Intensive Course on Agent-Based Modelling & Simulation for Business and Marketing

University of Sydney
July 5 to 28 2011

Overview

The University of Sydney is pleased to announce the first intensive course on agent-based modelling (ABM) in Sydney, Australia. The course will bring a group of advanced graduate students together with academics interested in developing ABM skills for an intensive four-week course on ABM and its application to marketing, management and the social sciences more broadly. The course will be led by Professor David Earnest, Old Dominion University, based on a similar course he offers there. The course combines lectures with hands-on experience in lab sessions, building simulations of business and social phenomena. Upon completion of this course, participants will not only be familiar with the theoretical and methodological foundations of ABM, they will be able to implement their own simulations in the programming language NetLogo to support their research.

Further details and applications to attend the course are available on the course website:
http://abmsydney.myreviewroom.com/

Course Leader:
Professor David Earnest, Old Dominion University USA

Venue:
Economics and Business Building, University of Sydney

Sponsors:
- Australian Research Council DP0881799 IF Wilkinson, RE Marks and LC Young
- University of Sydney Business School
- Australia New Zealand Marketing Academy
- School of Marketing, University of Western Sydney
- School of Marketing, University of Western Australia
- Centre for Research in Complex Systems (CRiCS), Charles Sturt University
- Centre for Industry and Innovation Studies (CInIS), University of Western Sydney
- School of Economics, University of New South Wales

Dates:
July 5th to July 28th 2011 (Note: It is intended to repeat the course on a regular basis in future years, depending on funding support and student interest.)

Schedule:
The class meets all day every Tuesday and Thursday for four weeks, with additional assignments and exercises to be completed by the participants working individually and in teams. The course includes formal lectures and intensive computer lab workshops. There are also a limited number of spaces available for appropriately qualified students and faculty to audit the formal lecture components of the course. The formal lectures will be recorded for future broadcast and use. The first week will be held as a short course, providing an introduction to ABM and its applications, with additional demonstration of simulations and research seminars on Wednesday.

Aims:
Agent-based simulation models of business, psychological, social, economic, biological, climate and materials systems are revolutionising the way research is done in many disciplines. This intensive course for research students and faculty is designed to teach participants how to use agent-based simulation methods, including NetLogo, to further their research interests. Students who successfully complete the course will be able to design, develop, test and implement ABM relevant to their research interests. While the application focus of the course is on marketing and management, researchers from other social science disciplines will also benefit.

Fees:
Students accepted on the course will not be charged any fees but will be responsible for their own accommodation, travel and meal expenses for attending the course. Refreshments and a light lunch will be offered free of charge during class meeting days. Several course dinners are planned which may require the charging of fees.

Scholarships:
A limited number of scholarships are available for students living outside Sydney. Some of these, but not all, are restricted to members of the Australia New Zealand Marketing Academy. If you seek funding support to attend the course, you will need to indicate this in your online application.

Accreditation:
The course is not a formal postgraduate course offered by the University of Sydney. It is offered to assist researchers to become competent in ABM using NetLogo. It is up to the students themselves to gain appropriate credit for participating in the course from their home institution. There is the possibility that students might be able to obtain credit for the course as miscellaneous UNSW students.

Applications for Course Participation:
There are a limited number of places available on the course and acceptance is based on application and merit (see below for details of application procedure). Students may apply to be full participants or to audit the lecture components of the course. *Application procedures and forms are available at http://abmsydney.myreviewroom.com/*

a) **Full Participation**: Students and faculty accepted into this program will attend lectures, participate in workshops and completed assigned readings and tasks. They will receive feedback on their assignments, a certificate of attendance and have the option of receiving a formal grade for the course based on their individual assignments, group work and pseudo-code development project. They can use the grade and certificate to seek appropriate accreditation for the course at their home institution.

b) **Audit Only**: Students and faculty may apply to audit the course, which means they can attend all the lectures but will not be expected to complete assignments and receive formal feedback on them, or participate in the group (pseudo–) code development assignment.

c) **Short Course**: The first week will be held as a short course, providing an introduction to ABM and its applications, with additional demonstration of simulations and research seminars on Wednesday. Registration is open for all interested parties. Depending on student numbers, it may be possible to extend the short course and continue on an audit only basis.

Applicants ideally should have completed a minimum of two years of graduate study in marketing, management, or other social science fields and have identified an area of application for ABM and simulation techniques. Applicants for full participation should submit a recent curriculum vitae, a letter of recommendation and a one page outline of a current or proposed research project in computational social sciences. Preference will be given to applicants who best demonstrate the ability to successfully complete research in this area.

*** First round applications close June 2 2011 ***

While applications will be accepted up to the start of the course there are a limited number of places available and acceptance is based on merit, demonstrated in the application documents and recommendation. An initial round of offers of places on the course will be made from those received by June 2 2011. Depending on availability additional students may be offered places after this cut-off date, alternatively they may be offered a place on the waiting list or be permitted to audit the course.

Prerequisites
Fully participating students should have completed prior coursework in research design. Although not a requirement, some prior coursework in statistics and/or formal modelling (for example, game theory) might be helpful.

Background and Rationale

The subjects of complexity and agent-based modelling (ABM) are fast growing areas of research and theory in many sciences, including business and the social sciences generally. This interest is indicated perhaps most clearly with the award of the Nobel Prizes in Economics to Elinor Ostrom in 2009 for her work in complex systems and the management of common pool resources, to Thomas Schelling in 2005 for his work on the unintended macro outcomes of micro behaviour in complex systems, and to Vernon Smith in 2002 on the role of social relations and the self-organising properties of market systems (not to mention the very early one given to Herbert Simon).

Many types of socio-economic systems as well as psychological, biological and ecological systems are increasingly being understood as complex adaptive systems in which order emerges in a bottom-up self-organising manner from the micro interactions taking place over time among the actors comprising the system, be they chemicals, animals, humans or ideas. Such systems also interact with other systems which buffet and challenge them. There are also feedback effects in which large-scale order feeds back to affect local interactions. There is now a growing industry of pop and scientific books and articles describing complexity and what it means for understanding, researching and operating in complex adaptive systems of different kinds. For more information and resources concerning complexity and agent-based modelling, visit the Agent-Based Computational Economics (ACE) site run by Professor Leigh Tesfatsion. The site covers material and resources related to learning and teaching, research and demonstration programs in a wide variety of disciplines, not just economics.

Simulation using agent-based modelling methods plays an essential role in the study of complex adaptive systems. This is because highly non-linear systems of this kind, though they can in principle be written down in mathematical form, are beyond traditional methods of solution. The only option is to compute the results of the rules over time using computers, hence the use of terms such as computational economics and computational social science. Agent-based models of business and social systems offer a way forward in studying the behaviour and evolution of complex systems that would not be possible otherwise. Such models are not the same as previous types of simulations such as Monte Carlo methods or System Dynamics. The models construct complex systems from the bottom up by specifying the individual agents' characteristics and values, how they change and interact with other agents, and the environmental agents and conditions in which they operate.

Not only is it impossible to solve the highly nonlinear mathematical equations of motion of such systems with all the interactions taking place, it is also not physically, economically or morally possible to conduct the range experiments required to tease out the effects of different elements of such business and social systems. Once again we are led back to simulation and agent-based models that are now possible given rapid improvements in the power and accessibility of computers and developments in object-oriented programming methods.

A major factor limiting serious science and agent-based modelling of complex adaptive systems in marketing, business and the social sciences is a lack of adequate programming skills among researchers, who are generally not trained in such techniques, which are not easy to acquire. Or, rather, this was the case until quite recently, but as a result of developments in more user-friendly, agent-based modelling systems and programming languages researchers can more readily learn these techniques. The trouble is there are limited opportunities for them to do so. This intensive course is designed to provide a solution to this problem for researchers in our region. We plan to repeat it on a regular basis. There are few courses of this type offered anywhere in the world and none has so far been offered in Australia. David Earnest is one of the few academics willing and able to offer such a course.

Professor David Earnest
http://www.odu.edu/~dearnest/

David C. Earnest is an associate professor of political science and international studies at Old Dominion University in Norfolk, Virginia USA. He completed his Ph.D. in political science at The George Washington University in 2004. He also holds an M.A. in security policy studies from the Elliott School of International Affairs at The George Washington University, and a B.A. in political science from Stanford University. He teaches international political economy and political methodology. His substantive research focuses on the political incorporation of migrants in democratic societies, while his methodology interests are in the application of agent-based models to problems of international politics.

Dr. Earnest has published in leading journals, including World Politics and the International Studies Quarterly. He is author of Old Nations, New Voters: Nationalism, Transnationalism and Democracy in the Era of Global Migration (2008, State University of New York Press).

Previously he held an appointment as a Fellow in Political-Military Studies at the Center for Strategic and International Studies in Washington, DC, where he was a specialist in military technology, the defense industrial base, and transatlantic security relations.

David teaches two specialist postgraduate courses in agent-based modeling at Old Dominion that provide the foundation for the design of this intensive course:

- *IS 795/895: Agent-Based Modeling & Simulation for International Studies*
  This course introduces masters and doctoral students to complex systems theory and to the application of agent-based modeling technologies to a variety of social systems. The course seeks to train graduate students to use basic computer simulations as a tool of inference for their research in international studies. Topics include the principles of chaos and complex systems and their relevance to contemporary issues in world politics; the epistemological foundations of simulation; object-oriented programming for the beginner; basic genetic algorithms, and the inferential challenges of nonlinear systems. Consistent with the University's commitment to modeling and simulation, the course emphasizes the interdisciplinary nature of agent-based modeling and simulation and welcomes students from a variety of disciplines, including physics, chemistry, geography, biology, engineering, sociology, psychology, economics and international studies.

- *IS 697: Independent Research*
  This directed-reading course offers advanced graduate students the opportunity to prepare for their comprehensive exams in the IPE and Modeling & Simulation fields. The course will emphasize broadening the student's familiarity with important works in M&S as well as developing practical skills to succeed in the comprehensive exam. Toward this end, much of the course work consists of exercises in agent-based modeling. By the end of the semester, students will have enhanced his or her skills in agent-based modeling and social network analysis through two practical analytical exercises.

These courses have been combined, redesigned and adapted for intensive model delivery focusing on business and marketing systems as well as other types of social systems.

David will be assisted by other faculty in delivering the course. These include:
- Professor Ian Wilkinson, Honorary Professor of Marketing, University of Sydney Business School (www.sydney.edu.au/business/staff/ianw)
- Professor Bob Marks, Emeritus Professor, School of Economics, University of New South Wales (www.agsm.edu.au/bobm)
- Professor Louise Young, Professor of Marketing, University of Western Sydney (www.uws.edu.au/marketing/som/academic_profiles/professor_louise_young)
- Professor Terry Bossomaier, Director Centre for Research in Complex Systems, Charles Sturt University, Bathurst (http://charybdis.mit.csu.edu.au/crics/)
- Fabian Held, Doctoral Student, Discipline of Marketing, University of Sydney Business School (http://fabianheld.wordpress.com)

NetLogo
http://ccl.northwestern.edu/netlogo/

NetLogo is fast becoming one of the main tools of choice for agent-based modelers. It grew out of an earlier project StarLogo, which was designed to teach ABM to primary school children. So it cannot be too difficult to learn! Over several years NetLogo has been further developed and extended and extensive support material added to become a major research tool for researchers developing ABM.

NetLogo is a multi-agent programmable modelling environment. It is used by tens of thousands of students, teachers and researchers worldwide. It is authored by Uri Wilensky, who is currently a professor of Learning Sciences and Computer Science at Northwestern University, and was developed at the Centre for Connected Learning at Northwestern University.

NetLogo programs can be ported into more comprehensive ABM platforms such as RePast.

NetLogo is freely available for use on MACs, PCs and may be downloaded at
http://ccl.northwestern.edu/netlogo/

For further details go to the NetLogo website.

Course Summary

(A detailed outline with readings and assignments will be sent to students accepted onto the course before classes begin)

Week 1: Why Agent-Based Models?

July 5
AM: Introduction and Class Materials: Thinking about agents
PM: Introduction to Modelling and NetLogo/ Demonstration

July 6:
AM: Seminars on applications of Agent-based model research (David Earnest and local researchers)
PM: Seminars on applications of Agent-based model research (David Earnest and local researchers)and discussion on how to design ABM research

July 7
AM: Complex systems theory and social science
PM: ABM versus other modelling paradigms/ Review and windup for "short course" participants.

Week 2: The Basics of Agent-Based Modelling

July 12
AM: Emergence, nonlinearity, tipping, and equilibria
PM: Introduction to NetLogo - Workshop

July 14
AM: Research Design and Model Verification
PM: Designing Experiments and Analysing Results in BehaviorSpace

Week 3: Advanced Topics and Applications 1

July 19
AM: Criticism of ABM
PM: Model Validation

July 21
AM: Evolutionary Computation and "Smart" Agents
PM: Social Network Analysis

Week 4: Advanced Topics and Applications 2

July 26
AM: Applications to Organisation Theory, Business and Marketing 1
PM: Applications to Organisation Theory, Business and Marketing 2

July 28
AM: Project presentations, discussion and feedback 1
PM: Project presentations, discussion and feedback 2