MLTT Year End Report

Applied Complex Systems

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Goals: The goal of this course was to introduce the field of complex systems to undergraduates. Our approach combined computational modeling, qualitative modeling, mathematical modeling, current events, and history. The goal did not change substantively from the original plan.

The course combined computer science, epidemiology, sociology, history, economics, political science, ecology, physics, and a bit of math. Had I not had the leverage to encourage other professors to pitch in – the course could not have been taught. No one would have the breadth and depth to cover the range of topics and concepts that comprised the course.

The biggest challenge was making the course coherent. When we covered emergence, we wanted to span physical systems (the emergence of physical structures like waves and turbulence) as well as biology (flocking) and sociology (culture). This required careful definitions of concepts up front as well as reminders after the guest lectures to solidify understandings.

Interdisciplinary Model: We relied on an embedded guest lecture approach, which worked wonderfully. Rick Riolo taught agent based models. Carl Simon taught disease models. Robert Deegan taught emergence in physical systems. Lada Adamic taught networks, and Allen Stamm and Elizabeth Bruch taught applied cases on Rwanda and segregation.

This approach allowed individuals to teach to their strengths. In the case of professors Stamm and Bruch, we were able to structure lectures prior to their visits so that they could, in effect, give graduate seminar versions of their work. The students were prepared for what would prove to be rather demanding lectures and came away impressed with both the guests and themselves – as in "wow, I cannot believe that I followed that!" The professors were pleased by the amount of student engagement and responsiveness.

To be honest, one of the biggest challenges in putting the course together was scheduling. UM faculty members are busy. Working around other conflicts necessitated reorganizing the syllabus. One anticipated challenge– creating a commonly understood level of technical detail – proved not to be a problem because most of the faculty belongs to Complex Systems and we spoke throughout the term about the appropriate level of detail for the embedded lectures. Had we not done so, the course would not have been as successful as it was.

Student Interaction: The final project exemplifies how we encouraged students to work together. This project consisted of seven parts. It combined interdisciplinary thinking and teamwork.

Part 1: Research Topic (1/2 page) and Complex System Relevant Concepts Report due

*Part 2: I*n class evaluation of Complex Systems Relevant Concepts by classmates.

Part 3: Outline of agent based model or systems dynamics model due

Part 4: 3-5 Page explanation of problem, topic to be studied

Part 5: Comparison of complex systems relevant concepts by outsiders to own evaluation (1-3 pages)

Part 6: Sketch of what an agent based or system dynamics model might look like. (1-5 pages)

Part 7: Realistic and critical analysis of what we might hope to learn from constructing such a model and from thinking about this problem or topic as a complex adaptive system

Note that in Part 2, classmates working as teams evaluated the projects and that in Part 5, students responded to those evaluations. Parts two and five took entire class periods and were a huge success.

Benefits to Faculty: The benefits to faculty were twofold. First, we all had to learn how to present topics from multiple disciplines. For example, when discussing phase transitions, I had to span physics, economics, sociology, and ecology. At the same time, I wanted to be concrete. This wasn't always easy. But the process helped me to see across disciplines in a way I had not previously. My discussions with the other lecturers suggest that they had similar experiences.

Second, we all had to recognize that the students didn't necessarily see the big picture or the little details on the topics covered. So, when students read "The Ghost Map," they needed a basic understanding of the field epidemiology, which Carl Simon provided. Further, when presenting that background, we all had to learn to avoid the jargon that usually gets built up in the first few weeks of a course.

Summary: The class was very successful by traditional measures – course evaluations, written feedback, and our own internal evaluation. In addition, a number of students who took the course have expressed an interest in taking more courses of this type. Hardly a week goes by when I don't get an email from a student who took the course relating some idea or concept that we covered in class.