



MONASH University
Business and Economics

ECC3860
Integrated economic modelling

Unit Guide

Semester 2, 2010

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ECC3860 Integrated economic modelling - Semester 2, 2010

Chief Examiner:

Simon Angus

Lecturer(s) / Leader(s):

Clayton

Dr Simon Angus

Contact hours: Monday 2-4pm, 11.E962

Dr Brett Parris

Contact hours: Thursday 1.30-3.30 PM, 11.E660

Tutor(s):

Clayton

Mr Behrooz Hassani-M

Contact hours: Monday 2:30 - 3:30 PM, Thursday 1 - 2 PM, 11.E755

Introduction

Welcome to ECC/ETC 3860, Integrated Economic Modelling (IEM)!

We are extremely excited to offer this unit jointly between the Department of Economics and the Department of Econometrics and Business Statistics at Monash University, Clayton. To our knowledge, this is one of the first *Complex Adaptive Systems (CAS)* undergraduate units to be taught in an Economics context in Australia, so we will all be part of a ground-breaking work in this unit!

Why now? A quick look at the newspapers and news bulletins reveals a telling set of problems facing Australia at present: the global financial crisis, the sovereign debt crisis in Europe, the enhanced greenhouse effect, global and national food security problems, and continuing concerns over the shifting global trade balance from the US to China. In IEM this semester, we will be arguing that all of these problems can be, and *should* be, analysed through the CAS perspective.

What are the commonalities? Take the example of the sovereign debt crisis in Europe, where we have: many economic actors (sovereign nations); drawn into economic transactions via a complicated network of transfers, loans and debts; non-rational biases in these actors' behaviours (fear, anxiety, herd-behaviour); and consequent outcomes which seem abrupt and unpredictable (credit-flights, stock-market bubbles and crashes, riots and political turmoil) -- in short, we have the elements of a *Complex System*.

Complex Systems Science (CSS) aims to understand such systems with a view to producing models of their behaviour for analysis and ultimately, prediction. The common tool of CSS is *Agent-Based Modelling (ABM)*, which allows for non-rational, heterogeneous, and asymmetrically interacting agents to come together in a digital universe. Sound familiar? .. If you've played *Civilization*, *World of Warcraft*, *SimCity*, or *SecondLife*, stay tuned -- we'll show you how games are actually more helpful to economists than just providing entertainment in their spare time!

We hope you enjoy exploring with us the fascinating world of Complex Adaptive Systems and ABMs!

Unit synopsis

The aim of this unit is to enable students to understand some of the complexities of interdisciplinary policy problems, particularly in the areas of sustainable development, and to enable them to design and undertake integrated modelling exercises for themselves. A complex systems science perspective will be adopted, introducing Agent-Based Modelling (ABM) as a flexible and powerful tool for exploring solutions to complex real-world problems. The ABM approach will be demonstrated and critically assessed through several interdisciplinary, integrated economy/sustainability models. Additionally, a flexible ABM modelling platform (NetLogo) will be introduced and demonstrated.

Learning outcomes

The learning goals associated with this unit are for students to:

- understand some of the complexities of interdisciplinary policy problems, particularly in the areas of sustainable development
- comprehend and critically assess the complex systems perspective
- critically evaluate agent-based models and their outputs
- develop and analyse an agent-based model of an integrated modelling problem
- undertake verification, validation, evaluation and assessment of integrated modelling outputs
- apply integrated modelling approaches to real-world interdisciplinary economic problems.

Contact hours

39 contact hours

Unit relationships

Prerequisites

Students must have passed ETC1000 before undertaking this unit

Co-requisites

It is recommended that students study ECC2800 Prosperity, poverty and sustainability in a globalised world

Teaching and learning method

Timetable information

For information on your timetable, including tutorial allocation if required, please refer to:

<http://allocate.its.monash.edu.au/>

Unit Schedule

Topic	Lecturer/Speaker	Key Dates	Activity
Intro to IEM [1]	Angus/Parris		
The CAS Perspective [2-3]	Parris		
A Tour of Complex Policy Problems [4-5]	Parris		
Intro to ABMs [6-7]	Angus		
The Art of ABMs [8]	Angus	End of week 4 tutorial	Complexity Assignment DUE (10 marks)
Simulation & Gaming [9]	Parris	Start of week 5 tutorial	Minor Project Topic Announced
Overview of CAS Modelling [10]	Parris		
CAS Examples [11-13]	Angus	End of week 6 tutorial	Minor Project DUE (15 marks)
Data Acquisition [14-15]	Parris		
Calibration, Verification [16-18]	Angus		
Research Examples [19-21]	Parris	In week 10 tutorial	Major Project Presentation (5 marks)
Analysis & Interpretation of Outputs [22-23]	Angus		
Review [24]	Angus/Parris	Last day of semester (week 12)	Major Project Due (25 marks)

Introduction to ETC/ECC 3860 *Integrated Economic Modelling*

[Lecture 1: Simon Angus, Brett Parris & Behrooz-Hassani M.]

Don't be alarmed by the number of readings listed on the following pages - we don't expect you to read them all. Required readings are marked with **. The other readings are ones you may find useful or interesting. Since there's only one unit covering complex systems approaches to integrated economic modelling, we thought it best to give you an idea of the breadth of material being produced and the amazing work being done in this exciting and rapidly expanding field. You won't have to go hunting either - all readings will be provided as pdfs in a zip folder.

Part 1: Introductions to Integrated Modelling (Motivation)

1.1: Economic Conundrums and the Complex Adaptive Systems Perspective

[Lectures 2 & 3: Brett Parris]

Ackerman, F., (2002) "Still Dead after All These Years: Interpreting the Failure of General Equilibrium Theory", *Journal of Economic Methodology*, Vol. 9, No. 2, June, pp. 119-139.

Arthur, W.B., (1990) "Positive Feedbacks in the Economy", *Scientific American*, Vol. 262, No. 2, February, pp. 92-95 & 98-99.

** Arthur, W.B., (1999) "Complexity and the Economy", *Science*, Vol. 284, No. 5411, 2 April, pp. 107-109.

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Colander, D. and Rothschild, C., (2010) "Sins of the Sons of Samuelson: Vision, Pedagogy, and the Zig-Zag Windings of Complex Dynamics", *Journal of Economic Behavior & Organization*, Vol. 74, No. 3, June, pp. 277-290.

Conlisk, J., (1996) "Why Bounded Rationality?" *Journal of Economic Literature*, Vol. 34, No. 2, June, pp. 669-700.

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Kirman, A.P., (1989) "The Intrinsic Limits of Modern Economic Theory: The Emperor Has No Clothes", *Economic Journal*, Vol. 99, No. 395, Supplement, pp. 126-139.

** Kirman, A.P., (1992) "Whom or What Does the Representative Individual Represent?" *Journal of Economic Perspectives*, Vol. 6, No. 2, Spring, pp. 117-136.

** Kirman, A.P., (2008) "Economy as a Complex System", In *The New Palgrave Dictionary of Economics Online* ed. Durlauf, S.N. and Blume, L.E.; 2nd Edition; Palgrave Macmillan. http://www.dictionarofeconomics.com/article?id=pde2008_E000246

Miller & Page, (2007) *Complex Adaptive Systems*, Chapter 2: Complexity in Social Worlds, pp. 9-31.

Neumayer, E., (1999) "Global Warming: Discounting is not the Issue, but Substitutability is", *Energy Policy*, Vol. 27, No. 1, January, pp. 33-43.

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Velupillai, K.V., (2007) "Variations on the Theme of *Conning* in *Mathematical Economics*", *Journal of Economic Surveys*, Vol. 21, No. 3, July, pp. 466-505.

1.2: A Tour of Complex Policy Problems: Climate-change, economic development, energy, sustainability, finance, conflict, innovation

[Lectures 4 & 5: Brett Parris]

Ayres, R.U., (2008) "Sustainability Economics: Where do we Stand?" *Ecological Economics*, Vol. 67, No. 2, September, pp. 281-310.

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Antonelli, C., (2009) "The Economics of Innovation: From the Classical Legacies to the Economics of Complexity", *Economics of Innovation and New Technology*, Vol. 18, No. 7, pp. 611-646.

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Bettencourt, L.M.A., Lobo, J., Helbing, D., Kühnert, C. and West, G.B., (2007) "Growth, Innovation, Scaling, and the Pace of Life in Cities", *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 104, No. 17, 24 April, pp. 7301-7306.

** Bezemer, D.J., (2009) "'No One Saw This Coming': Understanding Financial Crisis Through Accounting Models", Munich University, Munich Personal RePEc Archive, MPRA Paper No. 15892, 16 June, 50 pp. <http://mpa.ub.uni-muenchen.de/15892/>

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Lean, J.L. and Rind, D.H., (2008) "How Natural and Anthropogenic Influences Alter Global and Regional Surface Temperatures: 1889 to 2006", *Geophysical Research Letters*, Vol. 35, L18701, 16 September, 6 pp.

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Neumayer, E., (2007) "A Missed Opportunity: The Stern Review on Climate Change Fails to Tackle the Issue of Non-Substitutable Loss of Natural Capital", *Global Environmental Change*, Vol. 17, No. 3-4, August - October, pp. 297-301.

** Ormerod, P., (2010) "The Current Crisis and the Culpability of Macroeconomic Theory", *Twenty-First Century Society*, Vol. 5, No. 1, February, pp. 5-18.

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Rosenzweig, C., Karoly, D., Vicarelli, M., Neofotis, P., Wu, Q., Casassa, G., Menzel, A., Root, T.L., Estrella, N., Seguin, B., Tryjanowski, P., Liu, C., Rawlins, S. and Imeson, A., (2008) "Attributing Physical and Biological Impacts to Anthropogenic Climate Change", *Nature*, Vol. 453, No. 7193, 15 May, pp. 353-357.

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Turner, G.M., (2008) "A Comparison of *The Limits to Growth* with 30 Years of Reality", *Global Environmental Change*, Vol. 18, No. 3, August, pp. 397-411.

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Weart, S., (2003) "The Discovery of Rapid Climate Change", *Physics Today*, Vol. 56, No. 8, August, pp. 30-36.

Part 2: The Agent-Based Modelling Approach (Method)

2.1: Introduction to Agent-Based Modelling

[Lectures 6 & 7: Simon Angus]

Axtell, R.L., (2000) "Why Agents? On the Varied Motivations for Agent Computing in the Social Sciences", Center on Social and Economic Dynamics, Working Paper No. 17, Washington DC, November, 22 pp. http://www.brookings.edu/reports/2000/11technology_axtell.aspx

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pp. 109-115.

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Holland, J.H. and Miller, J.H., (1991) "Artificial Adaptive Agents in Economic Theory", *American Economic Review*, Vol. 81, No. 2, May, pp. 365-371.

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2.2 The art of ABMs – designing 'good' models (interplay)

[Lecture 8: Simon Angus]

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2.3 What can we learn from the overlap between simulation modelling and gaming?

[Lecture 9: Brett Parris]

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2.4: Overview of ABM Platforms

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[Lectures 11 & 12: Simon Angus]

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Part III: ABMS and the Real World (Verification & Interpretation)

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3.3 Examples: economics, energy, development, drugs, epidemics, conflict

[Lectures 20, 21 & 22: Brett Parris]

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3.4 Analysis and interpretation of ABM outputs

[Lectures 23 & 24: Simon Angus]

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Gimblett, H.R. (Ed.) (2002) *Integrating Geographic Information Systems and Agent-Based Modeling Techniques for Simulating Social and Ecological Processes*, Studies in the Sciences of Complexity; Oxford University Press for the Santa Fe Institute, Oxford & New York, xiv + 327 pp.

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Mitchell, M., (2009) *Complexity: A Guided Tour*, Oxford University Press, Oxford, xvi + 349 pp.

Perez, P. and Batten, D.F. (Eds.), (2006) [Complex Science for a Complex World: Exploring Human Ecosystems with Agents](http://epress.anu.edu.au/cs_citation.html), ANU E Press, Canberra, xv + 334 pp.
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Tesfatsion, L. and Judd, K.L. (Eds.), (2006) *Handbook of Computational Economics, Vol. 2: Agent-Based Computational Economics*, North-Holland, Amsterdam, Boston & London, xxx + 829-1660 pp.

Weisfeld, M., (2004) *The Object-Oriented Thought Process*, 2nd Edition; Sams Publishing Developer's Library, Indianapolis, xi + 271 pp.

Unit Resources

Prescribed text(s) and readings

Gilbert, N., (2008) *Agent-Based Models*, Quantitative Applications in the Social Sciences No. 153; SAGE Publications, Los Angeles & London, xiii + 98 pp.

Recommended text(s) and readings

Miller, J.H. and Page, S.E., (2007) *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*, Princeton University Press, Princeton, NJ & Oxford, xix + 263 pp.

North, M.J. and Macal, C.M., (2007) *Managing Business Complexity: Discovering Strategic Solutions with Agent-Based Modeling and Simulation*, Oxford University Press, Oxford & New York, xi + 313 pp.

Library resources

The Monash University Library provides a range of services and resources that enable you to save time and be more efficient in your learning and research at URL: <http://www.lib.monash.edu.au> or via the Library tab in the [my.monash portal](#).

Blackboard (MUSO)

- All unit and lecture materials, plus other information of importance to students, are available through the MUSO (Monash University Studies Online) site. You can access MUSO via the My.Monash Portal: <http://my.monash.edu.au>

Under “Online Systems” click the MUSO hyperlink

In order for your MUSO unit(s) to function correctly, your computer needs to be set up and certain programs may need to be installed such as a compatible Java version (eg version 1.5.0). This can easily be done by going to <http://www.monash.edu.au/muso/support/students/browserset.html> to update the relevant software.

You can contact MUSO Support by:

Jobdesk: http://jobdesk.monash.edu.au/login/index.cfm?jobdesk_id=14

Email: muso.support@calt.monash.edu.au

Phone: (+61 3) 9903-1268

Operational hours (Monday – Thursday) – local time

Australia: 8 am to 10 pm (8pm Non Teaching period)

Malaysia: 6 am to 8 pm (6 pm Non Teaching period)

South Africa: 11pm to 1pm (11 am Non Teaching period)

Operational hours (Friday) – local time

Australia: 8 am to 8 pm

Malaysia: 6 am to 6 pm

South Africa: 11pm to 11 am

Operational hours (Saturday-Sunday) – local time (Teaching and Exam Period Only)

Australia: 1 pm to 5 pm

Malaysia: 11 am to 3 pm

South Africa: 4 am to 8 am

Further information can be obtained from the following site

<http://www.monash.edu.au/muso/support/index.html>

Required software and/or hardware

Key online resources and websites:

Software

MASON <http://cs.gmu.edu/~eclab/projects/mason/>

Netlogo <http://ccl.northwestern.edu/netlogo/>

Pajek <http://pajek.imfm.si/doku.php?id=pajek>

Repast <http://repast.sourceforge.net/>

StarLogo TNG <http://education.mit.edu/drupal/starlogo-tng>

UCINET <http://www.analytictech.com/ucinet/>

Visual Paradigm for UML <http://www.visual-paradigm.com/product/vpuml/>

People

Simon Angus <http://users.monash.edu.au/~sanguis/cgi-bin/moinres.cgi/sanguis>

Andrew Crooks <http://gisagents.blogspot.com/>

Behrooz Hassani-M. <http://users.monash.edu.au/~behroozh/>

Brett Parris <http://users.monash.edu.au/~bparris/BPAgentBasedModelling.html>

Leigh Tesfatsion's ABM portal <http://www.econ.iastate.edu/tesfatsi/ace.htm>

Jose M. Vidal <http://jmvidal.cse.sc.edu/>

Other

A Course in Individual and Agent-Based Modeling <http://www.railsback-grimm-abm-book.com/>

CosNet – The ARC Complex Open Systems Research Network <http://www.complexsystems.net.au/>

Java <http://www.java.com/en/>

Journal of Artificial Societies and Social Simulation <http://jasss.soc.surrey.ac.uk/JASSS.html>

Open Agent-Based Modelling Consortium <http://www.openabm.org/site/>

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TurtleZero (Netlogo) <http://www.turtlezero.com/index.php>

VLab - Virtual Complexity Lab at Monash University <http://vlab.infotech.monash.edu.au/>

Assessment

Assessment Summary

Within semester assessment: 60%

Examination (2 hours): 40%

Faculty assessment policy

For information regarding assessment policy, please refer to the appendix at the end of this Unit Guide.

Second marking

For information regarding second marking practice, please refer to

<http://www.buseco.monash.edu.au/asg/agu/policies/written-assign.html#secmark>

Return of final marks

The final mark that a student receives for a unit will be determined by the Board of Examiners on the recommendation of the Chief Examiner taking into account all aspects of assessment. The final mark for this unit will be released by the Board of Examiners on the date nominated in the Faculty Calendar.

Applications for extension of time

For information regarding extensions of time, please refer to

<http://www.buseco.monash.edu.au/asg/agu/policies/written-assign.html#extovertime>

Additional assessment information

Assessment Components

Assessment	%
Discussion Log	5
Tutorial Assignments	25
Major Project	30
Examination (2hr)	40

Discussion Log [5%]

Discussion Logs (online) will be formed to discuss the prescribed readings.

- *Group formation:* You must fill out the Online Group Formation Form (accessible via MUSO > Admin) by the **end of week 1** of semester. You will receive notification of your group assignment by the end of week 2.
- *Assessment:* You will be assessed individually on how active you have been in the discussion log. As a guide, each student should aim to summarise at least 1 prescribed reading article for each week, and respond to other group member's posts each week to pass this assessment. Your activity on the Discussion Log should take no more than 30min each week.

Tutorial Assignments (2) [25% total]

1. Complexity Assignment (10%, due in week 4 tutorial)

Part A. Find an example from everyday life that operates as a complex system

- Identify the elements of the system, and the feedbacks between the elements.
- Are the feedbacks non-linear in nature? Why?
- Does the system demonstrate emergence? If so, how?

Part B. Sketch (using UML, pseudo-code) how you might model this system using NetLogo.

- What agents would you need?
- What attributes would each agent need to possess?
- What behaviours would each agent need to be able to exhibit?
- What context (e.g. spatial landscape, network, abstract) would the agents inhabit?

Assessment: Your assignment should be no more than **5 pages (including figures)**. It should be typed clearly. Text answers should be as concise, clear and informative as possible. The UML/pseudo-code component should follow the guidelines given in the tutorials.

Submission: You should **submit your assignment (e.g. .doc, .docx, .pdf file) to MUSO by the end of your week 4 tutorial.**

2. 'El Farol' Project (15%, due in week 6 tutorial)

At the beginning of the week 5 tutorial, you will be given a modelling problem. The same problem will be given to all students. You have until the end of the week 6 tutorial to send your NetLogo model of the problem to your Tutor (by email).

Assessment: This is an individual assignment. Of course, we expect some discussion between you and your tutorial members. However, you must turn in your own assignment work. Evidence of plagiarism between your assignment and another will incur severe penalties. You will be rewarded to the extent to which your model and Info tab answer the following questions --

1. Does your model display realistic dynamics?
2. Does your model demonstrate a good grasp of NetLogo? (i.e. use of NetLogo procedures)
3. Does your explanation of your model and its insights show a command of NetLogo and its applications? (in the Info tab)

Submission: You should **submit your assignment (.nlogo file) to MUSO by the end of your week 6 tutorial.**

Major Project [30% total]

Class Presentation [5%, in tutorial of week 10]

- To be based on major project
 - ◆ Emphasis will be on your presentation skills, communication, and how you answer questions etc.;
 - ◆ Questions and answers will be taken, giving an opportunity to receive feedback on your approach;
 - ◆ Demonstration of code is not necessary in this presentation, but may be helpful.

The Project [25%, due end of semester]

You will be required to design, implement and analyse a model that explores an integrated economic / complex adaptive systems problem from a list of projects given out later in the unit.

Note: This is an individual assignment. Of course, we expect some discussion between you and your tutorial members. However, you must turn in your own assignment work. Evidence of plagiarism between your assignment and another will incur severe penalties.

Project submission:

- Your submission **must include** your **.nlogo file** (and any input data attachments), and a **report (no more than 5 pages, .doc, .docx, .pdf)** file that addresses item 5. in the marking guide below.
- Your project must be submitted to MUSO **by 11:59pm on the last day of Semester**. Late submissions will attract a **5% (raw) deduction** for every day (or part thereof) that it is late.
- Your project will be marked as follows:
 1. [3%] The **assumptions** of the model (are these realistic/intuitive? do they allow for straight-forward analysis?)
 2. [5%] The **behaviour** of the model (does it give realistic behaviour? does it shed light on the research question?)
 3. [5%] The **coding** of the model (in the 'Procedures Tab': is the code easy to follow and commented throughout? does the code make appropriate use of NetLogo procedures? is the code modular?)
 4. [4%] The **explanation** of the model (in the Info Tab: does the explanation of the model fit with what has been modelled? are there interesting extensions to the model?)
 5. [8%] The **analysis and interpretation** of your model (what does it show? does it answer the research question? what policy implications (if any) does this analysis suggest?)

End of Semester Examination [40%]

1. **Aim:** to test overall understanding of integrated modelling problems and tools used to analyse them.
2. **Task:** 2 hour end-of-semester examination requiring students to answer a number of short-answer and long-answer questions on material from the unit.
3. **Assessment:** emphasis on comprehension and overall synthesis of ideas and examples presented in the unit.

Special consideration

For information regarding special consideration, please refer to the appendix at the end of this Unit Guide.

Assessment criteria - grading descriptors table

	High Distinction (80%+)	Distinction (70 - 79%)	Credit (60 - 69%)	Pass (50 - 59%)	Fail (Less than 50%)
General description	Outstanding or exceptional work in terms of understanding, interpretation and presentation	A very high standard of work which demonstrates originality and insight	Demonstrates a high level of understanding and presentation and a degree of originality and insight	Satisfies the minimum requirements	Fails to satisfy the minimum requirements
Reading	Strong evidence of independent reading beyond core texts and materials	Evidence of reading beyond core texts and materials	Thorough understanding of core texts and materials	Evidence of having read core texts and materials	Very little evidence of having read any of the core texts and materials
Knowledge of topic	Demonstrates insight, awareness and understanding of deeper and more subtle aspects of the topic. Ability to consider topic in the broader context of the discipline	Evidence of an awareness and understanding of deeper and more subtle aspects of the topic	Sound knowledge of principles and concepts	Knowledge of principles and concepts at least adequate to communicate intelligently in the topic and to serve as a basis for further study	Scant knowledge of principles and concepts
Articulation of argument	Demonstrates imagination or flair. Demonstrates originality and independent thought	Evidence of imagination or flair. Evidence of originality and independent thought	Well-reasoned argument based on broad evidence	Sound argument based on evidence	Very little evidence of ability to construct coherent argument
Analytical and evaluative skills	Highly developed analytical and evaluative skills	Clear evidence of analytical and evaluative skills	Evidence of analytical and evaluative skills	Some evidence of analytical and evaluative skills	Very little evidence of analytical and evaluative skills
Problem solving	Ability to solve very challenging problems	Ability to solve non-routine problems	Ability to use and apply fundamental concepts and skills	Adequate problem-solving skills	Very little evidence of problem-solving skills
Expression and presentation appropriate to the discipline	Highly developed skills in expression and presentation.	Well developed skills in expression and presentation.	Good skills in expression and presentation. Accurate and consistent acknowledgement of sources.	Adequate skills in expression and presentation	Inadequate skills in expression and presentation. Inaccurate and inconsistent acknowledgement of sources.

Source: University of Adelaide 2005

Appendix

Please visit the following URL: <http://www.buseco.monash.edu.au/unit-guide/appendix.html> for further information about:

- Continuous improvement
- Assessment policy
- Grading Scale policy
- Special consideration
- Plagiarism, cheating and collusion
- Plagiarism register
- Non-discriminatory language
- Students with disabilities
- Using the University's computer and IT facilities
- Faculty policies
- Related links