This course is about modeling complex adaptive systems with an emphasis on agent-based modeling. The course will consist of two parts. First, we will read about complex adaptive systems and the tools used to model those systems, focusing in particular, on agent-based modeling. Agent-based models consist of a number of diverse agents, the behaviors of which are governed by (often simple) decision rules. The dynamic interaction of the agents with one another and with their environment can produce emergent patterns and structures at the macro-level. We will discuss the strengths and weaknesses of the agent-based modeling approach, compare the approach to other types of modeling approaches (e.g., game theory), and examine applications of agent-based modeling in political science and related disciplines.

Second, this course will also teach you how to construct agent-based models using a widely-used toolkit, Repast, with programming done in Java. Java is an Object-Oriented Programming Language. Repast is an agent-based modeling toolkit. We will also be using the Eclipse Integrated Development Environment. Java, Repast, and Eclipse are open source and can be downloaded for free. Note: No programming experience is required and basic Java programming will be introduced during the course. We will discuss in detail how to install this software in class.

All lectures, short assignments, and supplementary material will be posted on SmartSite@UCDavis.

Readings
One book is required for this course:


One additional book is recommended:

The Miller & Page and de Marchi books are available in the campus bookstore, but they can be purchased online for a potentially lower price (try [www.amazon.com](http://www.amazon.com), [www.dealoz.com](http://www.dealoz.com), or [www.addall.com](http://www.addall.com)). The remaining required readings for this course consist of articles taken from scholarly journals. Note: You should do the reading(s) assigned for a given day before coming to class.

You may also want to purchase a book on Java. While there are numerous books on Java, below are two I think are particularly good.


Finally, if you are interested in understanding the emergence of the field of complex adaptive systems you may wish to purchase the two books listed below, both of which were written for a general audience. The first book provides a historical account of some early researchers in this field, including Murray Gell-Mann, Philip Anderson, Ken Arrow, Brian Arthur, John Holland, and others. This book also describes the founding of the Santa Fe Institute. The second book is a personal account of the science of complex adaptive systems by Murray Gell-Mann, who won the Nobel Prize in Physics in 1969 and was one of the founders of the Santa Fe Institute.


**Evaluation**

Your grade for this course will consist of 3 parts:

1. Research Project (60%)

The research project will consist of extending an already existing agent-based model. The project will be co-authored with another student in the class. Each group will choose from a set of models (those for which I have code) that were programmed in Java and use Repast. You will be required to extend the model by changing some of the assumptions of the model (which will require you to program), conduct new simulations of the model, and present and interpret the simulations results. We will talk more in class about this project.

The research project will count at 60% of the course grade. You will present the findings from your research project at a poster presentation at the end of the quarter that will be open to faculty and graduate students. You will also need to turn in a paper.
2. Short Assignments (30%)

There will be 6 short assignments in this course. Each of these assignments will count as 5% of the course grade. The assignments, unless otherwise stated, will be due at the beginning of class on the day for which they are due.

Short assignments will be marked down the equivalent of a full letter grade for each 24 hour period in which they are late, starting at the beginning of class on the day on which they are due, whether or not you attend class. Additionally, no matter how many days have passed, an assignment will not be accepted for any amount of credit once the graded assignments for the same assignment are returned. For example, an assignment due at 9:00am on Tuesday but turned in anytime after 9:00am Tuesday and before 9:00am on Wednesday will be marked down one letter grade. Those turned in between Wednesday at 9:00am and Thursday at 9:00am will be marked down two letter grades. But assuming the graded assignments are returned to the rest of the class the following Tuesday, after Tuesday at 9:00am no additional assignments will be accepted, period. I will only make an exception to this policy if: 1) you contact me in writing at least 7 days in advance to discuss a conflict, or 2) you provide documentation of a severe illness or family emergency that prevented you from completing the assignment on time.

You can either: 1) type your assignments in Microsoft Word or any other WYSIWYG program (not the best idea), or 2) type your answers using \LaTeX. If you plan on having methods as one of your main fields, I strongly suggest that you learn \LaTeX and that you do so now. Good places to start are the \LaTeX Users Group, Comprehensive \LaTeX Archive Network, and \LaTeX Wiki. All assignments should be submitted as hard (paper) copies.

3. Class Participation (10%)

Class participation consists of attending class and participating in discussion. Both are vital to develop a full understanding of the material. I expect you to have read the assigned readings prior to coming to the class for which they were assigned.

Since this is a graduate course, it need not be said that attendance is mandatory. And since this is a graduate methods course, talking in class is particularly crucial. Although the sometimes daunting nature of the material can sometimes make it intimidating to ask questions in class, asking your questions and getting the help you need is nothing short of critical for your success in this course. I can only address difficulties you may be having with the material if you bring them to my attention.
## Class Schedule

Note: I will be out of town on March 31 and May 26. In addition, the Networks Conference at Davis is on May 19. We will reschedule these classes.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Week 1</td>
<td><strong>Modeling</strong></td>
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<td></td>
<td>Miller &amp; Page: Ch. 3</td>
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<tr>
<td>Week 2</td>
<td><strong>Modeling Complex Adaptive Systems</strong></td>
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<tr>
<td></td>
<td>Miller &amp; Page: Ch. 1, 2, and Appendix B</td>
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<tr>
<td>Week 3</td>
<td><strong>Computational Modeling</strong></td>
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<tr>
<td></td>
<td>Miller &amp; Page: Ch. 5 &amp; 6</td>
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</tbody>
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Week 4  **Emergence**

Miller & Page: Ch. 4

Gell-Mann, Murray. 2007. Beauty and Truth in Physics. [TED Talks](#)

Nova Science NOW. 2008. Emergence. [PBS](#)


Week 5  **A Basic Framework**

Miller & Page: Ch. 7


Week 6  **Complex Adaptive Social Systems in One Dimension**

Miller & Page: Ch. 8


Week 7  **Social Dynamics I**

Miller & Page: Ch. 9 (p. 141-154)


Week 8 Social Dynamics II

Miller & Page: Ch. 9 (p. 154-177)


Bak, Per. 1996. How Nature Works. New York: Springer-Verlag. (Ch. 1)


Week 9 Evolving Automata & Organizational Decision Making

Miller & Page: Ch. 10 & 11


Week 10 The Interest in Between

Miller & Page: Ch. 12, Epilogue, Appendix A