UCT Computer Science

Graduate Student Handbook

2022

UNIVERSITY OF CAPE TOWN

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This booklet contains details of the structure of the various graduate courses offered by the Computer Science Department at UCT, covering the Masters and Doctoral Degrees, as well as some information about the department itself.

The booklet was compiled by the UCT Computer Science MSc and PhD coordinator, together with the head of department of Computer Science.

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.

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1. General Information on our Postgraduate Degrees

The Department of Computer Science of the University of Cape Town has one of the best computer science departments in the country for pursuing graduate work. We have a strong core team of established researchers with international recognition in a wide variety of disciplines, with doctorates and experience from some of the world's leading computer science institutes.

All of our postgraduate degrees are **full-time**; we do not offer part-time courses.

1.1. Degrees

1.1.1. PhD

The PhD is a research degree on an advanced topic under supervision. Examination is by thesis alone. A candidate shall undertake doctoral research and advanced study under the guidance of a supervisor(s) appointed by Senate. The thesis must constitute a substantial contribution to knowledge in the chosen subject, must show evidence of original investigation and give a full statement of the literature on the subject. The PhD degree demands that the candidate is able to conduct independent research on his/her own initiative. Through the thesis the candidate must be able to demonstrate that he/she is at the academic forefront in the topic selected, that the work is original and that it advances our knowledge in the relevant field.

1.1.2. Masters in Computer Science (by Coursework and Dissertation)

This course provides training in research in Computer Science, through the medium of a set of courses and a minor dissertation.

The course aims to provide students with an overview of those fields of Computer Science in which the department undertakes research, from which the student has to enroll for the Research Methods module, and selects six of the remaining coursework modules: Distributed Scientific Computing, Evolutionary Computation, Information Retrieval, Intelligent Systems, Introduction to ICT for Development, Logics for Artificial Intelligence, Introduction to Image Processing and Computer Vision, Ontology Engineering, Virtual Reality, Natural Language Processing and Internet Systems Engineering. Upon successful completion of the coursework component, students will be required to register for the minor dissertation component and complete a suitable research project under supervision of an appropriate computer science academic staff member. The research component will expose the student to research methodology, experimental design, data analysis techniques, and dissertation writing skills. Students should be in a position to submit the final dissertation before the end of the second year.

1.1.3. Masters in Computer Science (by Coursework and Dissertation) specializing in Artificial Intelligence

This course provides training in research in Computer Science, through the medium of a set of courses and a minor dissertation with a specific focus on Artificial Intelligence

The course aims to provide students with an overview of those fields of Artificial Intelligence in which the department undertakes research, from which the student has to enroll for the Research Methods module, and selects six of the remaining coursework modules: Evolutionary Computation, Intelligent Systems, Introduction to Image Processing and Computer Vision, Logics for Artificial Intelligence, Machine Learning, Natural Language Processing, Ontology Engineering. It is also possible to substitute one or two courses from the mainstream Computer Science courses or from another department. Upon successful completion of the coursework component, students will be required to register for the minor dissertation component and complete a suitable research project under supervision of an appropriate computer science academic staff member. The research component will expose the student to research methodology, experimental design, data analysis techniques, and dissertation writing skills. Students should be in a position to submit the final dissertation before the end of the second year.

1.1.4. Masters in Computer Science (by Dissertation only)

This course is primarily intended for students who completed Honours in Computer Science at UCT. Other students must enrol in the Masters in Computer Science by Coursework and Dissertation, unless permission is obtained from the Head of Department, based on a motivation provided by a potential supervisor.

This course consists of an investigation of an approved topic chosen for intensive study by the candidate (student), culminating in the submission of a dissertation. The dissertation shall demonstrate the successful completion of a programme of training in research methods, a thorough understanding of the scientific principles underlying the research and an appropriate acquaintance with the relevant literature. It must be clearly presented and conform to the standards of the department and faculty. The dissertation will usually consist of a report detailing the conduct, and analysis of the results of, research performed under the close guidance of a suitably qualified supervisor(s). The dissertation should be well-conceived and acknowledge earlier research in the field. It should demonstrate the ability to undertake a substantial and informed piece of research, and to collect, organise and analyse material.

1.1.5. Masters in Information Technology

The MIT degree is by coursework and research, using mainly self study materials for the coursework - there are no lectures. It is a two year conversion programme aimed at students without a degree in computer science or information technology/systems. The ideal candidate for this programme is someone who uses information technology in his or her job, but who has no formal university qualification in IT. A non-IT honours degree, or equivalent, is the minimum requirement for entry into the MIT course.

The rules pertaining to Masters in IT are maintained separately and can be accessed here.

1.2. Programme Convenors

The 2022 Masters in Computer Science and PhD programme coordinator is ***Prof James Gain***, Room 313, Computer Science Building (email: pgcoordinator@cs.uct.ac.za).

The 2022 Masters in Information Technology programme coordinator is ***Assoc Prof Melissa Densmore***, Room 312, Computer Science Building (email: mit@cs.uct.ac.za).

The postgraduate programmes also have senior postgraduate students employed as Teaching Assistants (TAs). The role of the TA is to assist with course administration.

In addition, class representatives will be elected at the beginning of the year.

1.3. Rules and requirements for all postgraduate degrees

1.3.1. Role of the student

Graduate students are expected to be interested in deepening their knowledge and experience, particularly in Computer Science, but also in related fields.

Graduate students are expected to engage with the process of research and development, to be critical thinkers and to work productively, both independently and as part of a team. Students are expected to go beyond the basic requirements of a course or a project, reading widely in the relevant academic literature to contextualize and frame their work. We expect assignments and research projects to be solved independently and creatively, showing due appreciation for academic concepts and principles. In addition, students are expected to communicate ideas and results clearly in both written deliverables and presentations. In particular, graduate students are expected to:

- ensure that they **register for** and **complete successfully** sufficient courses to complete the coursework requirement for their degree;
- behave as a professional, arriving **punctually for all classes**, meetings and seminars;
- **attend all classes** and participate actively in class;
- manage their time effectively, working hard and consistently and **submitting all assignments by the posted deadlines**;
- work largely unsupervised and independently;
- engage in the process of peer review - evaluating their own and others' work and r**esponding to criticism thoughtfully and dispassionately,** using critique to improve their work;
- to engage actively with research talks and symposia hosted by the department;
- and to **raise any issues timeously** and politely with the course coordinator and/or the teaching assistant.

1.3.1.1. Role of Class Representatives

Class representatives will be elected for each class. Class representatives are expected to arrange regular meetings with the course coordinator, in order to resolve in consultation issues that arise during the course of the year. In addition, occasional meetings with the Head of Department will be scheduled. It is the responsibility of the class representative to act as a liaison between the class and the department: issues must be raised promptly, giving a balanced view of the class opinion. Therefore, class representatives are expected to regularly poll the class and give formal class feedback after meetings. In addition, graduate class representatives are expected to schedule the

examination timetable in the exam period at the end of each block, in consultation with the appropriate lecturers. Individual course may have additional duties for the class representatives.

1.3.2. 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 and the continent. 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;
- and promote, support and advise schools in the teaching of topics related to Computer Science.

For our graduate programmes, our role is more specifically to produce individuals who are educated, articulate, and able to perform research and exercise critical judgement in the field of Computer Science. 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 this is taught as a matter of course) - we want our students to remain useful scientists a decade from now.

1.3.3. Fees

Fees vary from year to year: consult the latest UCT *Fees Handbook* for accurate figures[1]. The Coursework Masters fees are course-based: additional courses over and above the basic requirements will incur an additional fee.

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] http://www.students.uct.ac.za/students/fees-funding/fees/handbook

1.3.4. Financial Assistance

Financial assistance is available for prospective graduate students. The *Financial Assistance for Postgraduate Study and Postdoctoral Research Handbook*[2] lists opportunities for both SA and international students - also look at the University's Postgraduate Degree Funding web page[3]. 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 – though in recent years this has come as early as June; the notification date is February of the next year.

The Faculty of Science offered scholarships to a limited number of PhD students each year - these must be applied for in the previous year.

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.

1.3.5. Facilities

All postgraduate students are assigned either shared or dedicated workspaces in the **ICT4D lab** or **Room 300 lab**, with equipment provided for by the supervisors of the research. However, in 2022 due to the exigencies of Covid-19 access to the postgraduate laboratories is carefully controlled. Should you require access, permission is required and should be requested via ***Jenine Christians*** (Jenine.Christians@uct.ac.za). Once permission has been granted the rules for access must be strictly adhered to.

The department has a server infrastructure that delivers core services to students and staff over high speed wired and wireless networks. Different research projects require different specialised equipment and the research supervisors will address these needs.

1.3.6. CS Department Seminars/Colloquia

All postgraduate students must allocate one hour per week for attendance at departmental colloquia. Computer Science colloquia are normally held during the lunch hour (1-2pm) and normally on a Thursday. **Please note that attendance of at least 75% of the colloquia is mandatory for Masters by C&D students**. 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.

1.3.7. Missing assignments, tests or examinations, medical notes and short leave

[2] http://www.students.uct.ac.za/students/study/handbooks/current
[3] http://www.uct.ac.za/apply/funding/postgraduate/applications/

All students are expected to do all assigned work and submit assignments by the posted deadlines. The standard penalty for late submission is 10% of the total mark per day, or part thereof.

If a student falls ill, they must submit a **medical note** to the **course convenor** as soon as possible and discuss making up for missed work with the course convenor.

Note that:

- A note from the UCT Wellness Centre is not a medical note.
- Generally, self-reported symptoms e.g. "Two days ago I was feeling ill", are not enough to constitute a medical note, even if you report this to a doctor and they issue a medical. Such medicals will usually say "according to the patient..." or "I was informed". **Such a note is not valid**, since there is no way of corroborating the illness.

Students who miss a test, exam or any other formal assessment **will only be allowed admission to an alternate assessment**, where this is possible and scheduled, if the circumstances warrant this as per the **rules for Deferred Examinations** in the UCT General Rules and Policies Handbook.

In other/exceptional circumstances, where a student would like to be away from their studies for a short and defined period of time, the **Short Leave Application form** must be filled out and submitted to the course convenor for recommendation and HoD for approval.

1.3.8. Policy on Plagiarism

The University of Cape Town has well defined policies on the copying of academic submissions and plagiarism, which are contained in the general Rules for Students and set out in full on the web. The Department of Computer Science has set out the a guide and interpretation of these rules and policies as they apply to courses involving computer programming, and the use of the computer. The rules defined here are in line with the best procedures in other institutions and are available on request from the course convenors. **All graduate students are expected to familiarise themselves with the rules on plagiarism**.

1.3.9. Appeals Procedure

If a student feels that their marks are incorrect for any piece of marked work, they must first approach the tutor or TA responsible for that test or assignment. Then, if need be, they may appeal to the course convenor. Finally, they may appeal to the HoD.

1.4. Coursework Information

1.4.1. Modules

The Departmental coursework modules are listed in the Compulsory and Elective Modules sections for the relevant degrees. We offer sufficient modules at all levels for you to fulfil your coursework requirement. However, you may, subject to the restrictions mentioned below, take selected modules from other departments. Note, however, that any module you register for outside the department must be of an

appropriate level, have relevance to Computer Science and **have the prior approval of the respective programme coordinator**.

1.4.2. Lecture Periods

Lectures are scheduled in lecture periods 1–8 (8am/9am/10am/11am/12pm/ 2pm/3pm/4pm). The timetable is drawn up in consultation with lecturers to best accommodate their lecture commitments and to even out the workload. 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.

1.4.3. Module Registration

Coursework modules are selected on registration, and changed to the module selection must be done via a change of curriculum form, signed by the course coordinator and the programme convenor; and then submitted to the Science Faculty Office.

You may only drop or add a module with the approval of the lecturer concerned and the programme coordinator. Such approval will not be granted if more than 1/6th of the lectures have already been given in the module concerned.

1.4.4. 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 12 credit module in Computer Science Honours and Masters. Open book and take-home examinations are preferred by some lecturers.

The examination timetable is the responsibility of the teaching assistant, the tutors 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 as the exam papers will not have been seen by the external examiner at this stage. We do not have any supplementary exams for postgraduate courses in the CS department.

2. PhD and Masters Degree Structure and Rules

1. Course Codes

PhD - CSC6000W

Masters by Coursework and Dissertation - CSC5001W (first year) and CSC5002W (second/subsequent year)

Masters by Dissertation - CSC5000W

2. Further Study

Students who successfully complete Masters in Computer Science at UCT are eligible to apply to proceed to a PhD in Computer Science.

3. Admission Requirements

The number of places in the Masters programme is limited and students are selected on merit from the list of applicants each year. Criteria for selection include the strength of your previous Computer Science qualifications, your relevant industrial experience and your maturity as a postgraduate student.

Students are admitted to the PhD degree on an individual basis only, after being accepted by a research supervisor in the department.

4. Orientation, Registration and Start of Year

The academic year for new MSc and PhD students begins on the first day of undergraduate lectures - consult the UCT calendar for start dates[4].

The orientation meeting will take place on the first day of term for all students. Attendance is compulsory!

Details about registration can be found here.

5. Coursework

Research Methods Course

ALL Masters in Computer Science and PhD students MUST attend the Research Methods seminar-based course in their first year of enrolment.

All students enrolled in the Masters by Coursework and Dissertation degree must complete 90 credits of coursework from the courses on offer for this degree. This includes the Research Methods course (CSC5020Z) for 18 credits, together with six elective coursework Masters courses. Details about the Research Methods course, as well as the available elective courses, can be found at the end of this booklet.

In exceptional cases, students may take approved courses in cognate departments with the prior permission of the course convenor.

[4] http://www.uct.ac.za/main/calendar/academic-calendar

6. Research Proposal

The research proposal is a document and associated presentation in which you propose your research topic for your degree to a committee and obtain feedback on the work you wish to do. All Masters and PhD students must write and present a research proposal in the first year of their studies. The deadlines for presenting their research proposal are as follows:

- MSc by Coursework and Dissertation: 15 December.
- MSc by Dissertation only: End of the first semester.
- PhD: 30 September.

Please contact the Teaching Assistant for postgraduate studies if you have any additional questions/queries.

The proposal procedure is as follows:

1. *Form a committee* - Your committee must consist of your primary supervisor and at least two other non-supervisors, with at least one of the two being a member of the Department of Computer Science academic staff. Your committee members must have at least the qualification of the degree you are pursuing, unless a letter of motiva- tion is approved by the Postgraduate Coordinator. It is your responsibility to find and contact appropriate members of your committee. If you are struggling to do so, please talk to your supervisor.
2. *Write a research proposal* - The content and length of your written proposal depends on what is appropriate for your research subarea, and must be discussed with your supervisor. As a guideline, it should be at most 8 pages for a Masters and at most 10 pages for a PhD.

   Your final written proposal must be submitted to your committee at least one full week before your proposal presentation.

3. *Plan and present your proposal* - Arrange a time and date (a one hour time slot) for your presentation with your committee. Then book a venue for the presentation or use videoconferencing. In the case of a venue-based presentation, you should liaise with the Senior Secretary at Reception to help you to do so (or ask your supervisor for help). If the venue does not have a built-in data projector, ensure that you secure a portable data projector for your presentation.

   Ensure that you send an email to the TA (pgta@cs.uct.ac.za) so that he can announce your presentation (including title, abstract, your name, supervisor, degree type, date and venue details) at least one full week before your presentation.

4. *Format of the presentation* - Your primary supervisor will chair the event. Your committee members must all be in attendance, either in person or remotely. Your presentation should be at most 10 minutes long. The next 20 minutes will be for your committee members, and anyone else in attendance, to ask questions. Your committee members will then privately discuss your proposal.
5. *Proposal outcome* - Your committee chair (your supervisor) will email the result of your research proposal presentation to you and the postgraduate coordinator with any necessary comments. It is your responsibility to ensure

that the supervisor sends this email. There are three possible outcomes to the research proposal presentation:

Pass: You have passed and no further action is required on your part.

Pass with edits approved by committee chair: You will be given explicit feedback and some time to address that feedback in written form. If the feedback comes from a particular committee member, your supervisor may request that you seek specific approval of your changes from that committee member to ensure that it is adequately addressed.

Fail with the option to reschedule: In this case you will receive more substantial feedback from the committee. They will determine the amount of time (typically in the range of 2-6 weeks) that you have to address the concerns and present to the committee a second time.

7. Thesis

The thesis is the major written document produced at the end of the research conducted and submitted for examination. More details on the form and requirements of the thesis can be found in the Science Faculty Postgraduate Handbook.

Once the student has completed the thesis to the satisfaction of the university, and completed all coursework associated with the degree registered for, the student will then qualify for the degree.

5. Compulsory Masters/PhD Modules

The coursework module offered below are required for ALL Masters and PhD students. The details may vary from year to year, depending on the current Computer Science staff.

5.1. Research Methods (RM) (Course code: CSC5020Z)

Prerequisites: None

Course Objectives: The Research Methods course introduces students to research methods from the perspective of Computer Science, preparing them for the minor dissertation component of the degree.

Course content includes: Types of research, how to find papers and how to read papers; Research Ethics; Scientific and technical writing; Research methods: qualitative and quantitative and both; Literature reviews; Research proposals; Problem statements, research questions and hypotheses; Research statistics; Research planning and grant writing; and Academic career planning.

Credits: 18 credits (18+ lectures)

Lecturer or Convener: ***Prof. James Gain***

Assessment: Students in the Masters by Coursework and Dissertation degree will be assessed by a mark assigned to their literature review and research proposal.

Prescribed Book: Notes and slides will be distributed.

6. Elective Masters Modules

Coursework modules offered at the Masters level vary from year to year, depending on the interests of the current Computer Science staff. The following list of modules, as well as their details, is provisional for this year and **subject to change**. Modules are listed according to course code. You may enrol for any module, as long as you satisfy the individual prerequisites listed. You have to pass six elective modules in order to complete the coursework component of the Masters by Coursework and Dissertation programme. Once you have completed the coursework component, you will be eligible to register for the dissertation component of the degree.

6.1. Multi-Dimensional Data Visualization (MDVIS): CSC5008Z

Prerequisites: There are no specific prerequisites for this module, other than a background in computing. However, interest in the design and development of graphical displays, data and graphics/visual art/aesthetics/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: Visualisation is the graphical representation of data with the goal of improving comprehension, communication, hypothesis generation and decision making.

This course aims to teach the principles of effective visualisation of large, multidimensional data sets. The course will outline our current understanding of human perception and demonstrate how we can use this knowledge to create more effective data visualisations.

In this course, you will design a complex multidimensional visualisation, starting with a rational first design based on the science of perception and following with phases of criticism and improvement.

There is a strong focus on high-dimensional data and how to display/interact with this effectively.

NOTE: Attendance of ALL lectures is expected, and attendance at presentations is required.

Credits: 12 credits (lectures and one large assignment, which encompasses two in-class presentations and critique).

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

Course Content: Topics covered are: perception and attention; visual “pop-out”; patterns; colour; visual space and time: depth perception and motion; channel effectiveness and design heuristics; visual objects and meaning; analysis of data graphics and visualization examples

Number of lectures: 16, plus 8 presentation sessions = 24 hours.

Practical work: 30 hours

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 weeks 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%. Note, the practical and assignment each have a 40% subminimum for passing the course.

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.

6.2. Distributed Scientific Computing (DSC): CSC5022Z

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: 12 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 Computing.

Number of lectures: 12 **Practical work:** 40 hours

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.

6.3. Evolutionary computation (EC): CSC5023Z

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: 12 credits.

Lecturer or Convener: ***Associate Professor 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: 12 **Practical work:** 32 hours

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%.

6.4. Information Retrieval (IR): CSC5024Z

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: 12 credits

Lecturer or Convener: ***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: 15 **Practical work:** 22 hours

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!

6.5. Intelligent Systems (INTSYS): CSC5025Z

Prerequisites: A strong mathematics background.

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

Course Objectives: This module provides provides an overview of modern intelligent systems, including their design and implementation, and current research trends in the area. The course will focus on Bayesian Artificial Intelligence, decision theory and statistical

Credits: 12 credits.

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

Course content: Topics will include:

- Overview of intelligent systems: Top down versus bottom-up AI, Cognitive computer systems
- Bayesian AI
- Statistical machine learning
- Designing and implementing intelligent systems
- Streaming sensor data

Number of lectures: 14-16 **Practical work:** 24 hours

Practical Assignments: Three 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.

6.6. Introduction to ICT for Development (ICT4D): CSC5026Z

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: 12 credits.

Lecturer or Convener: ***Assoc Prof 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:** 16 hours

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: 25% each; Case Study Presentation: 25%

Prescribed/Recommended Book: Geek Heresy, by Kentaro Toyama

6.7. Logics for Artificial Intelligence (LAI): CSC5027Z

Prerequisites: Familiarity with basic discrete mathematics is required. Prior exposure to logic is 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: 12 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

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.

6.8. Ontology Engineering (OE): CSC5028Z *- not offered in 2022*

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: 12 credits.

Lecturer or Convener: ***Assoc. Prof. Maria 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:** 20 hours **Lecture block:** Block 3

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: An Introduction to Ontology Engineering by Maria Keet.

6.9. Introduction to image processing and computer vision (ICV): CSC5029Z

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

Keywords: image processing; computer vision; segmentation; feature detection

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. A selection of machine learning algorithms will also be introduced. Research papers will be examined which relate these topics to real-world problems. Students are expected to read the papers, and will be assigned papers to present. A class participation mark will be kept as part of the practical record.

Credits: 12 credits.

Lecturer or Convener: ***Assoc. Prof. Patrick Marais***

Course Content: A number of lectures (as indicated below) will be presented by the course convener, interspersed with paper/review sessions in which topical papers are discussed by the students and convener.

- Basic Signal processing 1
- Image Transforms & Operations 2
- Simple Image Features 2
- Image Segmentation & Registration 1
- Classical Segmentation techniques 3
- Machine Learning & GAs in CVision 3
- Paper Reviews 6

Number of lectures: 12 + 6 Paper Presentation slots

Practical work: 30 hours

Practical Assignments:

- 3 Paper Sessions (2 papers each plus student presentations)
- 3-4 week programming project

Assessment: Exam: Open Book; 2 hours. DP Requirement: 50% in class record (composed of prac and review questions). Class Record: Practical 60%, Paper Discussions 40%. Final Mark: Exam 30%, Class Record 70%.

Prescribed/Recommended Book: There is no prescribed book: some notes and web resources will be provided.

Useful Reference: Image processing, Analysis and Machine Vision (4th Ed.), Milan Sonka et al, Wadsworth Publishing, 2014.

6.10. Advanced Topics in Computer Science Master's I: CSC5030Z - *not offered in 2022*

6.11. Advanced Topics in Computer Science Master's II: CSC5031Z - *not offered in 2022*

6.12. Internet Systems Engineering: CSC5032Z - *not offered in 2022*

Prerequisites: Working knowledge of computer networks. For practicals, some familiarity with the Linux command line interface will be useful.

Keywords:

Course Objectives: The objective is to gain advanced understanding of techniques for traffic engineering and quality of service in internet architectures. The course focuses on advanced topics in internetworking, traffic engineering, and mechanisms for measuring performance and Quality of Service (QoS) for network services and the Internet.

Credits: 12 credits.

Lecturer or Convener: *Dr. Josiah Chavula*

Course Content: New Network and Transport Protocols (IPv6, Mobile IP, IP Multicast, Multipath TCP, QUIC); Routing and Traffic Engineering (Interdomain Routing and Traffic Engineering with Border Gateway Protocol); Traffic Engineering with Overlay Networking (MPLS/GMPL, Location/Identifier Separation Protocols, Software Defined Networking and

Network Function Virtualization); **Internet Measurements** (Quality of Service and Quality of Experience (QoS and QoE), IP Traffic Monitoring and Analysis). In addition, selected reading/discussion topics will be included: Cloud Infrastructure; Content Delivery Networks; Internet Access in the Developing World, Community Networks; ICT4D, Online Data Protection and Online Censorship.

Number of lectures: 15 **Practical work:** 25 hours

Practical Assignments:

- 1 Paper Session (paper reading plus student presentations)
- 3 week network/architecture analysis project

Assessment: Assessment: Assignments: 40%. Discussion sessions: 15%. Active Participation in Class: 5%. Final Exam: 40%

Prescribed Book: There is no prescribed book: some notes and web resources will be provided.

Recommended:

- James F. Kurose, Keith W. Ross. Computer Networking : A Top-down Approach, Pearson, 2012 (6th edition)
- Research papers (from Journals and Conferences)

6.13. Human Computer Interaction (HCI): CSC5033Z - not offered in 2022

Prerequisites: None

Keywords: User-centered Design

Course Objectives:

This course will introduce you to advanced concepts and practice around user-centred design of digital systems.

Credits: 12 credits.

Lecturer or Convener: ***Assoc Prof. Melissa Densmore***

Course Content:

This course 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.

This course is offered concurrently with Honours HCI. Masters students will be expected to do additional readings, to attend a weekly discussion on the reading, and to develop and evaluate an artefact produced for the course.

Number of lectures: 15 **Practical work:** 30h

Practical Assignments: Individual Assignments, Group Project

Assessment: Participation 10%, Practical Assessment: 20%, Group Project: 40%, Final Exam: 30%

Prescribed/Recommended Book: None

6.14. Machine Learning (HCI): CSC5034Z

Prerequisites: None

Keywords: User-centered Design

Course Objectives:

This course will introduce you to the fundamental concepts and practice around machine learning.

Credits: 12 credits.

Lecturer or Convener: ***Associate Professor G.S. Nitschke***

Course Content:

CSC5034Z is a first semester module that is offered as an introductory Machine Learning module and will be recommended for those who have not done CSC3022F or equivalent. Please see the course entry for CSC3022F in the Science Faculty Handbook for more details.

Number of lectures: ~15 **Practical work:** ~30h

Practical Assignments: Individual Assignments

Assessment: Practical Assessment: 33.3%, Tests: 16.7%, Final Exam: 50%

Prescribed/Recommended Book: None

6.15. Natural Language Processing: CSC5035Z

Prerequisites: Basic calculus, linear algebra, and probability theory. Basic machine learning knowledge is recommended (supervised learning and classification), but students with a strong mathematics background who haven't done machine learning before may also take the course. No prior knowledge about linguistics is required.

Keywords: natural language processing, machine learning.

Course Objectives: The course will introduce students to the most important applications and currently used models in Natural Language Processing. The course will cover applications such as text classification, language modelling, sequence labelling, syntactic parsing, machine translation and question answering. Students will learn to work with count-based and feature-based models, as well as word embeddings and neural networks.

Credits: 12 credits

Lecturer or Convener: ***Dr. Jan Buys***

Course Content: This module will cover the following topics:

- Text processing (tokenization, lemmatization and text normalization).
- Naive Bayes and logistic regression for text classification (e.g. sentiment analysis).
- Word vectors and vector semantics.

- Language models (n-grams and feed-forward neural networks).
- Sequence labelling with hidden Markov Models (for Parts-of-Speech tagging and Named Entity Recognition).
- Syntactic dependency parsing.
- Recurrent neural networks for sequence processing.
- Machine translation with encoder-decoder neural networks.
- Transformers and contextual embeddings.
- Information extraction and question answering.

Number of lectures: 15

Practical work: 30 hours

Practical Assignments: 3 assignments on implementing NLP models in Python (The PyTorch library will be used for neural networks).

Assessment: Open-book Exam - 50%, Assignments - 50%.

Recommended Books: Dan Jurafsky and James H. Martin. Speech and Language Processing. 3rd edition draft, 2020 (available online). More resources and references to research papers will be provided.

6.16. Virtual Reality (VR): CSC5036Z

Prerequisites: A general understanding of computer graphics and some familiarity with the Unity game development platform. This does not need to be in the form of a formal course, a small Unity project that you have developed will be sufficient to satisfy the pre-requisite. **space may be limited due to equipment requirements**.

Keywords: virtual reality, augmented reality, computer graphics.

Course Objectives: Virtual Reality (VR) involves the creation of a digital replacement for the senses (sight, hearing, smell, taste, touch) using devices, such as head-mounted displays and haptic feedback, in such a way that users perceives themselves to be immersed in an alternate or augmented reality. VR has applications in games, simulation and training. This course will introduce the theoretical underpinnings and practical skills necessary for creating virtual environments.

Credits: 12 credits (16-18 lectures and one large assignment, which encompasses an in-class presentation)

Lecturer or Convener: ***Prof. James Gain***

Course Content: This module will cover the following topics:

- Overview (including current technologies)
- Interaction in VR
- Navigation and Locomotion in VR
- Simulation Sickness
- Immersion and Presence
- Designing VR Environments with Unity
- Non-visual Modalities (binaural output, virtual flavour, haptics)

Number of lectures: 16-18

Practical work: 30 hours

Practical Assignments: The single major practical will involve development of a Virtual Reality environment in Unity. This will be undertaken in groups with 2 or 3 members.

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

Recommended Books: There is no prescribed book: some notes, research papers and web resources will be provided.