



COMPUTER MODELING IN THE SOCIAL SCIENCES: Experience With a New Computer Science Course

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Introduction

Computer Modeling in the Social Sciences (ACS 389.30) is an experimental computer science course offered through the Applied Computer Science Department of Illinois State University. It has now been taught twice, and the results have been encouraging. This paper discusses the purpose, scope and structure of that course, and presents some example student modeling projects done in the class. Problems with the course are discussed and recommendations made for implementation of similar courses elsewhere.

Purpose and Structure of the New Course

The Applied Computer Science (ACS) Department at Illinois State University (ISU) is a young and vigorously growing department whose emphasis upon the practical application of computers to the solution of problems sets it apart from competing institutions. The author, having spent the previous six years primarily involved in solving problems through the application of computer modeling techniques [1,3,4,8,9], was attracted to the ISU ACS program because of its applied problem solving orientation.

Because no computer modeling course existed when the author first took a position at ISU in 1978, such a course was proposed and accepted experimentally. The ISU ACS Department sees its role as one of training students in all areas of endeavor to efficiently use the computer technology to solve problems in their own areas. Because of the author's experience in computer modeling in the areas of energy analysis, environmental problems and political science, it was agreed to aim the new course primarily at the social science areas and to use the course to engage social science students in computational activities they might not otherwise encounter. The problem areas where modeling techniques were to be applied were to be oriented towards the

social sciences, but also to be open to the specific interest areas of the students in the class. In practice, a wide variety of problem areas evolved.

The principal text for the course is Models in the Policy Process [8], co-authored by the author in 1976. This book takes the reader through a non-technical development of the principal computer-modeling methodologies and dwells at length on the two major policy-oriented modeling methodologies, econometrics and system dynamics. The models are placed in a political science context and are examined through case studies for the ways in which they have affected the policy-making process. Emphasis is on the principles of good modeling, the characteristics of effective models, and the pitfalls and dangers of using models in inappropriate ways.

Because the course is oriented towards non-technical social science students, it was felt that the econometric modeling methodology could only be analyzed vicariously due to the large time and prerequisite knowledge necessary to actually instill econometric modeling skills in students at the junior-senior level. The system dynamics methodology, however, is easily taught to students with little background. The methodology is supported by the DYNAMO modeling language, and the principle DYNAMO text, DYNAMO User's Manual [12], covers the necessary material in less than 80 pages of easily read discussion.

One of the attractive features of the DYNAMO modeling language is that it frees the user from worrying too much about the actual machine characteristics and language attributes like precision and formatting. Rather, the user focuses on the system to be modeled and directly codes statements representing hypothesized relationships assumed to be operative in the real system. Unlike almost all other computer languages, DYNAMO has the interesting feature that

the order of the statements is usually not important. A second feature is that the results of the model are automatically plotted visually for the user on scaled time plots.

The course then consists of studying Models in the Policy Process through the semester, learning the DYNAMO methodology, analyzing for strengths and weaknesses of a number of existing models, and creating a new model in an area of choice. A model is developed in class during the semester, which serves as an example for the students' own modeling efforts.

Application Areas

Some of the DYNAMO models studied by the class are the models of Jay Forrester, viz., Industrial Dynamics [5], Urban Dynamics [6], and World Dynamics [7]. The Limits To Growth model [10,11] by Meadows is also studied, altered, and run. These models sometimes suggest applications to students. One example was a Bangladeshi student whose model was of the growth and decay patterns to be expected on St. Martins Island in the Indian Ocean, not far from the student's home. Although a simple model, this example was sufficient to display the patterns of housing proliferation, overcrowding, drop in attractiveness to immigrants, and resulting equilibrium.

Another student was interested in the environmental deterioration of Lake Erie due to phosphates. He studied the chemistry and physics of water pollution and immediately was forced to make many simplifying assumptions. It is emphasized in the course that all models are approximations. Assumptions are not considered bad so long as the modeler keeps the assumptions made in view and presents them along with the results of the model. The Lake Erie model showed rising phosphate levels in the lake through the year 2100 and concluded that little can be done through conventional means to prevent a continued deterioration of the lake, although it could be slowed.

The Political Speech Writer Model

In the fall of 1979, the attention of the class was drawn to a series of articles in the popular press concerning the efforts of Professor John Cragan of ISU to create optimal political speeches based upon computer analysis of the acceptability of given concepts. Cragan and his associate Donald Shields of University of Missouri-St. Louis had previously published the results of their work [2], but only in an election year had the press picked up on it. The class was asked to attempt a similar task without using the Cragan-Shields work.

The class analyzed the problem, drafted a proposed solution, broke into small, structured groups to implement the solution in the PL/I language, assembled the model, created speeches with it, and then presented the results to Cragan in class. Both the class and Cragan benefited from the exercise. Cragan was pleased to find a new technique invented in class to increase the coherency of the speeches produced, while the class learned a few pointers about proper speech construction.

The first Speech Writer created by the class required speech fragments from the press to be classified into one of four world views. Each fragment also had associated with it three keywords, or topic areas. All fragments were read by all class members, who assigned to each a ranking of acceptability. The class average ranking for each fragment was submitted to the Speech Writer. A theme keyword was specified, and the highest ranking fragment with that theme as a keyword was chosen as the starting point. Subsequent fragments up to a given speech length were selected by giving relative advantage to fragments with similar keywords to those of the fragment last chosen. It was this coherency test that Cragan found interesting enough to incorporate in his own work.

The first Speech Writer created speeches that started off strong and then tailed off as fewer and less relevant fragments remained to be chosen. Cragan suggested leaving the second best fragment for last. The class adopted the suggestion and created the second Speech Writer. By analyzing the behavior of the first model, a better internal ranking algorithm was developed and implemented. The Speech Writer now creates speeches which have a sense of theme, coherency and development about them. An example has been included as an appendix to this paper.

Problems with the New Course

While student response has been enthusiastic at ISU to this new course, several cautions are in order. The course must be sold to the social science departments. Social science students normally shy away from any involvement with the computer. It is difficult to find social science students for the course because the course is not listed in the departments these students normally look to for coursework.

For the course to work well at other universities, the instructor should have some modeling experience. The tests used, while they are the best available, must be supplemented with a variety of

readings. Many of the models studied have entire books devoted to explaining them. The instructor's modeling experience is necessary in choosing appropriate supplemental materials. Experience in the DYNAMO language is also highly recommended if the course is to be taught as this one has been. Many installations do not have DYNAMO on the system, and a package will have to be ordered [13]. If problems arise, there are few local people to turn to for assistance.

Conclusion

The experience accumulated from twice teaching Computer Modeling in the Social Sciences indicates that the course has value as a means of instilling in students two important capabilities--the ability to learn about social-political systems by modeling them, and the ability to analyze existing models for their strengths, weaknesses and hidden assumptions. The course needs to be taught by a person with modeling experience, and there needs to be a computer system available to support the chosen simulation language.

The application of models to current events proved to be a major stimulant of interest in the methodologies studied, as the example in the Appendix shows. When the Iranian crisis emerged in mid-semester, the Speech Writing Model was able to quickly produce several speeches of interest on the new topic.

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Appendix

What follows is a sample output of the second version of the Political Speech Writing Model, developed in the Computer Modeling in the Social Sciences class in the Applied Computer Science Department at Illinois State University during the fall semester, 1979.

A Speech in Favor of Economic Action Against Iran			THEME:Economic
<u>Speech fragment:</u>	<u>Preliminary Rank:</u>	<u>Three Keywords:</u>	
Jimmy Carter's order to freeze an estimated \$6.5 billion in Iranian government assets held in the U.S. had serious political implications, but it also was a sound dollars-and-cents move.	9	Carter Admin Iran Economic	
To the extent that the Iranians considered we were dependent upon their oil, we want to tell them it is simply not true.	8	Iran Economic Exports/Imports	
It is necessary to eliminate any suggestion that economic pressures can weaken our stand on basic issues of principle.	9	U.S. Exports/Imports Economic	
It must be dawning on people that incidents like this are going to happen again and again if we do not free ourselves of our dependence on such a volatile part of the world.	9	Economic U.S. Exports/Imports	
The U.S. prestige and influence in the world has declined sharply in the past decade, and American self-confidence has slipped in the process.	9	U.S. Economic Political	
In the second week of the embassy siege, the Carter administration launched what amounted to political, economic, and psychological warfare against Tehran.	8	Political Carter admin Economic	
In a series of dramatic but carefully limited moves, the President fought back with economic reprisals.	8	Economic Carter admin Response	
The United States will not yield to international terrorism or blackmail.	10	U.S. Terrorism Blackmail	

Total rating of speech is 70.