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Research has experienced profound methodological changes in the last decades. A significant part of scientific enquiry now relies on computational approaches to complement theory and experiment. This a fundamental shift. In the words of Nobel laureate Ken Wilson: computation has become the "third leg" of science. Simulations allow us to perform virtual experiments that are too dangerous, too costly, unethical, or plainly impossible to conduct in reality. Visualisation offers us entirely new ways to explore and understand data, and only computational analysis makes it possible to cope with the vast amounts of data that contemporary science and engineering must process.

Computational science and eResearch are core drivers of innovation. Bioinformatics, climate studies, and ecological modelling are among the most prominent and most important examples, but the fundamental impact of this shift is felt far beyond the so-called "hard" sciences.

Arguably, one of the pivotal influences of computational science is to change the character of whole disciplines by making it possible for them to perform "hard" qualitative data-based studies in areas where this was impossible before. For example, social science researchers can conduct quantitative studies by simulating virtual societies in order to understand the ramifications of hypothetical changes in behaviour or policies. Medical researchers can simulate the spread of world-wide epidemics to evaluate possible containment methods, and economists can use simulations to "measure" the impact of such epidemics and other disasters on national and global financial systems.

This unit will equip students with a thorough understanding of how computational science relates to and extends traditional methods. Students will have the opportunity to work on problems from their "home discipline" which will enable them to understand the potential and limitations of computational studies in these fields.

Topics include: history of science; the role of computational methods; simulations and virtual experiments; capturing complex systems; the limits of modelling; is computational science a paradigm shift?; data-intensive research; virtual collaboration; the scope of e-Research.

Mode of Delivery

Clayton (Day)

Contact Hours

2 hrs lecture/wk, 3 hrs laboratory/wk

Workload requirements

Students are expected to spend a total of 12 hours per week on average during semester on this unit.

This includes 2 hours of lecture and 3 hours of laboratory work per week.

The remaining 7 hours are allocated to preparation and revision, reading time, and solving assignments.
Chief Examiner

Associate Professor Bernd Meyer

Campus Lecturer

Clayton

Bernd Meyer

Consultation hours: Friday 3.30-4.30 or by appointment (Clayton)

Tutors

Clayton

Zoe Bukovac

Consultation hours: by appointment
Academic Overview

Learning Outcomes

On successful completion of this unit, students will have:

An awareness of:

• the potential of computational and mathematical modelling in experimental work;
• the fundamental limitations of computational experiments.

An understanding of:

• the role of hypothesis, experiment, model, and theory in the classical scientific approach;
• the expectation-observation-reflection refinement cycle in experimental research;
• the role of a mathematical model;
• the role of simulation in modern science;
• the role of visualisation and of data mining techniques for data analysis;
• the role of high performance computation in computational science.

Knowledge of:

• different types of model (mental, computational, mathematical, animal, ...);
• the basic categories of computational modelling: analytic versus simulation; ab initio versus coarse-grained; discrete versus continuous; deterministic versus stochastic;
• inherent difficulties of computational approaches (e.g. parameter sensitivity and combinatorial explosions);

The ability to:

• conduct basic computational experiment in at least one chosen application domain (with tools that do not require programming);
• perform basic computational data interpretation with visual and non-visual methods;
• critically evaluate such experiments;
• work in teams to design, conduct, evaluate, review, and critique experiments that address basic research questions in their chosen application domain and to explain the designs and results to outsiders.
## Unit Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Activities</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>No formal assessment or activities are undertaken in week 0</td>
</tr>
<tr>
<td>1</td>
<td>Introduction: What is computational science, simulation &amp; modelling</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Types of Models, System Dynamics</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Computational Models, Cellular Automata Simulation</td>
<td>Essay start</td>
</tr>
<tr>
<td>4</td>
<td>Computational Models, individual-based simulation (Disease models)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Computational Models, individual-based simulation (Swarm Models)</td>
<td>Project part 1 start</td>
</tr>
<tr>
<td>6</td>
<td>Deterministic versus stochastic models</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Causal models</td>
<td>Project part 1 due; Project part 2 start</td>
</tr>
<tr>
<td>8</td>
<td>Visualization</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Model Fitting and optimisation</td>
<td>Essay due</td>
</tr>
<tr>
<td>10</td>
<td>Visual Data Analysis</td>
<td>Project part 2 due</td>
</tr>
<tr>
<td>11</td>
<td>High-performance Computing</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1. Reflection: A new paradigm? 2. Revision</td>
<td>Project peer evaluation due</td>
</tr>
<tr>
<td>SWOT VAC</td>
<td></td>
<td>No formal assessment is undertaken in SWOT VAC</td>
</tr>
</tbody>
</table>

*Unit Schedule details will be maintained and communicated to you via your learning system.

## Assessment Summary

Examination (3 hours): 60%; In-semester assessment: 40%

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Value</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modelling Project Part 1: Model Building and Evaluation</td>
<td>30% (of non-exam component)</td>
<td>26 April 2013</td>
</tr>
<tr>
<td>Modelling Project Part 2: Implementation and Use</td>
<td>30% (of non-exam component)</td>
<td>15 May 2013</td>
</tr>
<tr>
<td>Essay</td>
<td>25% (of non-exam component)</td>
<td>10 May 2013</td>
</tr>
<tr>
<td>Peer Assessment</td>
<td>15% (of non-exam component)</td>
<td>31 May 2013</td>
</tr>
<tr>
<td>Examination 1</td>
<td>60%</td>
<td>To be advised</td>
</tr>
</tbody>
</table>
Teaching Approach

- **Lecture and tutorials or problem classes**
  The unit is taught on campus with additional on-line materials. It will be team taught, i.e. selected lectures will be given by specialists in a particular area.

- **Problem-based learning**
  The unit employs an active learning approach with components of peer instruction. In practice this means that the lectures will not only be used to present new information, but much of the classroom time will be dedicated to the discussion of example problems and to group work. Laboratories are a direct extension of this but focus more strongly on the individual contribution of the students. They will be used to solve complex problems with the guidance of a tutor.

The boundaries between lecture and laboratory are thus somewhat fluid.
Assessment Requirements

Assessment Policy

Faculty Policy - Unit Assessment Hurdles

Academic Integrity - Please see the Demystifying Citing and Referencing tutorial at
http://lib.monash.edu/tutorials/citing/

Assessment Tasks

Hurdle Requirements

Hurdle requirement: active participation in pracs and lectures in at least 50% of weeks = 6/12 marks. A mark can be earned each week by active contributions, including informed questions in lectures and pracs, participation in class discussions, contributions to online forums, contribution of materials to online collections.

Participation

• Assessment task 1

  Title:
  Modelling Project Part 1: Model Building and Evaluation

  Description:
  Part 1 of the modelling project consists of the initial description of a modeling project in the student's chosen application domain. Deliverables include 1) the description of the phenomenon to be investigated, 2) specification of the hypothesis that will be investigated with the computational experiment, 3) choice of the modelling approach and reasons for this choice, 4) experimental plan, 5) detailed specification of the model.

  Weighting:
  30% (of non-exam component)

  Criteria for assessment:
  Marks will be allocated according to correctness, completeness, and depth of the analysis (1-3), feasibility and adequateness of the experimental plan (4), and completeness, correctness, and style of the model (5).

  Particular importance will be placed on how well underlying principles and theories are demonstrated in the student's answer.

  Due date:
  26 April 2013

  Remarks:
  Topics for the modelling project must be individually approved by the chief examiner.

• Assessment task 2

  Title:
  Modelling Project Part 2: Implementation and Use

  Description:
Part 2 of the Modelling Project consists of the implementation of the model proposed in Part 1 and its use to conduct the experimental plan. The deliverables are the model implementation, a brief evaluation of the model's affordances and shortcomings, and an evaluation of the experimental results.

**Weighting:**
30% (of non-exam component)

**Criteria for assessment:**
Marks will be allocated according to correctness and style of the implementation, scope and correctness of the experimental evaluation, and depth of insight into the model's characteristics.

**Due date:**
15 May 2013

**Remarks:**
Any aspect of the project may be modified from the proposal made in Part 1 in response to feedback received. However, all such modifications must be individually approved by the chief examiner.

** Assessment task 3**

**Title:**
Essay

**Description:**
This is an individually written essay on the application of computational models in an application domain that students can choose according to their individual interests.

**Weighting:**
25% (of non-exam component)

**Criteria for assessment:**
Marks will be allocated according to how well the examples are chosen to demonstrate the extension of conventional approaches to the problem by computational methods, the quality of the student's argument, and the adequateness of the report style.

**Due date:**
10 May 2013

** Assessment task 4**

**Title:**
Peer Assessment

**Description:**
An important aspect of the unit is that students will learn how the same computational approaches apply to very different application areas and disciplines. This will be facilitated through cross-discipline peer evaluation. Groups will be formed according to chosen application areas and modelling approaches and apply the same approaches to problems in their respective disciplines. Subsequently students will perform a cross-evaluation in which they critically evaluate the work of another student or group of students from a different discipline area.

**Weighting:**
15% (of non-exam component)

**Criteria for assessment:**
Marks will be allocated according to the depth of demonstrated insight into the modelling approach, correctness of the evaluation, the quality of the student's argument, how well underlying principles and theories are demonstrated in the student's answer, and the adequateness of the report style.

**Due date:**
31 May 2013
Examinations

- Examination 1

  Weighting: 60%

  Length: 3 hours

  Type (open/closed book): Closed book

  Electronic devices allowed in the exam: None

Learning resources

Monash Library Unit Reading List
http://readinglists.lib.monash.edu/index.html

Feedback to you

Types of feedback you can expect to receive in this unit are:

- Informal feedback on progress in labs/tutes
- Graded assignments with comments

Extensions and penalties

Submission must be made by the due date otherwise penalties will be enforced.

You must negotiate any extensions formally with your campus unit leader via the in-semester special consideration process:

Returning assignments

Students can expect assignments to be returned within two weeks of the submission date or after receipt, whichever is later.

Resubmission of assignments

Students will not be allowed to resubmit assessment unless special consideration applies.

Referencing requirements

Please refer to the Library Guides for Citing and Referencing at http://guides.lib.monash.edu/content.php?pid=88267&sid=656564
Assignment submission

It is a University requirement (http://www.policy.monash.edu/policy-bank/academic/education/conduct/plagiarism-procedures.html) for students to submit an assignment coversheet for each assessment item. Faculty Assignment coversheets can be found at http://www.infotech.monash.edu.au/resources/student/forms/. Please check with your Lecturer on the submission method for your assignment coversheet (e.g. attach a file to the online assignment submission, hand-in a hard copy, or use an online quiz).

Online submission

If Electronic Submission has been approved for your unit, please submit your work via the learning system for this unit, which you can access via links in the my.monash portal.

Recommended text(s)


Examination material or equipment

The exam is a closed book exam.

If computational equipment is required it will be provided by the University.

You must not use any of your own computating equipment during the exam.
Other Information

Policies

Monash has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University’s academic standards, and to provide advice on how they might uphold them. You can find Monash’s Education Policies at: www.policy.monash.edu.au/policy-bank/academic/education/index.html

Key educational policies include:

- Plagiarism; http://www.policy.monash.edu/policy-bank/academic/education/conduct/plagiarism-policy.html
- Special Consideration; http://www.policy.monash.edu/policy-bank/academic/education/assessment/special-consideration-policy.html
- Grading Scale; http://www.policy.monash.edu/policy-bank/academic/education/assessment/grading-scale-policy.html
- Discipline: Student Policy; http://www.policy.monash.edu/policy-bank/academic/education/conduct/student-discipline-policy.html
- Academic Calendar and Semesters; http://www.monash.edu.au/students/dates/
- Orientation and Transition; http://intranet.monash.edu.au/infotech/resources/students/orientation/
- Graduate Attributes Policy http://www.policy.monash.edu/policy-bank/academic/education/management/monash-graduate-attributes-policy.html

Student services

The University provides many different kinds of support services for you. Contact your tutor if you need advice and see the range of services available at http://www.monash.edu.au/students. For Sunway see http://www.monash.edu.my/Student-services, and for South Africa see http://www.monash.ac.za/current/.

Monash University Library

The Monash University Library provides a range of services, resources and programs that enable you to save time and be more effective in your learning and research. Go to www.lib.monash.edu.au or the library tab in my.monash portal for more information. At Sunway, visit the Library and Learning Commons at http://www.lib.monash.edu.my/. At South Africa visit http://www.lib.monash.ac.za/.
Disability Liaison Unit

Students who have a disability or medical condition are welcome to contact the Disability Liaison Unit to discuss academic support services. Disability Liaison Officers (DLOs) visit all Victorian campuses on a regular basis.

Website: http://www.monash.edu/equity-diversity/disability/index.html
Telephone: 03 9905 5704 to book an appointment with a DLO; or contact the Student Advisor, Student Community Services at 03 55146018 at Sunway
Email: dlu@monash.edu
Drop In: Equity and Diversity Centre, Level 1, Building 55, Clayton Campus, or Student Community Services Department, Level 2, Building 2, Monash University, Sunway Campus

Your feedback to Us

Monash is committed to excellence in education and regularly seeks feedback from students, employers and staff. One of the key formal ways students have to provide feedback is through the Student Evaluation of Teaching and Units (SETU) survey. The University’s student evaluation policy requires that every unit is evaluated each year. Students are strongly encouraged to complete the surveys. The feedback is anonymous and provides the Faculty with evidence of aspects that students are satisfied and areas for improvement.

For more information on Monash’s educational strategy, see:

www.monash.edu.au/about/monash-directions and on student evaluations, see:
www.policy.monash.edu/policy-bank/academic/education/quality/student-evaluation-policy.html

Previous Student Evaluations of this Unit

This is the first time MON1002 is being offered.

If you wish to view how previous students rated this unit, please go to https://emuapps.monash.edu.au/unitevaluations/index.jsp