



MONASH University

**FIT4010**  
**Advanced topics in algorithms and discrete structures**

**Unit guide**

**Semester 2, 2008**

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# **FIT4010 Advanced topics in algorithms and discrete structures - Semester 2 , 2008**

## **Unit leader :**

Bernd Meyer

## **Lecturer(s) :**

### **Clayton**

- Bernd Meyer
- Mark Wallace
- Kim Marriott

## Introduction

Welcome to FIT4010 Advanced Topics in Algorithms and Discrete Structures. This year we will be looking at algorithms to solve constrained optimisation and satisfaction problems. These problems are important because they have many industrial applications, such as timetabling, resource allocation, visualization, airline scheduling or fleet-coordination. Unfortunately, almost all of these problems are computationally very difficult and, therefore, specialized techniques are required to handle them. Hands-on experience will be provided through practical assignments.

## Unit synopsis

The unit will cover techniques for solving constrained optimisation and satisfaction problems. There are two aspects to solving such problems. The first aspect deals with the algorithms used to solve the problem. The second aspect deals with how to model and actually solve these problems in practice.

We will cover methods that have been developed in mathematics (or operations research) for solving linear programming problems, mixed integer programming problems, and non-linear programming and methods developed in artificial intelligence to solve combinatorial satisfaction and optimization problems based on propagation and meta-heuristic approaches.

Modelling will primarily be taught using the modelling language MiniZINC. Other modelling languages, such as OPL, may be covered as examples.

## Learning outcomes

Upon successful completion of the unit students will have:

- an appreciation of the importance of combinatorial optimisation problems,
- an understanding of why they are difficult to solve
- knowledge of the main techniques and algorithms used to solve these problems
- an understanding of the mathematical formalisms underpinning these algorithms,
- the ability to recognize whether a problem can be solved with a particular technique/algorithm,
- an appreciation of the difficulty in modelling such problems
- an understanding of constraint programming (CP)
- the ability to model such a problem using a state-of-the-art modelling language.

## Workload

- two hour lecture and
- one hour tutorial (or laboratory) (requiring advance preparation)
- a minimum of 2-3 hours of personal study per one hour of contact time in order to satisfy the reading and assignment expectations.
- You will need to allocate up to 5 hours per week in some weeks, for use of a computer.

## Unit relationships

## **Prerequisites**

Completion of the Bachelor of Computer Science or equivalent to the entry requirements for the Honours programme. First year mathematics and experience with a functional or logic programming language such as ML or Prolog.

## **Relationships**

The unit is an elective in the Bachelor of Computer Science Honours programme.

## Continuous improvement

Monash is committed to 'Excellence in education' and strives for the highest possible quality in teaching and learning. To monitor how successful we are in providing quality teaching and learning Monash regularly seeks feedback from students, employers and staff. Two of the formal ways that you are invited to provide feedback are through Unit Evaluations and through Monquest Teaching Evaluations.

One of the key formal ways students have to provide feedback is through Unit Evaluation Surveys. It is Monash policy for every unit offered to be evaluated each year. Students are strongly encouraged to complete the surveys as they are an important avenue for students to "have their say". The feedback is anonymous and provides the Faculty with evidence of aspects that students are satisfied and areas for improvement.

## Student Evaluations

The Faculty of IT administers the Unit Evaluation surveys online through the my.monash portal, although for some smaller classes there may be alternative evaluations conducted in class.

If you wish to view how previous students rated this unit, please go to <http://www.monash.edu.au/unit-evaluation-reports/>

Over the past few years the Faculty of Information Technology has made a number of improvements to its courses as a result of unit evaluation feedback. Some of these include systematic analysis and planning of unit improvements, and consistent assignment return guidelines.

Monquest Teaching Evaluation surveys may be used by some of your academic staff this semester. They are administered by the Centre for Higher Education Quality (CHEQ) and may be completed in class with a facilitator or on-line through the my.monash portal. The data provided to lecturers is completely anonymous. Monquest surveys provide academic staff with evidence of the effectiveness of their teaching and identify areas for improvement. Individual Monquest reports are confidential, however, you can see the summary results of Monquest evaluations for 2006 at <http://www.adm.monash.edu.au/cheq/evaluations/monquest/profiles/index.html>

## Improvements to this unit

Major revision of syllabus.

New recommended textbook.

Change from using a programming language to a high-level modelling language.

## Unit staff - contact details

### Unit leader

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## Teaching and learning method

The main teaching forum will be the lectures and tutorials. Students are also expected to make use of the on-line discussion forums for any questions regarding the unit material or organisation.

## Communication, participation and feedback

Monash aims to provide a learning environment in which students receive a range of ongoing feedback throughout their studies. You will receive feedback on your work and progress in this unit. This may take the form of group feedback, individual feedback, peer feedback, self-comparison, verbal and written feedback, discussions (on line and in class) as well as more formal feedback related to assignment marks and grades. You are encouraged to draw on a variety of feedback to enhance your learning.

It is essential that you take action immediately if you realise that you have a problem that is affecting your study. Semesters are short, so we can help you best if you let us know as soon as problems arise. Regardless of whether the problem is related directly to your progress in the unit, if it is likely to interfere with your progress you should discuss it with your lecturer or a Community Service counsellor as soon as possible.

## Unit Schedule

Week	Topic	Key dates
1	Overview of unit; what is constrained optimisation and what is it good for; complexity of constrained optimization; NP-hardness; exponential search.	
2	Linear Programming and Integer Programming: Simplex Algorithms, Network Flow Algorithms, Branch & Bound	
3	Duality, Lagrange Multipliers and KKT Conditions	
4	Quadratic Programming, Interior Point Methods	
5	Modelling with LP/IP/MIP	
6	Modelling with LP/IP/MIP	Assignment 1: Fundamentals of Continuous Optimization and Integer Optimization
7	Consistency Methods	
8	Modelling with CP I	
9	Modelling with CP II	
10	Local Search, Simulated Annealing	
11	Tabus Search & Evolutionary Methods	
Mid semester break		
12	Modelling Search Methods	Assignment 2: Modelling with Constraints
13	Research Issues in Optimization and Constraint Handling	

## Unit Resources

### Prescribed text(s) and readings

There are no prescribed books.

### Recommended text(s) and readings

There are several recommended books for this subject:

- Introduction to Mathematical Programming. Wayne L. Winston. Duxbury Press, 1995.
- Introduction to Operations Research. F.S. Hillier and G.J. Lieberman. McGraw-Hill, 8th Ed, 2005.
  
- Constraint Programming-An Introduction. Kim Marriott and Peter Stuckey. MIT Press, 1998.

In addition to this, selected research papers will be referenced throughout the course.  
The lecture material will be loosely based on this material and will be available on the Web.

### Required software and/or hardware

The main software used will be the MiniZinc language, software will be distributed in the initial tutorial

### Equipment and consumables required or provided

Students will need access to a personal computer running the CLP language ECLiPSe. It is downloadable from <http://sourceforge.net/projects/eclipse-clp>

### Study resources

Study resources we will provide for your study are:

- Weekly detailed lecture notes;
- Weekly tutorial or laboratory tasks;
- Assignment specification;
- Discussion groups;
- This Unit Guide outlining the administrative information for the unit;
- The unit web site on MUSO, where resources outlined above will be made available.

### Library access

The Monash University Library site contains details about borrowing rights and catalogue searching. To learn more about the library and the various resources available, please go to <http://www.lib.monash.edu.au>. Be sure to obtain a copy of the Library Guide, and if necessary, the instructions for remote access from the library website.

### Monash University Studies Online (MUSO)

All unit and lecture materials are available through MUSO (Monash University Studies Online). Blackboard is the primary application used to deliver your unit resources. Some units will be piloted in Moodle. If your unit is piloted in Moodle, you will see a link from your Blackboard unit to Moodle (<http://moodle.monash.edu.au>) and can

bookmark this link to access directly. In Moodle, from the Faculty of Information Technology category, click on the link for your unit.

You can access MUSO and Blackboard via the portal: <http://my.monash.edu.au>

Click on the Study and enrolment tab, then Blackboard under the MUSO learning systems.

In order for your Blackboard unit(s) to function correctly, your computer needs to be correctly configured.

For example:

- Blackboard supported browser
- Supported Java runtime environment

For more information, please visit: <http://www.monash.edu.au/muso/support/students/downloadables-student.html>

**You can contact the MUSO Support by: Phone: (+61 3) 9903 1268**

For further contact information including operational hours, please visit:  
<http://www.monash.edu.au/muso/support/students/contact.html>

Further information can be obtained from the MUSO support site:  
<http://www.monash.edu.au/muso/support/index.html>

## Assessment

### Unit assessment policy

This unit is assessed with a single assignment that is composed of four hurdles, a written report, and an oral presentation. To pass the unit you must:

- Pass both assignments with 50% hurdles
- achieve no less than 50% of the possible marks overall

### Assignment tasks

- **Assignment Task**

**Title :** Assignment 1: Fundamentals of Continuous Optimization and Integer Optimization

**Description :**

**Weighting :** 50%

**Criteria for assessment :**

**Due date :** August 18

- **Assignment Task**

**Title :** Assignment 2: Modelling with Constraints

**Description :**

**Weighting :**

**Criteria for assessment :**

**Due date :** October 6

### Assignment submission

Assignments will be submitted by **mixed electronic and paper** submission. Students submit the assignment in the labs, with the appropriate cover sheet correctly filled out and attached. Electronic submissions must be provided on CD unless other arrangements have been made with the lecturer prior to the due date.

### Assignment coversheets

The work submitted must be your own work. For the written report you must sign a statement that the work is your own work. The coversheet for the Faculty of Information Technology, can be found at <http://www.infotech.monash.edu.au/resources/student/assignments/>

For the code reviewed/submitted, the text of the section titled "Student's Statement" should be typed into a file named **declaration.txt** and added to the main directory where the code resides.

## University and Faculty policy on assessment

### Due dates and extensions

The due dates for the submission of assignments are given in the previous section. Please make every effort to submit work by the due dates. It is your responsibility to structure your study program around assignment deadlines, family, work and other commitments. Factors such as normal work pressures, vacations, etc. are seldom regarded as appropriate reasons for granting extensions. Students are advised to NOT assume that granting of an extension is a matter of course.

Requests for extensions must be made to the unit lecturer at your campus at least two days before the due date. You will be asked to forward original medical certificates in cases of illness, and may be asked to provide other forms of documentation where necessary. A copy of the email or other written communication of an extension must be attached to the assignment submission.

### Late assignment

Assignments received after the due date will be subject to a penalty of 5% per day, including weekends. Assignments received later than one week (seven days) after the due date will not normally be accepted.

### Return dates

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

Assessment for the unit as a whole is in accordance with the provisions of the Monash University Education Policy at <http://www.policy.monash.edu/policy-bank/academic/education/assessment/>

### Plagiarism, cheating and collusion

Plagiarism and cheating are regarded as very serious offences. In cases where cheating has been confirmed, students have been severely penalised, from losing all marks for an assignment, to facing disciplinary action at the Faculty level. While we would wish that all our students adhere to sound ethical conduct and honesty, I will ask you to acquaint yourself with Student Rights and Responsibilities (<http://www.infotech.monash.edu.au/about/committees-groups/facboard/policies/studrights.html>) and the Faculty regulations that apply to students detected cheating as these will be applied in all detected cases.

In this University, cheating means seeking to obtain an unfair advantage in any examination or any other written or practical work to be submitted or completed by a student for assessment. It includes the use, or attempted use, of any means to gain an unfair advantage for any assessable work in the unit, where the means is contrary to the instructions for such work.

When you submit an individual assessment item, such as a program, a report, an essay, assignment or other piece of work, under your name you are understood to be stating that this is your own work. If a submission is identical with, or similar to, someone else's work, an assumption of cheating may arise. If you are planning on working with another student, it is acceptable to undertake research together, and discuss problems, but it is not acceptable to jointly develop or share solutions unless this is specified by your lecturer.

Intentionally providing students with your solutions to assignments is classified as "assisting to cheat" and students who do this may be subject to disciplinary action. You should take reasonable care that your solution is not accidentally or deliberately obtained by other students. For example, do not leave copies of your work in progress on the hard drives of shared computers, and do not show your work to other students. If you believe this may have

happened, please be sure to contact your lecturer as soon as possible.

Cheating also includes taking into an examination any material contrary to the regulations, including any bilingual dictionary, whether or not with the intention of using it to obtain an advantage.

Plagiarism involves the false representation of another person's ideas, or findings, as your own by either copying material or paraphrasing without citing sources. It is both professional and ethical to reference clearly the ideas and information that you have used from another writer. If the source is not identified, then you have plagiarised work of the other author. Plagiarism is a form of dishonesty that is insulting to the reader and grossly unfair to your student colleagues.

## **Register of counselling about plagiarism**

The university requires faculties to keep a simple and confidential register to record counselling to students about plagiarism (e.g. warnings). The register is accessible to Associate Deans Teaching (or nominees) and, where requested, students concerned have access to their own details in the register. The register is to serve as a record of counselling about the nature of plagiarism, not as a record of allegations; and no provision of appeals in relation to the register is necessary or applicable.

## **Non-discriminatory language**

The Faculty of Information Technology is committed to the use of non-discriminatory language in all forms of communication. Discriminatory language is that which refers in abusive terms to gender, race, age, sexual orientation, citizenship or nationality, ethnic or language background, physical or mental ability, or political or religious views, or which stereotypes groups in an adverse manner. This is not meant to preclude or inhibit legitimate academic debate on any issue; however, the language used in such debate should be non-discriminatory and sensitive to these matters. It is important to avoid the use of discriminatory language in your communications and written work. The most common form of discriminatory language in academic work tends to be in the area of gender inclusiveness. You are, therefore, requested to check for this and to ensure your work and communications are non-discriminatory in all respects.

## **Students with disabilities**

Students with disabilities that may disadvantage them in assessment should seek advice from one of the following before completing assessment tasks and examinations:

- Faculty of Information Technology Student Service staff, and / or
- your Unit Coordinator, or
- [Disabilities Liaison Unit](#)

## **Deferred assessment and special consideration**

Deferred assessment (not to be confused with an extension for submission of an assignment) may be granted in cases of extenuating personal circumstances such as serious personal illness or bereavement. Information and forms for Special Consideration and deferred assessment applications are available at <http://www.monash.edu.au/exams/special-consideration.html>. Contact the Faculty's Student Services staff at your campus for further information and advice.