideas and results clearly in your final paper report.

1.4.   Role of the Department

The UCT Computer Science department is a team of qualified, established researchers, comprising some of the best Computer Scientists in the country.   In general, our role is to:

- produce skilled, high quality graduates who are familiar with the principles, theory and practice of Computer Science;
- carry out innovative research;
- provide services to Industry, through technology transfer and applied research;
- take an active part in the academic and governance affairs of the University;
- provide opportunities and support for students from disadvantaged backgrounds;
- 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 educated, articulate, and able to exercise critical judgement in the field of Information Technology. Our core function, therefore, is not that of providing vocational training, but to impart the fundamental skills that are needed for decision making or creative thinking. We do not aim to train people how to use computers and become programmers to meet the immediate demands of the marketplace (although you will learn those things as a matter of course) - we want our students to remain useful scientists a decade from now.

1.5.   Further Study

Students who successfully complete Honours in Computer Science at UCT are eligible to proceed to an M.Sc. in Computer Science by dissertation, provided that they find an approved supervisor for their intended course of study and research.

1.6.   ADMISSION REQUIREMENTS

The number of places in the UCT CS 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 under exceptional circumstances.

1.7.   FEES

Fees vary from year to year: consult the latest UCT *Fees Handbook* for accurate figures[3]. As a rough guideline to costs, the fees for 2016 were R45 500 for South African citizens and permanent residents. International students pay higher rates, which vary according to country of origin, as follows. Citizens and permanent residents of SADC countries pay the same fees as South African Residents. (The SADC countries are Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe.) Citizens from other countries pay a fee comprising a Course Based Fee, an International Term Fee and an International Administrative Service Fee. The International Term Fee for citizens of non-SADC African countries is typically lower than for citizens from non-African countries.

International students must pay fees prior to registration.

1.8.   FINANCIAL ASSISTANCE

Financial assistance is available for prospective Honours students. The *Financial Assistance for Postgraduate Study and Postdoctoral Research Handbook* [4] lists opportunities for both SA and international students - also look at the University's Postgraduate Degree Funding web page[5] . Pay particular attention to the deadlines for applications for financial assistance – deadlines are often as early as July of the preceding year!

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.

Bursaries for Computer Science Honours at UCT are also generally available from the department's Advisory Board members and other companies. Please apply to the head of department for these bursaries. A number of other software companies also offer bursaries and scholarships exclusively for this degree.

You are advised to apply for all bursaries as early as possible.

In addition to the above, some members of the department have funds for research purposes, which may be available to students involved in specific projects. Students with legitimate financial difficulties may also receive departmental support. Queries with regards to funding should be addressed to the Honours programme coordinator.

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[3] http://www.uct.ac.za/apply/handbooks
[4] http://www.uct.ac.za/apply/handbooks
[5] http://www.uct.ac.za/apply/funding/postgraduate/applications/

1.9.   FACILITIES

All Honours students are required to have their own laptop.

Honours students are accommodated in a dedicated laboratory with 24-hour access, a small kitchen and coffee area, lockers and some workstations.

Computing resources include servers and workstations running Ubuntu Linux and other Linux distributions and Microsoft Windows.

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.

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

2. Degree Structure, Rules and Programme

Note Well: As discussed below (Section 2.3) you must be at the University *two weeks before the normal start of the (undergraduate) academic year* in order to complete certain compulsory modules of the Honours course.

2.1. PROGRAMME COORDINATOR

The 2017 Honours programme coordinators are *Assoc. Prof Michelle Kuttel*, Room 304.02, Computer Science Building (email: mkuttel@cs.uct.ac.za) **for the first semester** and *Prof Edwin Blake* (email: edwin@cs.uct.ac.za) **for the second semester**.

The Honours programme also has a postgraduate student employed as a Teaching Assistant (TA). The role of the TA is to assist with course administration.

In addition, class representatives will be elected at the beginning of the year. The role of the class representatives is to raise any problems or issues timeously with the programme coordinator, or with the TA.

2.2. ORIENTATION AND REGISTRATION

The orientation meeting will take place at 9h30 am on **Monday 13 February 2017** for all students.

2.2.1. CSC4016W and CSC4000W Registration for South African students

Registration for the CSC4016W and CSC4000W degrees will take place at **9:30am on Monday 13 February 2017 for South African students** (venue to be announced). Please bring the following documents to registration:

- a certified paper copy of your Identity Document (ID).
- certified paper copies of your final transcript and proof of graduation (only for non-UCT Bachelor's degrees.).

2.2.2. CSC4016W and CSC4000W Registration for international students

In order to be able to register at UCT, international students need:

- A study visa. (Study visas must be obtained from the South African Embassy, High Commission or Consulate in your home country. They cannot be obtained from within South Africa.)
- Proof of proficiency in English.
- Health insurance.

The International Academic Programmes Offce (IAPO) can provide help and information about these and other requirements: http://www.iapo.uct.ac.za/

International students (including those from SADC countries) will apply for clearances from the International Academic Programmes Office at 10am on Monday 13 February 2017. This pre-registration clearance includes fee clearance, presentation of a study permit and

health insurance information. International students cannot register for the degree if they have not been cleared by IAPO. For any questions about the pre-registration process, please contact IAPO at intiapo@uct.ac.za or at +27 21 650 2822 / 3740.

Registration for international students Registration for the CSC4016W and CSC4000W degrees will then take place with the course convenor.

2.2.3.   CSC4003W Registration

Registration for the CSC4003W course (Business Science students) is handled by the Commerce Faculty, but will be possible on 13 February.

2.3.   Structure of The Honours Year

The Honours year begins on 13 February 2017 and ends on 30th November 2017.

NOTE: The Honours year commences four weeks before the undergraduate courses.

Since the courses given in the initial weeks 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 also runs in this period.

The remaining 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 (usually in late October or early November, depending on the year).

2.3.1.   Work Load

Honours is an intensive, full-time course and may not be taken together with other courses or while you are employed. 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 practicals[6].

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

2.3.2.   Project block

Approximately eight weeks have been reserved in the first and second term to allow students to focus entirely on their Honours project. Lectures and practicals will not run in the project block.

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[6] 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.

2.3.3. CS Department Seminars/Colloquia

You must allocate one hour per week for attendance at departmental colloquia. Computer Science colloquia are normally held during the lunch hour and normally on a Thursday. **Please note that attendance of at least 70% of the colloquia is mandatory.** Failure to do this will impact on the mark for Research Methods with a **10% penalty**. A register of attendance at colloquia will be kept.

2.4. Coursework

The Departmental coursework modules are listed in Section 3 (Compulsory Modules) and Section 4 (Elective Modules). We offer sufficient modules at Honours level for you to fulfil your coursework requirement. However, you may, subject to the restrictions mentioned below, take selected modules from other departments. Approved External courses are listed in Section 5. Students are also encouraged to take other external modules (given by other UCT departments) to broaden their education. Note, however, that any module you register for outside the department must be of an appropriate level, have relevance to Computer Science and **be approved by the programme coordinator**.

2.4.1. Lecture Periods

Lectures are scheduled in lecture periods 1–8. The timetable is drawn up in consultation with lecturers to best accommodate their lecture commitments and to even out the work load. We attempt to avoid lecture clashes, but these will occur in exceptional cases. If the lectures for two different modules coincide, you may only register for one of the modules. Modules run only once in the year: they are not repeated.

2.4.2. Module Registration

A list of the modules available for the year will be handed out 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.

2.4.3. 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.

2.4.4.   MODULE CREDITS

An Honours coursework credit corresponds to 2.4[7] 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.

A total of 160 credits must be obtained during the course of the academic year. Research Methods and New Venture Planning are compulsory modules that must be completed by every student. You may select any remaining modules as electives, with a **minimum of 80 credits**, up to a maximum of 100 credits.

Note well: In order to gain credit for a module, students have to obtain **at least 40% for the module**.

2.4.5.   COURSEWORK MARK

To fulfil the Honours coursework requirement, the following rules apply:

- You must complete the compulsory **Research Methods** (10 credits) module successfully.
- You must complete the compulsory **New Venture Planning** (10 credits) module successfully.
- UCT CS students who completed CSC3003S in 2016 must complete the **Theory of Algorithms** (10 credits) module successfully.
- You must obtain credit for at least **80 credits of elective material** (you may take at most 100).
- The Research Methods and New Venture Planning credits and your **best 80 elective course work credits** will count towards your final mark. Of these:
  - At most 40 credits from Mathematics courses will be taken into account.
  - **At most 20 credits from outside the department** or **40 credits from Mathematics** courses will be taken into consideration; this *does not apply for Business Science* students[8].
  - At most 10 credits may be practical credits.

2.5.   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 you the challenge of completing a substantial research or software development task in a professional manner. Another objective of the project is to teach you how to plan and work as a team.

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

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

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.*

2.5.1.1. 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 block of about eight weeks has been set aside in the second and third terms, 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.

2.5.2. 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, it can be run as a team 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 reserves the right to reject such proposals.

Once the list of projects has been released, it is your responsibility to discuss the projects you are interested in 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 at a formal project presentation. Guidelines for the proposals will be distributed once the projects have been approved.

2.5.3. Deliverables

The final project paper 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 of 10% of the allocated marks per day 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 paper should constitute a comprehensive description of your project. A document detailing what such a paper should contain will be handed out when the projects are allocated. *No paper 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 for you to then revise it.   The project paper comprises 80% of the final project mark.   The reamining 20% is made up of additional marked deliverables.   These may change from year to year, but are likely to include: a formal project proposal and presentation, a prototype, a poster, a project webpage and a self-reflection report.

2.5.4.   Award for Best Project

In 2008, the department together with Business Systems Group (BSG) instituted an award for the best project. This goes to the team who has achieved the best overall result in their project in a particular year. Winners to date are:

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.

2012 *Smart Security Systems in an Internet of Things Environment* by Alexander Comer-Crook, Simon Groll, Shaun Michaels

2013 *StockOut Web Services* by James Lewis, Sven Siedentopf

2014 *Detection and Visualization of Radio Frequency Interference* by Philippa Hillebrand, Gerard Nothnagel

2015 *Evaluating Three-Dimensional Modelling Interfaces* by Siobahn O'Donovan and Steven Rybicki

2016 *Natural presenter tracking in 4K video* by Charles Fitzhenry, Maximillian Hahn and Mohamed Khatieb.

2.6.   Credit Requirements

2.6.1.   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. 80 credits of course work (this includes the compulsory modules) in CSC4000W and CSC4016W

2. 40 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 2.7.

2.6.2.   Passing Honours

In order to obtain the Honours in Computer Science degree, students must fulfill ALL these requirements:

- at least **50% overall average**.
- 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.
- At least 40% must be achieved in the Research Methods (RM) module, including full participation in the professional communications (PCU) module and attendance at least 70% of the departmental colloquia and other research meetings for Honours students.

- At least 40% must be achieved in the New Venture Planning (NVP) module.
- An average mark of at least 50% must be attained in the modules making up the best 100 course credits.
- No module will be considered for course credits unless a student has obtained at least 40% in that module.
- The final mark, which will be calculated as explained in Section 2.6.3, must not be less than 50%.

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

2.6.3.   Computing the Final Mark

The final course mark will be computed as follows:

- The project mark counts 3/8 of the total (60 credits out of 160)
- 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. The courses counted must include Research Methods and, except for Business Science students, New Venture Planning.

2.7.   Policy on Repeating Honours

Students have no automatic right to repeat Honours if they fail 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. Compulsory Honours Modules

Of the modules listed below, RM, PCU and NVP are compulsory for all Computer Science Honours students. The TOA module is compulsory **only for UCT CS graduates who completed CSC3003S in 2016**.

3.1. RESEARCH METHODS (RM) [BLOCK 1]

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 (16 lectures)

Lecturer or Convener: *Prof. Edwin Blake*

Course Content:

- *Communication and presentation skills (PCU course – see next section)*
- Types of research, how to find papers and how to read papers.
- Research Ethics
- Scientific and technical writing
- Assessment - Reviews and rebuttals
- Research methods: qualitative and quantitative and both
- Literature reviews
- Research proposals and teamwork

Assessment: The practical aspects of the work will be evaluated through the Professional Communications course (25%), a submitted literature review for your project (35%) and the project proposal (40%).

Prescribed Book: Notes will be distributed.

All Computer Science Honours students have to obtain at least 40% for this module in order to continue with Honours.

3.2. PROFESSIONAL COMMUNICATION UNIT (PCU) [*PCU IS A COMPONENT OF RM*] [PRE-BLOCK 1]

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 starts on 13 February and runs over a 2-week period. It provides a foundation for other courses (e.g. New Venture Planning course, research module, etc.) as well as other oral and written tasks you will be set later in the year.

Course Objectives. You will be expected to:

a) Select a topic (based on theme provided) and plan and present a business presentation. This presentation is expected to be a professional standard in terms of:
- ♦ format and organisation
- ♦ appropriateness to audience
- ♦ tone, language and style
- ♦ visual material

b) 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
- ♦ small group communication
- ♦ problem-solving and decision-making

c) Gather information, plan and write selected documents according to acceptable standards. These documents are expected to:
- ♦ confirm 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.

Credits: the course contributes 25% to the RM course.
Lecturer or Convener: *Assoc. Prof. Terri Grant*, e-mail: Terri.Grant@uct.ac.za.
Course Content:
- • *Written Communication Course Content:*
  - o selecting a document
  - o gathering information
  - o planning a document
  - o selecting appropriate style, tone and vocabulary
  - o writing logically and persuasively
  - o evaluating formats (conventional and electronic) and layout (principles of readability)
  - o integrating verbal and visual communication modes and practices
  - o documenting/citing accurately
  - o applying professional standards of presentation and delivery

- • *Oral and Group Communication Course Content*
  - o communicating effectively - a cyclical and negotiated process
  - o listening actively
  - o considering differences in perception, values and beliefs
  - o assessing verbal and visual cues
  - o planning an oral presentation
  - o integrating visual modes
  - o checking timing and balance
  - o handling questions
  - o handling stress/anxiety
  - o introducing group dynamics
  - o problem-solving and decision-making

Practical Assignments:
As the PCU course is a practical, highly intensive and a compulsory DP course, you will be expected to attend every workshop. Some of the sessions will be divided into separate time slots for (e.g. video). You will only be expected to attend one of these sessions.

You will receive various short assignments for both courses. Only the final written assignment (feasibility study/proposal/business plan) is a shared assignment. These will be marked separately using different course criteria. Your marks may therefore differ.

Your PCU and NVP facilitators will mark your final team presentations on a date to be confirmed in March. This mark, collaboratively negotiated, will be added to your PCU and NVP marks respectively to provide an overall mark for each course

Prescribed/Recommended Books: You will receive a textbook, *Communicating @ Work,* and an exercise / assignment booklet in the first PCU session.

3.3.   NEW VENTURE PLANNING (NVP)

Entrepreneurship is a critical element of economic development, for both developed and developing nations. An understanding of the process of entrepreneurial development and the elements of the entrepreneurial process is a valuable part of any learning programme. The New Venture Planning course will introduce students to the ideas, theories and concepts associated with entrepreneurial ventures, with a focus on the elements needed to develop a viable business plan. The discipline of thinking through all the various aspects of starting and operating a business or innovation.

Course Objectives:

Forecasting the future is a hazardous occupation, and no business, no matter how carefully planned, ever ended up exactly as it was intended to. However, the very process of producing a business plan provides benefits that are of enormous value to the business, even if in the final reckoning things turn out quite differently to how they were planned.

The learning experience will enable you to develop:

- The discipline of thinking through all the various aspects of starting and operating a business or new innovation;
- The skill to identify areas in which a business or innovation has particular advantages or weaknesses;
- 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;
- 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.
- An understanding of the lean start-up methods and approach.
- A greater understanding of the importance of the process of team formation and management in a multi-disciplinary project team.

The most effective way to understand the entrepreneurial process is to take a hands-on approach. To get financing for your idea you need to formulate your business idea and form your management team with the investor's perspective in mind. This means showing clearly and concisely what the customer benefits are and how it will generate revenue. You will focus on primary sources of information. You will need to talk to customers, users, distributors, industry organisations, competitors, designers, engineers, vendors, consultants, investors etc.

Credits: 10 credits

Lecturer or Convener: *Karen Hidden (karen@spark.co.za)*

Practical Assignments:

Idea Pitch

Teams will have three minutes to pitch their business ideas. No PowerPoint may be used for the presentation, and not all team members need present. The elevator presentation is a fast, slick pitch of the idea that the team has developed.

Business Model Canvas

The business model canvas is a one-page framework with the nine basic building blocks that show the logic of how a company intends to make money. These nine blocks cover the four main areas of a business: customers, offer, infrastructure and financial viability. Teams will blueprint their idea via this framework and present this to the class for discussion and input. Grades are awarded for depicting the business idea in a manner that is simple, relevant and intuitively understandable yet still demonstrates the complexities of how an enterprise functions.

Final Presentation

Each team will have 20 minutes to make a formal presentation of their business idea. This presentation will include all the relevant high-level information that is contained in a business plan. The intended audience are funders (banks, venture capitalists, etc). The presentation must be done using presentation slides and all team members are required to present.

Final Written Business Plan

The final written business plan should not exceed 30 pages including preliminaries, appendices and references and will be assessed based on its completeness in covering all aspects of the business venture. A financial viability model will need to cover income, expenses and cash flow projections for the business as well as capital expenditure and calculations of return on equity/capital.

Class sessions: Class sessions will focus on both content and general discussion and class activities; to ensure your active participation please read suggested pre-readings before class and come prepared to share and discuss your own ideas and experiences.

Each class session comprises three lectures; two lectures will be used for class activity and theory discussion and one lecture will be used for supervised group work. Attendance at all lectures and group work sessions is compulsory. Group work sessions will culminate in a number of 'one page' deliverables, the content of which will be discussed at each group session.

Assessment: The course assessment is made up as follows:

Task	Weighting
Idea Pitch (team)	10%
Business Model Canvas (team)	15%
Final presentation (team)	35%
Final written business plan (team)	40%

The final written business plan and team presentation are run in conjunction with the PCU module (see above).

All Computer Science Honours students have to obtain at least 40% for this module in order to continue with Honours.

3.4. Theory of Algorithms (TOA) [block 3]

Prerequisites: It is strongly recommended that you have completed a second year course in Mathematics, Applied Mathematics or Statistics.

Keywords: algorithms; complexity, Turing machines, computation

Course Objectives: This course will ensure that you understand the fundamentals of algorithms.

Credits: 10 credits.

Lecturer or Convener: *Prof. Tommie Meyer*

Course Content: Algorithms are central to computing. This course describes how algorithms are categorised. You will learn interesting algorithms in each category and analyse their complexity. You will also learn about Turing machines and the limits of computation.

Number of lectures: 16   **Practical work:** 9 hours   **Lecture block:** Block 3

Practical Assignments: Three closed practical assignments of three hours each.

Assessment: Exam: Three hours, 64%; Three practical assessments: 12% each.

Prescribed/Recommended Book: "Introduction to the Design and Analysis of Algorithms (International Edition)", 2011, Anany Levitin, Addison-Wesley, ISBN 978-0273764113.

4. Elective Honours Modules

Coursework modules offered at the Honours level vary from year to year, depending on the interests of the current Computer Science staff. The following list of modules is provisional for this year and **subject to change**. Modules are listed in alphabetical order. You may take any module, as long as you satisfy the individual prerequisites listed.

4.1.   Big Data Management and Analysis (BIGDB)
[block 1]

Prerequisites: A basic understanding of databases, similar to the CSC2001F database material, is expected.

Keywords: big data, data mining, database, data warehouse, NoSQL, Hadoop

Course Objectives: This course will enable students to understand the challenges of designing and implementing database applications at very large scale. They will know the approaches taken by big data technologies such as NoSQL, Hadoop and data mining tools, and have practice in applying this knowledge.

Credits: 10 credits.

Lecturer or Convener: _Assoc. Prof. Sonia Berman_

Course Content: The focus of this course is on systems designed for big data storage and analysis. Topics covered include NoSQL, Hadoop, HBase, HIVE, YARN and Apache Spark, as well as an introduction to data mining techniques and tools. The course concludes with a series of short presentations on new developments in database technology such as spatial, temporal, mobile, multimedia, text and social network data management.

Number of lectures: 16   **Practical work:** 10 hours   **Lecture block:** Block 1

Practical Assignments: Two assignments will be set – a big data analysis practical and a paper presentation – 5 hours each. Assignments are done in groups of 3 - 4.

Assessment: Exam: open book, 2 hours, 60%; Practical assessments: 20% each.

Prescribed/Recommended Book: Notes will be provided.

4.2.   Computational Geometry for 3D Printing (CGP) [block 2]

Prerequisites: Computer Graphics from CSC3020H and C++ from CSC3022H. These prerequisites may be waved based on appeal, but sufficient evidence of the necessary skills will be required.

Keywords: computer-aided geometric design, fabrication, computer graphics

Course Objectives: To master surface and volumetric modelling concepts applicable to 3D printing.

Credits: 10 credits (10 lectures and three practicals), 15 credit option possible, with additional practical work.

Lecturer or Convener: _Assoc. Prof James Gain_

Course Content: The use of 3D printers for rapid prototyping is becoming increasingly prevalent. However, the process used by most current 3D printers of depositing thin layers of semi-molten material, which is known as Fused Deposition Modelling (FDM), is not

without limitations. Factors such as material thickness and support structures need to be considered. This course will cover the theoretical concepts required for creating geometric models suitable for 3D printing. From a practical perspective, students will code modelling software, then design and ultimately print a 3D model.

Topics covered include:

- Geometry and Topology for Computer Graphics
- 3D Printing Concepts: Printing Hardware, Overhang Support, Applications
- Volumetric Concepts: Voxels, Computational Solid Geometry, Isosurface Extraction
- Surface Concepts: Parametric Surfaces, Mesh Smoothing, Free-Form Deformation

Number of lectures: 10   **Practical work:** 39 hours   **Lecture block:** Block 1

Practical Assignments: Three practicals (10-15 hours each). These build successively towards a final self-contained modelling package and a 3D printed showpiece. A substantial practical extension (5 credits) is optional.

Assessment: Exam: open book, 2 hours, 40%. Practical assessments, 15-20% each; Final printed show piece, 10%

Prescribed/Recommended Book: No prescribed text but research papers and readings will be provided.

4.3.   Distributed Scientific Computing (DSC) [block 2]

Prerequisites: A basic understanding of computer networking and software systems.

Keywords: Grid computing, Cloud Computing, Infrastructure as a Service, Platform as a Service, Software as a Service.

Course Objectives: To provide an understanding of the basic components used to build Grid and Cloud computing systems, with a focus on how these can support Scientific Computing.

Credits: 10 credits.

Lecturer or Convener: *Prof. Rob Simmonds*

Course Content: This course gives an overview of the components that make up Grid and Cloud computing environments. These include the components used to build distributed data and computing grids and the various "as a Service" systems referred to as Cloud computing. It also looks at how these are used for a range of activities, including supporting large scale Scientific Computin.

Number of lectures: 10   **Practical work:** 40 hours   **Lecture block:** Block 2

Practical Assignments: 2

Assessment: Exam: open book, 2 hours, 60%; Practical assessments: 40%.

Prescribed/Recommended Book: There is no prescribed text book, but research papers and online references will be provided.

4.4.   Evolutionary computation (EC) [block 1]

Prerequisites: Programming skills in Java (including data structures and algorithms) are

required. A basic understanding of genetics and evolution is useful, but not required.
Keywords: evolutionary algorithms.

Course Objectives: Evolutionary computation entails the use of simulated biological

evolution to solve problems that are difficult to solve using traditional computer science and engineering methods. This course examines different Evolutionary Algorithms (EAs) and the types of problems EAs are best suited to solve. Course objectives include: gaining an understanding of various evolutionary computation techniques, identifying EAs suitable for solving different types of problems, and how to apply EAs to optimisation, machine learning, or design tasks.

Credits: 10 credits.

Lecturer or Convener: *Dr G.S. Nitschke*

Course Content: The topics covered include:

1. Introduction to Evolutionary Computation.
2. What is an Evolutionary Algorithm?
3. Genetic Algorithms.
4. Evolution Strategies.
5. Evolutionary Programming.
6. Genetic Programming.
7. Niching
8. Multi-Objective Optimisation.
9. Co-evolution.
10. Working with EAs.

Number of lectures: 10   **Practical work:** 32 hours   **Lecture block:** Block 1

Practical Assignment: Implement an evolutionary algorithm to solve a given optimisation problem and use statistical analysis to compare results with another evolutionary algorithm (implemented by a classmate).

Assessment: Exam: closed book, 2 hours, 60%; Practical assignment: 40%.

4.5.   Human-Computer Interaction (HCI) [block 2]

Prerequisites: None.

Keywords: user-centered design, evaluation, user study, usability, methods (quant/qual)

Course Objectives: This course will introduce you to basic concepts and practice around user-centred design of digital systems

Credits: 10 credits.

Lecturer or Convener: *Dr Brian DeRenzi and Dr Melissa Densmore*

Course Content:

This module covers how to design and evaluate interactive systems for real users both in the developed and developing worlds. We will look at both theory and practice of designing digital systems.

Topics include the design cycle, sketching and storyboarding, task analysis, contextual inquiry, conceptual models, usability inspection, human information processing, experience design, and qualitative and quantitative study design and evaluation. We will also invite guest speakers from industry and research to talk about their own experiences with user-centred design.

Number of lectures: 16   **Practical work:** 12 hours   **Lecture block:** Block 2

Practical Assignments: Practical assessments will consist of two group project assignments (Prototype – 10%, Evaluation – 20%) and one individual assignment (15%).

Assessment: Exam (take-home): 40%; Practical assessments: 45%; Class Participation: 15% (includes online discussion)

Prescribed/Recommended Book: None

4.6.   Information Retrieval (IR) [block 3]

Prerequisites: Basic understanding of XML data is required. Some background on statistics and linear algebra will be useful.

Keywords: search engines

Course Objectives: Understand how search engines work at an algorithmic level. Learn how to build and incorporate basic and specialized search engines into your own projects.

Credits: 10 credits

Lecturer or Convener: *Assoc. Prof. Hussein Suleman*

Course Content:

- Introduction to Information Retrieval (IR)
- Models of Basic IR (Boolean, Vector, Probabilistic)
- IR evaluation and testbeds
- Stemming, Stopping, Relevance Feedback
- Models of Web and linked-data retrieval (Pagerank, HITS)
- Latent Semantic Analysis and Clustering
- Multimedia IR
- Cross-lingual and multilingual IR
- IR in Practice (CMSes, digital libraries, Web, social media, etc.)
- Selected topics from:
    - Distributed and Federated IR
    - Recommender Systems
    - Natural Language Processing for IR
    - Sentiment Analysis
    - Opinion Retrieval
    - Text Summarization

Number of lectures: 16   **Practical work:** 22 hours   **Lecture block:** Block 3

Practical Assignments: 1-2 programming assignments: to use and/or extend existing IR tools or build a new tool from scratch.

Assessment: Exam (take-home): 40%; Assignments: 40%; Class participation: 20%

Prescribed/Recommended Book: There is no prescribed book, but after the course you will know how to find all the information you need online!

4.7.   Intelligent Systems (INTSYS) [block 3]

Prerequisites: A strong mathematics background.

Keywords: Artificial Intelligence, Bayesian networks, machine learning, intelligent systems

Course Objectives: This course will introduce you to two widely used Artificial Intelligence approaches, i.e. Bayesian Artificial Intelligence and statistical machine learning. You will also learn how to incorporate these techniques into real world computer systems

Credits: 10 credits.

Lecturer or Convener: *Assoc. Prof. Deshen Moodley*

Course Content: This module provides an introduction to designing and implementing intelligent systems, with a focus on Bayesian AI and statistical machine learning

Topics

1. Overview of intelligent systems
   a. Top down versus bottom-up AI
   b. Cognitive computer systems
2. Bayesian AI
   a. Bayesian theory and Bayesian networks
   b. Utility and decision theory
   c. Decision networks
   d. Dynamic Bayesian networks
3. Statistical machine learning
   a. Bayesian optimisation
   b. Supervised learning
   c. Model evaluation and validation
   d. Unsupervised learning (optional)
4. Designing and implementing intelligent systems
   a. Streaming sensor data
   b. Modeling observations, events, time and space
   c. Classification, prediction and decision making

Number of lectures: 14-16 **Practical work:** 24 hours   **Lecture block:** Block 3

Practical Assignments: Three practical assignments – Bayesian AI, statistical machine learning, design and implementation of an intelligent system.

Assessment: 2 hr open book exam: 50%, Practical assessments: 15-20% each.

Prescribed/Recommended Book: Extensive readings, lecture notes and papers will be provided.

4.8.   Introduction to ICT for Development (ICT4D)
[block 1]

Prerequisites: None.

Keywords: ict4d, hci4d, socio-economic development, social good

Course Objectives: Understand basic ideas underlying ICT4D and how they are used in practice. Learn about and critically evaluate ICT4D projects. Learn how to design and evaluate development-oriented computing projects.

Credits: 10 credits.

Lecturer or Convener: *Dr Brian DeRenzi and Dr Melissa Densmore*

Course Content:

- Introduction to key terminology around socio-economic development
- Key concepts in ICT4D (e.g. social inclusion, after access)
- Case studies in specific domains, including healthcare, agriculture, mobile money, education, etc.
- Critical evaluation of ICT4D projects

Number of lectures: 16   **Practical work:** 8 hours   **Lecture block:** Block 1

Practical Assignments: There will be three individual assignments, and students will be expected to work in groups to lead one case study discussion.

Assessment: Exam: none; Practical assessments: 20% each; Class Participation: 20% (includes online discussion); Case Study Presentation: 20%

Prescribed/Recommended Book: None

4.9.   Logics for Artificial Intelligence (LAI) [block 1]

Prerequisites: Familiarity with basic discrete mathematics is highly recommended.

Keywords: logic, knowledge representation and reasoning, computational logic, description logics, logic-based ontologies.

Course Objectives: This course will introduce students to logics used in the area of Knowledge Representation - a subarea of Artificial Intelligence.

Credits: 10 credits.

Lecturer or Convener: _Prof. Tommie Meyer_

Course Content: Logic plays a central role in many areas of Artificial Intelligence. This course will introduce students to Description Logics, a family of logics frequently used in the area of Knowledge Representation and Reasoning. Description Logics are frequently used to represent formal ontologies. Topics covered include the following:

1.   The Description Logic ALC
2.   Reasoning in Description Logics with Tableaux Algorithms
3.   Reasoning in the EL family of Description Logics
4.   Query Answering

Number of lectures: 16   **Practical work:** 22 hours   **Lecture block:** Block 1

Practical Assignments: Students will be given a number of assignments. This may include an assignment involving the Protégé ontology development environment.

Assessment: Exam: open book, 3 hours, 50%; Assignments: 50%.

Prescribed/Recommended Book: None. Extensive lecture notes will be provided.

4.10.   Multi-Dimensional Data Visualization (MDVIS) [block 1]

Prerequisites: There are no specific prerequisites for this module, other than a background in computing. However, interest the design and development of graphical displays, data and graphics/visual art/aethetics/design is required to appreciate the course content. In addition, as this is an M.Sc course**, space may be limited**.

Keywords: data analysis, visualization, design, big data.

Course Objectives: This course froms part of the CSC5008Z Data Visualization course offered as part of the M.Sc in Data Science. Visualization is the graphical representation of data with the goal of improving comprehension, communication, hypothesis generation and decision making. As visualization is recognized a valuable tool for presentation and exploration of complex , multidimensional data sets, there is an increasing demand for data scientists with the ability to create effective and sophisticated visualizations. This course aims to teach the principles of effective visualization of large, multidimensional data sets. We cover the field of visual thinking, outlining current understanding of human perception

and demonstrating how we can use this knowledge in the design of effective interactive data visualizations.

Credits: 10 credits (8 lectures and one large assignment, which encompasses two in-class presentations and critique), with an option to do the full 15-credit MSc version.

Lecturer or Convener: *Assoc. Prof. Michelle Kuttel*

Course Content: 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 multidiminsonal data graphics, interfaces and visualizations.

Number of lectures: 8, plus 2 long presentation sessions (a total of 14 hours).

Practical work: 30 hours   **Lecture block:** Block 1

Practical Assignments: The single major practical will involve multi-stage design and testing of a graphical display of multi-dimensional data. Topics will be listed in the first week of the course and design stages will be presented to class for discussion and critique. The practical is expected to involve about 16 hours of work.

Assessment: Exam - 50%, Practical - 50%.

Recommended Books:

- Visual Thinking for Design by Colin Ware.
- The Visual Display of Quantitative Information by Edward R. Tufte (second edition).
- Visualization Analysis and Design by Tamara Munzner.

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.

4.11.   Ontology Engineering (OE) [BLOCK 1]

Prerequisites: Experience in modelling (ER, UML Class diagrams) and some familiarity with logic will be helpful.

Keywords: ontologies, modelling, OWL, Description logics, Semantic Web, automated reasoning

Course Objectives: The principal aim of this module is to provide the participant with an overview of ontology engineering—including language features, automated reasoning, and top-down and bottom-up ontology development—and a main application field being the Semantic Web.

Credits: 10 credits.

Lecturer or Convener: *Dr C.M. Keet*

Course Content: Ontologies are used in a wide range of applications, such as data integration, recommender systems, e-learning, semantic scientific workflows, and natural language processing. While some of these applications pass the revue, the main focus of the course is on the ontologies. The topics covered include the following:

1. Logic foundations for ontologies

- Languages (Description Logics, OWL)
- Automated reasoning (class and instance classification, satisfiability and ontology consistency checking)

2. Ontology development
   - Ontology engineering, top-down: foundational ontologies, ontology design patterns
   - Ontology engineering, bottom-up: exploiting legacy material, such as relational databases, thesauri, text
   - Methodologies for ontology development and maintenance, methods to enhance ontology quality and to automate some aspect of the methodology

Number of lectures: 16   **Practical work:** 8 hours   **Lecture block:** Block 1

Practical Assignments: There will be two assignments: developing a small ontology in an Ontology Development Environment and a group project on a selected topic that delves deeper into a specific OE topic.

Assessment: Exam (closed-book but with some material provided) - 50%, assignments - 50%.

Prescribed/Recommended Book: There is no prescribed textbook, but extensive lecture notes (text, exercises, and slides) and papers will be provided.

4.12. User Experience in Games and Virtual Environments (UXG) [block 2]

Prerequisites: Third year games course (and the honours research methods module). Students who have a proven ability to design and implement an immersive game or virtual environment may apply to the lecturer for exemption from this requirement. In any event the course assumes you know design techniques and assumes you already have a modifiable game that you bring to the course. It will give you greater scope for experimentation if your game is 3-D, otherwise you will be limited to "flow" measurements.

This course requires a lot independent work and is only for students who are able to take responsibility for their own learning.

Keywords: user experience; game design; virtual environments; flow; presence; quantitative research; experiment design; experiment evaluation

Course Objectives: This course has two aims:

1.   Built on practical skills in creating games (or virtual environments — VEs) with the scientific skills to analyse users' experiences (UX) in them.

2.   Give you a deep understanding of quantitative scientific methods from experiment design, through experiment execution to analysis and write-up as a scientific paper.

Credits: 10 credits (8 lectures taught intensively at the start, thereafter practical work and write-up).

Lecturer or Convener: _Prof E.H. Blake_

Course Content: We'll first examine concepts of user experience in immersive games and VEs. The objective is learning what makes such games and environments effective and engaging. We will consider how you can measure user experience in a VE and game and consequently how to make them better.

There will be a very few lectures at the start to introduce important topics and then it will be up to you to devise the experiments in consultation with the lecturer. The format will be one

of seminars and design discussions. The course is open-ended and you may suggest topics of interest.

The topics are drawn from the following:

1. Introduction
    - What are Immersive Games & VEs?
    - What is User Experience?
2. Immersion: Flow and Presence
    - Presence and Perception
    - Immersion and Flow in Games

Measurement of Presence and Flow in Games and VE.

Number of lectures: 8   **Practical work:** 36 hours   **Lecture block:** Block 1 (Feb-March) (Block 2 is also possible)

Practical Assignments: This course will be very practically orientated.

You (and perhaps a partner, but you may work alone) will take one of your games or VEs (or, in exceptional cases, create a new one) and vary some aspects in a way that you hypothesize will have an effect on the users' experience (UX). Your idea will be discussed and refined. You will then use your theoretical understanding of UX to design an experiment, run it and analyse the outcomes and then write up what was achieved.

Typically, the work involves modifying a game to create a control and experimental condition and performing an experimental test on users of the effectiveness of the intervention. Other forms of quantitative experimentation on UX are possible.

Assessment: Students will be assessed on the practical work, including experiment design, (50%) and paper written as a 24-hour take home exam based on the outcomes of the work (50%).

Prescribed/Recommended Book: There is no prescribed book, selected readings and notes will be provided.

4.13. Self-Study Module (SELF) *[block 1/2/3]*

Prerequisites: There are no specific prerequisites for this module.

Keywords: independent research

Course Objectives: Occasionally an exceptional student may wish to pursue a topic which is not offered as a normal module or pursue a topic in more detail than is possible in a normal module. This can be done if a supervisor can be found amongst the members of staff or visitors to the department. It is the student's responsibility, in consultation with the programme coordinator, to find such a supervisor. Students will normally be limited to one such self-study module. The module must be approved **in writing** by the programme coordinator.

Credits: 5 credits.

Lecturer or Convener: *C.S. Academic*

Course Content: The focus and content of the module will be established in consultation with the supervisor and must be approved by the course convenor.

Number of lectures: None   **Practical work:** 33 hours

Lecture block: The topic of the study must be decided and approved by the end of the first week of the second semester. The self study paper must be handed in not later than the end of Block 3 of the Honour's academic year.

Practical Assignments: None.

Assessment: The mark for the self-study topic will be based on a full research (practice and experience) or review paper of between 8000 and 10000 words (approximately 15-25 pages).

Recommended Books: to be determined in consultation with the module supervisor.

5. Elective External Modules

Students are encouraged to take external modules, subject to the subminima for external courses (Section 2.4). **These external courses have to be approved by the Honours Programme Coordinator.** They will be weighted according to their relevance to computing in general. A critical aspect of undertaking such a module is obtaining 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.

5.1.   Mathematics Modules

Modules within the Department of Mathematics have been approved as external courses by the Department of Computer Science. Students doing CS Honours can do an extra mathematics course on top of the normal allowance of 20 credits for outside courses. This is a maximum of 40 credits.

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).

5.1.1.   Complexity Theory (CT, 36 lectures, first semester)

Lecturer or Convener: *Dr Holger Spakowski*

Semester: First.

Prerequisites: UCT MAM 3rd year module 3DM (Discrete Mathematics) or equivalent.

Course Objectives: 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. The central open problem is the P versus NP problem.

Credits: 20 (CS)/ 21 (MAM) credits. (36 lectures + 12 tutorials)

Course Content:
- o   Nondeterministic and deterministic Turing machines
- o   Basic time and space complexity classes
- o   Space and time hierarchies
- o   NP and NP-completeness
- o   The polynomial hierarchy
- o   Oracle complexity classes
- o   Relativisation of the P versus NP problem
- o   Space-bounded computation
- o   Probabilistic algorithms
- o   Boolean circuits
- o   Counting problems
- o   Interactive proof systems

See more at: http://www.mamhonours.uct.ac.za/complexity-theory#sthash.eA02cKhB.dpuf

Practical Assignments: None.

Assessment: Exam - 60%, Class Record - 40%

Recommended Book:

- Sanjeev Arora, Boaz Barak. Computational Complexity: A Modern Approach.   (first chapters) Available online: For instance http://www.cs.princeton.edu/theory/complexity/

5.1.2.   Graph Theory (CGT, 36 lectures, Second semester)

Lecturer: *Dr David Erwin*

Semester: Second

Prerequisites: An undergraduate degree in mathematics, including some group theory.

Course Description:

Graph Theory is an increasingly important area of modern mathematics. There are numerous applications of Graph Theory: Modelling the World Wide Web, the spread of disease, driving directions, and electrical networks, to name a few. This course, though, is delivered as a course of Pure Mathematics, i.e., it is a sequence of theorems and proofs.

Course Content:

- Introduction: Graphs and digraphs, degree, isomorphism, operations on graphs,
- distance, bipartite graphs, cut-vertices and bridges, trees.
- Connectivity, vertex and edge cuts, Menger's Theorem.
- Planar graphs, Kuratowski's Theorem, the Four and Five Colour Theorems.
- Vertex colouring, Brooks' Theorem.
- Eulerian and Hamiltonian graphs.
- Graphs and groups, permutation groups and the Cauchy-Frobenius-Burnside Theorem.

5.2.   Statistics Modules

It is possible to do one of the modules from Honours in Statistics as an external course, not all of which require third year Statistics. The course below has been approved for credit, any others require the approval of both CS and Statistics Honours Convenors.

5.2.1.   ANALYTICS (ANA, 36 lectures, second semester)

Prerequisites: The module does not require heavy stats/maths knowledge - a practical understanding of regression is probably enough (covered in STA2020F). All modelling is done in the R language.

Keywords: data analysis, visualization, design, big data.

Course Objectives: This module covers computationally-intensive statistical methods for analyzing predominantly large datasets.

Credits: 20

Lecturer or Convener: *Dr Miguel Lacerda, Dr S¸ebnem Er, Dr Juwa Nyirenda*

Course Content: The course will cover three broad sections: (1) High performance computing, (2) Supervised Learning and (3) Unsupervised Learning. In the first section, students will learn how to analyse large datasets using the parallel processing capabilities of R and the UCT computer cluster. The second section will expose students to machine learning techniques for prediction and classification based on labelled training data. The last section will cover statistical methods for classifying observations into groups where the group memberships of the training data are not known in advance.

1. High Performance Computing
   - Parallel computing with R
   - Introduction to Linux
   - Cluster computing
2. Supervised Learning
   - Regression and classification trees
   - Bagging and random forests
   - Boosting
   - Neural Networks
3. Unsupervised Learning
   - Self-organising maps
   - Association rules and market basket analysis
   - Cluster analysis

Practical Assignments: None.

Assessment: Exam - 60%, Class Record - 40%

5.3.   School of Management Studies: Strategic Thinking (BUS4050W)

BUS4050W is the capstone course **available only to final year Business Science students**. This external course counts 20 credits.

BUS4050W aims to give students an opportunity to improve their strategic thinking ability. The course focuses on both classic strategic management thinkers and includes guest lectures who share their real world experience of strategic thinking. Consult the Faculty of Commerce handbook for more details.

5.4.   Department of Computer Science: Computer Graphics

You may take the Computer Graphics module from the undergraduate Games Course for 10 credits. Please contact Games course convenor (listed in the Science Faculty handbook) for more information and **ensure that you have approved your choice with the Honours Convenor**.