<table>
<tr><th colspan="5">HONOURS</th></tr>
<tr><th>Week</th><th>Begins</th><th>Topic</th><th>Topic</th><th>Topic</th></tr>
<tr><td>0</td><td>3 Feb</td><td rowspan="3">Project Management</td><td rowspan="3">Distributed & Parallel Programming</td><td rowspan="8"></td></tr>
<tr><td>1</td><td>10 Feb</td></tr>
<tr><td>2</td><td>17 Feb</td></tr>
<tr><td>3</td><td>24 Feb</td><td rowspan="4">Data Science for Analytics</td></tr>
<tr><td>4</td><td>3 Mar</td><td rowspan="4">Security</td></tr>
<tr><td>5</td><td>10 Mar</td></tr>
<tr><td>6</td><td>17 Mar</td></tr>
<tr><td>7</td><td>24 Mar</td><td></td></tr>
<tr><td></td><td>31 Mar</td><td colspan="3">Vacation</td></tr>
<tr><td>8</td><td>7 Apr</td><td rowspan="5">GPU</td><td>Security</td><td rowspan="6">Computer Hardware Interfacing</td></tr>
<tr><td>9</td><td>14 Apr</td><td></td></tr>
<tr><td>10</td><td>21 Apr</td><td rowspan="3">Engineering in ICTD</td></tr>
<tr><td>11</td><td>28 Apr</td></tr>
<tr><td>12</td><td>5 May</td></tr>
<tr><td>13</td><td>12 May</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Swot Time (19 May - 22 May) & June Exams (23 May - 13 Jun)</td></tr>
<tr><td>14</td><td>7 Jul</td><td rowspan="4">Machine Learning</td><td>Project Time</td><td rowspan="6"></td></tr>
<tr><td>15</td><td>14 Jul</td><td rowspan="4">Image Processing</td></tr>
<tr><td>16</td><td>21 Jul</td></tr>
<tr><td>17</td><td>28 Jul</td></tr>
<tr><td>18</td><td>4 Aug</td><td rowspan="2"></td></tr>
<tr><td>19</td><td>11 Aug</td></tr>
<tr><td></td><td>18 Aug</td><td colspan="3">Working vac</td></tr>
<tr><td>20</td><td>25 Aug</td><td colspan="3" rowspan="7">Project time</td></tr>
<tr><td>21</td><td>1 Sep</td></tr>
<tr><td>22</td><td>8 Sep</td></tr>
<tr><td>23</td><td>15 Sep</td></tr>
<tr><td>24</td><td>22 Sep</td></tr>
<tr><td>25</td><td>29 Sep</td></tr>
<tr><td>26</td><td>6 Oct</td></tr>
<tr><td></td><td></td><td colspan="3">Swot Time (13 Oct - 16 Oct) & November Exams (17 Oct - 14 Nov)</td></tr>
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Honours

The Honours Degree will benefit your career because:

- The Honours level is the international standard for a first degree. For international mobility, and entrance into postgraduate courses at foreign universities, the honours degree is a minimum requirement.
- The Rhodes degree is an advanced, marketable qualification, recognised internationally. The programme provides improved employment prospects (not only now, but later on in your career), and opens up increased opportunities for entrepreneurial prospects.
- It is the degree that provides entry into research and development.
- It allows specialisation not possible in general undergraduate degrees, and satisfies love of the subject.

COURSE CO-ORDINATOR

Your course co-ordinator is **Dr Stones Dalitso Chindipha**, room 006, Hamilton Building (S.Chindipha@ru.ac.za). Your project co-ordinator is **Prof Dane Brown**, room 106, Hamilton Building (D.Brown@ru.ac.za).

Queries and comments about the Honours course should be addressed to the course co-ordinator.

ADMISSION CRITERIA

While admission to the Honours programme requires a minimum mark of 60% for CS3 (aggregate for CS301 and CS302), students intending to study Honours should aim considerably higher than this minimum, as obtaining the required minimum does not automatically imply acceptance into Honours.

Acceptance into any postgraduate course is at the discretion of the Department. A number of factors may be considered when we make this decision. Space or supervision constraints may limit the number of students we can accept. We will also consider performance and participation across the whole of your academic career. Students will normally not be accepted for Honours if they have taken more than two attempts at any undergraduate Computer Science exam to achieve the minimum entry requirement.

Any occassional student wanting to do an Honours module must have completed at least CS101 or the equivalent.

COURSE OPTIONS

In the BSc (Honours) programme, you are required to take course options which count towards the final mark and which are examined formally in June or November. No more than 3 courses may be taken in the 2nd semester. The remaining marks come from project and assignment work undertaken during the year. Students may elect to do no more than one extra course.

- For students registered for 100%:
  - 60% Six formal course examinations and practical work, where at least 2 are CORE MODULES.
  - 40% Project assessment mark made up as follows:
    - 10% Project related assignments, including seminars and a short paper.
    - 30% Final research project
- For students registered for 60%:
  - 20% Two formal course examinations and practical work, where at least 1 is a CORE MODULE.
  - 40% Project assessment mark made up as follows:
    - 10% Project related assignments, including seminars and a short paper.
    - 30% Final research project
- For students registered for 40%:
  - 40% Four formal course examinations and practical work, where at least 1 is a CORE MODULE.

Criteria for the marking of the project will be given in a formal Project Management course, a **compulsory** module at the start of the year, that counts towards project related assignments. This module covers various aspects involved in tackling a large project, including writing and research skills. An important component of modern science is the ability to write up one's work in a clear form, perhaps with the intention of publishing it.

Each option will have related portfolio work that will consist of at least one formal submission per course. Shaded areas in the provisional course time-table denote periods that are intended for use to mop up assignment work and to focus your energies on your project work. Some of these weeks go into the vacations. It is assumed that Honours students will be working on their projects and coursework through the vacations.

Full time Computer Science students are required to complete six coursework modules. One of these may be an External module, with the permission of the Heads of both Departments concerned, with the remainder coming from the Core or Application pools. Joint Honours students must complete all their modules from the Core or Application pools.

This year, the following course options will be offered. They are classified into three categories.

CORE MODULES **	APPLICATIONS MODULES	EXTERNAL MODULES
Computer Security Distributed & Parallel Programming Machine Learning	Data Science GPU Programming ICT for Development (ICT4D) Image Processing Hardware Interfacing (Physics)	Information Systems Electronics Mathematics Physics

** Core modules are those which embrace issues generic to all computer systems; something taught in all CS schools. For full time Computer Science students, at least two options should normally be chosen from the CORE category. For Joint Honours students, at least one option should be chosen from the CORE category. The remaining options should be chosen from the CORE or APPLICATIONS categories. With permission, one of the remaining topics may be chosen from an outside department.

Students must discuss their course configuration with their project supervisor. The project supervisor will determine whether their course configuration supports their project both in terms of time management and course content. Students must email their course choices to the Admin Manager, and to the project supervisor, indicating that confirmation has been obtained.

LECTURES AND TIME ALLOCATION

Lectures are either single or double period slots. Other departments use different lecturing schemes, and time-tabling joint honours is sometimes rather awkward. Students planning to take modules from other departments should be careful that their load does not become excessive at any one stage of the year.

Honours lectures will be held in the CORAL SEMINAR ROOM, HAMILTON BUILDING. You will be informed of lecture time slots by each individual lecturer.

Additional short courses of either an optional or a compulsory nature may be mounted during the year, depending on the availability of expert lecturers.

NOTE:

(a) You will also need to timetable in
- any part time work which you may be doing,
- Departmental seminars, at which **all** postgraduate students should be present,
- formal project supervision sessions each week, or as arranged with your supervisor.

(b) Note that there is an extended period of time in term 4 with no modules on offer. This has been intentionally done to make sure significant headway is achieved towards finalising the project, and is not meant as a vacation. Furthermore, a first full draft of the research project will be expected at the end of this time period. In addition, enrichment lectures will be scheduled during this time to provide assistance with approaching your project and perfecting the write up. These lectures and any associated assignments are **compulsory.**

(c) Attendance at lectures, practicals, seminars and project supervision sessions is compulsory.

(d) To give you an idea of how we pitch the course work, we expect honours students to put in **50 hours of work per week**. When you are attending two course options, the approximate breakdown should be:
- 10 hours on lectures
- 2 x 10 hours on practicals
- 20 hours on your project

When you only attend one course option, and during break periods, you are expected to put more time into your project work.

EVALUATION

Please note that individual modules may have specific DP requirements that must be met before a student may write the examination for that module. Students should check with the lecturer of each module what the requirements are for that module.

- Normally, students must pass ALL qualifying coursework modules, as well as the research project component of the project module.
- If a pass mark is obtained for a coursework module, but the student has obtained less than 40% for the examination, a Failed Subminimum (FSM) will be given and this will be considered as a failed module.
- Students should note that the marks for modules may be subject to scaling at the Department's and/or the external examiner's discretion.
- Students who are not performing adequately after considering June exam results will be advised to withdraw from the Honours programme or take the Honours programme over two years.

HONOURS PROJECTS

A very important part of the Honours year is the project, which is undertaken on a rather grander scale than anything you might have done in your undergraduate years. At one stage we adopted a policy whereby students could identify their own project, if that seemed possible, but this led to some problems in supervision and motivation, and we now favour a scheme where we provide a fairly small list of projects that are of immediate relevance to staff and research interests here.

Ideally, we would like each student to be part of a team working in an area related to one of the main research thrusts in the Department (see Research section). You are advised to chat to staff members involved with a particular project you might be interested in before making a final choice. Project choices should be finalised by the second week of lectures. While there are different research groups and specialisations, Honours is your introduction to research. As such, the specific project you choose or area of research you go into at this early stage is not crucial, nor does it disqualify you from changing direction later and pursuing an area that diverges from your project. The purpose is to guide you and equip you with an academic approach to research, and this is independent of the project you choose.

An important part – perhaps the most important part – of the effort in the project goes into producing the report. Each report should be produced in the style of a paper for publication. We also require you to produce a short paper of your project work. One of the supervision requirements of all postgraduate projects is that the student set up and maintain a web page for their project, under the main research site of the Department and this must be updated regularly.

The final research projects have to include machine readable versions of the report as well as copies of any software written.

HANDOUT FEE

A non-refundable charge of R350-00 will be made to cover the cost of course handouts, laboratory consumables, and payments of royalties on copyright material. We keep this charge as low as possible. This amount will be debited to your student account.

AND FINALLY ...

Honours can be very worthwhile – but, like much else in life, it depends largely on what you put into it. We often have Honours students remarking that they have learned more about Computer Science in their Honours year than in their whole undergraduate degree. We hope, and expect, that you will put a lot into it, starting from day one. At this level everyone in the course – staff and students alike – become contributors to a pool of knowledge. Your project work, and the seminar programme, for example, become important areas in which information can be spread about the group as a whole.

A prize, generously sponsored by
Open Box Software,
is offered for the top student in the course

and a prize, generously sponsored by
Janinne Franke,
is offered for the top Honours research project.

HONOURS COURSE OUTLINES

All students who have not completed their undergraduate degree through Rhodes University are advised to discuss their module choices, in terms of what knowledge is assumed, with the relevant module lecturers at the beginning of the year.

Research (Project) Management Course (Prof Dane Brown)

This course aims to equip you with the skills to complete a fairly substantial research project.

The entire life cycle of the project is covered in detail -- from inception (finding a project topic and writing the proposal) to completion (research report structure and assessment). Other topics cover the purpose of, and how to write a literature survey, how to present a research seminar and general issues like research ethics, time management, scientific writing skills, and the use of LaTeX and BibTeX.

This module is compulsory and is assessed throughout the year and does not have a final exam.

Computer Security (Dr Stones Dalitso Chindipha)

Embark on a dynamic journey through the diverse domains of computer security in this engaging course. From mastering the intricacies of cryptography to unravelling the complexities of web application security, reverse engineering, Android security, binary exploitation, bash scripting, malware analysis, social engineering, and network security fundamentals, this course offers a comprehensive exploration of key topics. Gain hands-on experience in securing systems, analyzing vulnerabilities, and defending against cyber threats. Whether you're a novice or seasoned professional, this course empowers you with the expertise and practical skills needed to safeguard digital assets and navigate the ever-evolving landscape of cybersecurity.

Prerequisites: Students should be familiar with programming constructs such as those covered in CS201/CS202 and a good understanding of Computer Networks and Operating Systems as covered in CS302 and CS202, respectively. Knowledge of compilers/translators programming is an added advantage.

Data Science for Analytics (Prof Dane Brown)

This module covers some aspects of data science and its interesting applications. It is a key module for understanding how data influences various fields in computer science and the importance of analytics in research – especially toward conducting better, impactful experiments. Data science is a broad field, and core concepts are thus covered concisely in a practical way.

Topics covered include:

- Introduction
- Data collection and management
- Data visualisation
- Experimental basics
- Data analytics and practical statistics
- Project applications and metrics

Prerequisites: Enthusiasm and coding

Distributed & Parallel Programming (Prof George Wells)

To present students with an overview of distributed computing, parallel programming, and the relationship between them. Practical sessions cover the full range of parallel and distributed processing, and use the Java programming language.

Topics covered include:

- Background, terminology and theoretical foundations
- Hardware issues and system architectures
- Parallel algorithm patterns
- Parallel processing
  - Communication and synchronization
  - Threads, interprocess communication, CSP, etc.
- Distributed processing
  - Remote procedure/method calls, virtual shared memory, Message Oriented Middleware, grid computing, etc.
- Formal specification
  - The CSP meta-language, specifying parallel systems, proving safety, etc.

Prerequisites: Object-oriented programming in Java (or a similar language, such as C#).

GPU Programming (Prof Karen Bradshaw)

Although graphics processing units (GPUs) are well known for their use in rendering images, their power for general parallel computing has only been explored in the past decade. With the increased availability of parallel frameworks, programming models, and development tools, however, GPUs have developed into flexible processors that typically outperform CPUs in the parallel computation of some problems.

This module covers the fundamentals of parallel computing using the CUDA C/C++ parallel programming model as well as accessing CUDA via Python. The module focuses on basic CUDA commands and syntax, the use of CUDA libraries, and relevant optimizations specific to the architecture of the GPUs being used. Practical labs covering applications in graphics, simulations, physics, and other topics complement the programming concepts and techniques introduced in the lectures. Successful completion of the NVIDIA Fundamentals of Accelerated Computing with CUDA Python certificated course may form part of the assessment of the module.

Prerequisites: Competence in C/C++ programming and an independent work ethic are vital as the module is based on multiple hands-on assignments to understand the concepts.

ICT for Development (ICT4D) (Prof Nomusa Dlodlo)

The goal of the course is to develop skills in the basic theory and practice underlying ICT4D in low-resource settings. While low resource settings are various in nature, the scenarios will be mostly drawn from the realities of underdevelopment and poverty. This is an essential course for anyone seeking to use ICT to address inequalities in socio-economic development. The practical work will require the solution of a (small) real-life problem in a limited resource setting.

The course content will cover topics from the following five main areas:

- ICT4D foundations
- Living Lab as an advanced engineering methodology for system building
- Telecommunications in marginalized areas of South Africa
- User-oriented computing in marginalized areas of South Africa
- Software application development for marginalized areas of South Africa

Image Processing (Mr James Connan & Prof Dane Brown)

To introduce students to image processing. This module covers aspects of image generation and manipulation but focuses on the extraction of information from images. The concepts covered are relevant to computer vision and image manipulation.

Topics covered include:

- Basic concepts such as image file formats, scaling and rotation
- Colour manipulation such as grey scaling and colour models
- Image segmentation using background subtraction, edge detection, filters, etc.
- Image processing techniques such as Hierarchical Chamfer Distance Transforms, AdaBoost, Histograms and CAMShift
- Taking a look at current developments in the field and directions for possible research

Prerequisites: Enthusiasm and the ability to think outside of the box. Any language that has a wrapper for OpenCV should be usable.

Machine Learning (Prof Dane Brown & Mr James Connan)

This module covers several aspects of machine learning and its interesting applications, including computer vision, network security and several others. The concepts cover the fundamentals of machine learning and expand to the newer deep learning methods typically used in AI.

Topics covered include:

- Good practices and data visualisation
- Regression and classification
- Tree-based methods
- Neural networks
- Support Vector Machines
- Unsupervised learning
- Deep learning

Prerequisites: Enthusiasm and the ability to think outside of the box. Strong competency in mathematics and Python.

Computer Hardware Interfacing (Mr Anthony Sullivan)

This is an electronics orientated course, and is presented in the Department of Physics and Electronics.

This module aims to provide the student with a hands on knowledge of hardware interfacing using a microcontroller environment. The course is taught via the investigation of peripherals available on the development board, how they can be made to interact and produce a desired outcome. Short tasks will be set for investigation after each lecture (not all of these are for assessment purposes). The main assessment (besides the theory examination) is a practical assignment that effectively combines elements from each of the tasks to work together to produce a stated goal.

Contents:

Assembly level programming of the Atmel 8-bit RISC architecture and associated common peripheral interfaces. A strong emphasis is placed on the differences to 'normal' computer programming such as no scheduling or other OS provided crutches. Practical exposure to system design of fundamental hardware interfaces.

Prerequisites: Physics 1E2 or equivalent electronics experience. PLEASE NOTE THERE IS A 10 PERSON LIMIT ON THIS MODULE.

Masters & Doctorates

The Department of Computer Science has an established and highly respected research school. Research is funded by the Telkom Centre of Excellence in Distributed Multimedia, the National Research Foundation and Rhodes University. Each year, staff members and senior students present their work in national and international forums. Several staff members serve on international advisory boards, standardisation forums, and organising committees.

POSTGRADUATE SCHOOL LEADER

The postgraduate co-ordinator is **Prof Dane Brown,** Room 106, Hamilton Building (D.Brown@ru.ac.za). Queries and comments about the degrees should be addressed, initially, to him.

MASTER OF SCIENCE DEGREES - MSC

The Department of Computer Science offers a pure research MSc degree, for which the entire assessment is by thesis. Students work on an approved research topic, under the supervision of an experienced researcher, usually contributing towards an established project. Some of the projects offered for this purpose are undertaken in conjunction with external corporations or institutions. These projects are intended to increase the relevance to industry of the degree and usually require additional visits to the institution concerned. The research is written up as a thesis, which is examined by selected area specialists external to the University.

Duration

The residence period for the Master's degree is a minimum of one full year, from February to January of the following year. An MSc thesis typically takes between 18 to 24 months to complete.

Entrance requirements

The normal entrance requirement for an MSc candidate is an appropriate Honours degree, or an equivalent NQF level 8 qualification. In exceptional cases a BSc degree and a minimum of three years of relevant experience may be considered for acceptance.

MASTERS DEGREE PROGRESS MILESTONES

These progress milestones are intended to indicate the maximum time that a full-time student should take on each phase of the masters degree (by thesis) in order to successfully complete in a time period not exceeding two years. This allows ample time for examining, corrections, and the submission of a final paper on the work.

Students must produce reports at the end of each quarter of study detailing their progress and the meeting of the milestone requirements. More regular interim progress notes are also encouraged. Requirements for the project web page are detailed below.

Year one – quarter one

At the end of this quarter, students should have:

- written a project proposal (approximately ten pages long)
- presented a seminar on the material to his or her supervisors and peers
- created a web page for the project, containing at least an abstract and description of the project,
- links to related sites, and a research plan for the remainder of the project.

Year one – quarter two

At the end of this quarter, students should have:

- made some progress in implementing the project
- written an extended abstract for a suitable conference's "work in progress" track, outlining the project proposal.

Year one – quarter three

At the end of this quarter, students should have:

- completed a good portion of the implementation of the project and the research should be well underway
- made contact with researchers at other institutions active in the field and received wider feedback
- on the content and approach of the research project
- presented a written and oral paper on the project to a wider audience than his/her immediate institution.

Year one - quarter four

At the end of this quarter, students should have:

- completed the broad implementation goals of the project
- prepared a demonstration of the work
- submitted a revised plan of action with an implementation schedule for the 2nd year of the project and an updated literature survey
- added considerably to the number of web links to related sites
- prepared a content outline for the written thesis.
- completed the annual progress report.

Year two - quarter one

At the end of this quarter, students should have:

- made significant progress in writing the thesis
- submitted a rough draft of the thesis to the supervisor for comment
- identified all remaining problem areas that fall within the scope of the study.

Year two - quarter two

At the end of this quarter, students should have:

- submitted a complete draft of the thesis to the supervisor for comment
- made a critical self assessment on the approach of the project and the conclusions drawn
- submitted a paper to a suitable conference outlining the project's aims, results and conclusions.

Year two - quarter three

At the end of this quarter, students should have:

- submitted the final thesis in polished form for examination
- published the detailed conference paper on their project web page
- identified a journal, with a view to publishing an enhanced version of the paper
- polished the demonstration system if necessary
- if appropriate, prepared an online demonstration of the work into their project web page.

Year two - quarter four

At the end of this quarter, students should have:

- completed any updates or corrections required by the examiners, and submitted a final corrected thesis
- presented a final demonstration and verbal report to industrial partners/funders
- submitted a paper to a journal for refereeing, taking into account the feedback of the external examiners.

DOCTOR OF PHILOSOPHY DEGREES - PHD

As for the pure research MSc degree, the PhD degree involves the preparation of a thesis based on original and independent research. The residence period for full time pursuit of a PhD degree is normally 3 years.

A PhD candidate is expected to publish substantially more than an MSc candidate.

Research

CENTRE OF EXCELLENCE

Since 1997, the Department of Computer Science has hosted a Telkom Centre of Excellence, which focuses on distributed multimedia. The Centre brings together the research expertise within the department, contributions from other departments at Rhodes University and at other tertiary institutions (both nationally and internationally), and input from industry partners. The Centre is a good example of a triple helix at work, where academia, industry and government come together to pool resources and improve the competitiveness of the industry, via the preparation of highly skilled practitioners and the co-development of appropriate technology. The Centre is supported by Telkom.

The Centre operates under the management of a joint academic/industry steering committee, and has high level representation from the partner industries and from the DTI through the National Research Foundation. The Centre is headed by Mr James Connan.

RESEARCH GROUPS

The Department has a number of research and development groups, several of which feed into the realisation of the distributed multimedia platform under the auspices of the Centre of Excellence. They are:

- Artificial Intelligence (Prof Karen Bradshaw, Mr James Connan & Prof Dane Brown)
- Convergence (Prof Nomusa Dlodlo & Dr Zelalem Shibeshi)
- Distributed and Parallel Computing (Prof Karen Bradshaw & Prof George Wells)
- ICT4D (Prof Nomusa Dlodlo and Dr Zelalem Shibeshi)
- Security and Networks (Dr Stones Dalitso Chindipha)
- Software Design and Development (Dr Yusuf Motara)

They are described in some detail in the next few sections.

Artificial Intelligence and Robotics

Given that the AI field is very broad, this group focuses mainly on three distinct areas, namely, image processing (computer vision), machine learning and intelligent agents. Research is conducted in a wide range of application fields using the respective AI algorithms either individually or in some combination. As has become the norm, there is a continued shift to parallel image processing and machine learning using GPUs.

In all of the AI areas supported, research is aimed at solving real-world problems. Example fields for the application of computer vision techniques are biometrics, gesture recognition, surveillance, face recognition, facial expression recognition and object tracking. Members have extensive experience in the application of computer vision to real-world scenarios as former participants in the Integration of Signed and Verbal Communication: South African Sign Language Recognition, Animation and Translation Group.

Intelligent agents are robots that are able to mimic human behaviour in some way. Using machine learning techniques, it is possible to train a robot to perform a human task. Deep learning can be used in both land and aerial robots allowing these to solve tasks that are too difficult or dangerous for humans to solve.

Convergence

This group works on the provision of specific support for mobile devices in the previously developed distributed media-service platform. This is done through the investigation of available architectures to specialize appropriately, and the creation of suitable toolkits for the fast creation and deployment of services on the platform. Naturally, particular attention is given to services that integrate audio, video and location information.

Distributed and Parallel Computing

This group has a long history in the department, going back to the origins of the paradigm in the 1980's when transputers were the main focus. More recently, the group's research efforts have focused on various aspects of Linda, a coordination language for parallel/distributed programming, grid computing and general purpose GPU programming. Emphasis is also placed on making concurrent programming more readily accessible to non-computer scientists as well as the use of GPUs to speed up computation in a variety of scientific applications.

ICT4D

The ICT4D (Information and Communication Technologies for Development) research group explores how digital technologies can address social, economic, and environmental challenges in underserved communities. It focuses on areas like digital literacy, ICT infrastructure, financial inclusion, education, and healthcare. The group conducts research and develops innovative ICT solutions. Through field work that is structured as a living lab, a vehicle which permits the utilisation of a methodology where services needed by a community are co-created with the community, the group works in collaboration with government institutions, NGOs, and local communities to promote sustainable and inclusive technologies.

Security and Networks (SNRG)

The Security and Networks Research Group (SNRG) efforts are concentrated in the areas of Information Security and Computer Networks. Members of the group are currently involved in a variety of projects, including a selection of visualisation techniques for security metrics, network traffic classification and monitoring and intrusion detection. Efforts are focused around the emerging field of collaborative Cyber Threat Intelligence.

Software Design and Development

The Software Design and Development group focuses on finding ways in which the next generation of software can be conceptualised, designed, and implemented. It seeks to understand the mechanics of software creation, from the fundamental philosophies that underlie software modeling up to the effect of applying language features to particular problems. Since new methods are notoriously difficult to communicate, the group is also particularly interested in ways of explaining such methods in an intuitive and simple way. Its research agenda therefore encompasses Computer Science education and gamification in this context. At present, the efforts of the group are focused in the area of functional programming as an up-and-coming area of practical importance to many aspects of software design and development.