COMPUTER SCIENCE EDUCATION AND SOCIAL RELEVANCE

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Abstract

The rise of computer science as a theoretical discipline should not be allowed to proceed without promoting the study of the social implications and applications of the field. This paper describes an undergraduate course whose primary goal is to foster an understanding of how computers can be used for socially relevant purposes. The students were required to propose and execute a project which could benefit people directly. The projects are described and suggestions for further work are given.

The rapid rise of Computer Science as a major field of university study is unprecedented. In 25 years digital computers have risen from a laboratory experiment to a full-fledged academic discipline. Most major universities have created Departments of Computer Science and offer advanced degrees.

Paralleling the widespread implementation of computer systems has been the development of the theory of computing. While early workers were concerned with the practical difficulties of building and programming machines, more recent work has focused on the abstract problems. University study of computer science includes less and less programming and practical experience and emphasizes the pure theoretical problems. Mathematical logic, automata theory, formal languages, graph theory and the like have become the central disciplines for computer scientists. This is good and necessary. Without this emphasis the field would be crowded with trivial problems. The grand conceptual notions embodied in advanced theory eventually filter down and find application to practical problems.

On the other hand, the computer is a unique product of a different age. The rapid rise of computer science is a result as well as a part of the cause of the increasing rate of change of society. Computers will continue to play a central role in this acceleration of history. While jet planes only give two orders of magnitude improvement over walking, computers produce six orders of magnitude acceleration of thinking processes. It is a cliché to say that instruments of technology can be used for good or evil, but it remains true. The question of how best to apply these impressive intelligence amplifiers is a real one.

While computer scientists must continue to ponder the theory, they cannot disavow their responsibility to consider the real world applications. The integrated and rapidly changing nature of our world no longer permits scientists the luxury of isolationist specialization. They must be concerned with the effects of their abstract creations on present and future societies. The irresponsibility of automobile designers has created an automotive crisis which manifests itself in crowded highways and polluted air.

The nuclear physicists of the 1940's and 1950's were the first group of theoreticians to grapple with implications of their discoveries and creations. They were confronted with the realization that they had produced something which could bring incredible benefit or harm to the entire world. The controversy surrounding their work should be required study for all responsible scientists. The Bulletin for Atomic Scientists has provided a forum for these discussions and makes interesting reading.

Now, computer scientists are faced with similar problems. Theoretical study is necessary to prevent stagnation but every professional in this field must be conscious of the social implications of his work. The much repeated call for social relevance must be heard by computer scientists.

Students should be encouraged to find a faster algorithm for eigenvalue calculation but should be equally stimulated to study hospital management systems, urban dynamics, and sociological modeling. Pure scientific research, engineering and business use are necessary facets of computer science, but the application of the machine to the solution of pressing human problems must also be an essential component. The perplexing dilemmas of our times should be in the realm of concern of any responsible professional. The computer specialist who works with a tool of great intellectual power should be aware of how he can help solve these problems.

With these thoughts in mind, I began a course entitled simply Applications at the State University of New York at Farmingdale. The course is for the math-oriented students in our Data Processing curriculum. It is designed to give them a term of working out problems and gaining experience in complex FORTRAN programming. The course is preceded by a basic FORTRAN course, FORTRAN and statistics, numerical analysis, systems analysis, two terms of assembly language and appropriate mathematics courses. Co-requisite is "Decision Making by Computer" including simulation modeling. (For a more detailed description of the curriculum see Shneiderman and Highland, "Scientific and Industrial Programming Education at the Junior College Level," Proceedings of the IFIP World Conference on Computer Science Education, August 24-28, 1970.)

I wanted each student to select a project in an application field that he found interesting, formulate a proposal and carry out the work. I suggested a number of projects to give an idea of what I had in mind and what the scope of their work should be. Each student researched possible topics and had to have it approved before he could proceed. I tried to promote as much independence as possible but was always available to discuss difficulties.

One student was interested in consumer problems and inflation. He began working on a set of programs that would allow him to monitor pricing. After a good deal of consideration and discussion, he decided to apply his work to gasoline prices in the area. The other students in the class collected the data on prices for regular and premium, special offers or savings stamps, the location and company name. The range in prices for the same gas from the same company but different dealers was surprising; in one case, it was 28.9 to 41.9 cents per gallon. Listings were produced of sortings by price, manufacturer, and area. His data base grew and he became familiar with the techniques of data collection, storage and manipulation. By carrying out the study over a given period of time, the pricing policies of the companies and their individual stations could be analyzed. The dissemination of this information on the campus and through the local news media could have dual effects. First, consumers would benefit from the knowledge of where to buy gas at the best price. Secondly, if consumer action was widespread, there would be a feedback effect on the companies. They would be compelled to standardize prices.

A student who described himself as an outdoors and nature type was additionally inspired by the current interest in environment and began work on building a bibliographic data base on wildlife. Another ecologically related project was an attempt to build a simulation model of a closed system. This work is continuing with the aid of a faculty member in the biology department. They would like to develop a model that could be manipulated by biology students as an educational aid. Although neither of these projects will directly change the environment, they will help to foster greater understanding of the problems.

Two students concerned with medical problems began work on computerized symptom diagnosis. A local doctor gave them information on heart disease symptoms, but it became apparent that they needed a stronger background in decision tables and pattern recognition. Other researchers in this field have realized the complexity of symptom diagnosis. Progress in this field would promote improved health care. The experience of many doctors could be incorporated into the computer's data bank. The principle is simple. The patient's symptoms are input to the machine. On the basis of case histories stored, the machine suggests possible disease conditions. Computerized symptom diagnosis should never be used to replace a doctor's judgment, it is meant to be an aid.

A foreign student thought that law practice could be aided by computerized techniques. He contacted law firms and legal librarians to determine how machines might improve forensic practices. His main concern was in information retrieval systems for citation searching. If this system was implemented, legal researchers could spend their time more fruitfully.

A veteran, who had been stationed in Thailand, sought to help the people of Southeast Asia with rice production. He researched the various strains of rice developed by the International Rice Institute. The Institute, located in the Philippines, is supported by the Rockefeller Foundation. The program that was built selects the appropriate strain of rice depending on what qualities are desired. If this program was put into widespread use, the quantity and quality of the rice produced could be greatly improved. This would do much to alleviate food problems in Southeast Asia and elsewhere.

A member of the faculty of the Department of Police Science worked with one of the students. They wanted to prove that violent crime increases sharply in urban areas with high population density. The psychological strain of crowding is believed to produce stress which could result in violence. Crime statistics were obtained from all the police precincts in New York City. Currently, patrolmen are allocated on the basis of population and area, but no consideration is given to population density. If high population density does produce psychic strain which leads to violence, then additional police should be assigned to these areas. Furthermore, urban planners should be aware of this effect in preparing the future of our cities. Preliminary results support the hypothesis.

One of my best students worked on a system to help real estate brokers find the right house for their clients. The sophisticated system took into account a large number of factors including town, style of house, number of bedrooms, size of garage, type of heating, taxes, and, of course, the cost. His routines created the file, updated it, and searched through it for the best match to what was requested. Another student did similar work but he was concerned with used cars. His data bank was organized on the basis of body style, manufacturer, model year, and cost. Since homes and cars are generally the largest investments a family makes, these two systems would be useful. In addition, these programs serve as models for generalized consumer product search techniques.

Of great concern to the students, is the College itself. Two students thought they could improve the registration procedures. The techniques they developed and incorporated in a set of programs are currently being examined by the registrar. The question of off-campus housing interested another student. He worked with the housing placement office and developed methods for helping find apartments or rooms. Forms to be filled out by the student and the landlords were developed. This project will continue and hopefully will benefit students next year.

The variety of projects made for interesting discussions among the students. There was great interest about what fellow students were trying to do. The list of possible projects is unlimited. A statistical study of the comparative effectiveness of local governments in fighting crime, education, housing, welfare, or other services would be interesting and politically volatile. Politically active students might like to develop a data base on the voting records of Congress or state legislatures. To limit the extent they might confine the information to bills on a particular topic such as environment. Computerized studies of environmental pollution could provide information needed by politicians in support of control legislation.

A simulation study of traffic flow around the campus, with the hope of making suggestions for improvement, was proposed. Since parking space is limited, a program for helping students find rides to school would be a good idea. If a good routing algorithm was developed, it could be used to aid community services by selecting efficient routes for police patrol cars, garbage collection or post office pick-up and delivery.

On a wider scale, a computerized demographic simulation such as that envisioned by Buckminster Fuller's World Game could be used to plan for future resource utilization. The nature of population flows in urban and suburban regions could be the subject of a computerized analysis.

The same techniques used in computer dating programs could help unemployed workers find the right job or assist high school graduates in selecting a career or university.

Bibliographic data bases in machine readable form are ofter useful and in demand. The student would be wise to confine himself to a limited area since the number of references can grow quickly. Once the file has been established and basic output preparation programs have been written, the file can be expanded with references provided by other class members. Then programs for selective retrieval or sorting on the basis of keywords may be developed. By continuous evolution the student will produce a large data base and a complex information retrieval system.

There were 18 students in the class so it was possible for me to get involved with each project. I tried to leave the major decisions in the hands of the students, but gave advice frequently. More importantly, I helped lead the students to the proper reference material and often put the students in contact with professionals who were working on related problems. The response from outsiders was generally very good; most were willing to help the students and guide them properly.

I spent a great deal of time discussing problems in my office with individual students but less than a quarter of the class time was spent on individual projects. This left me the opportunity to lecture on character manipulation, text processing, data structures (arrays, lists, stacks, queues, etc.), searching and sorting data, information retrieval and compiler/interpreter design. There were programming assignments related to this lecture material. Much of this material was necessary to the execution of the projects. I tried to be responsive to the student needs and covered topics that they requested, such as direct access storage techniques or plotting and histogramming.

The students became deeply involved in their projects and felt that they were working on something that was their own. Thus, they were highly motivated and worked hard. The weaker, less mature students needed more attention since they had difficulty adapting to working at their own pace without the pressures and deadlines of exams.

For the first time, the students recognized the complexity of the real world, as opposed to texbook problems. In general, there was no "solution" to the problems they faced, they could only help to improve the situation. The realization that there is no answer which can be looked up in the back of the book is an important step in understanding social problems.

Hopefully, I influenced the students in the direction of social concern. The projects may or may not help anyone immediately, but possibly I have shifted the student's orientation so that when they go out to get jobs, they will find it more satisfying to work in a socially beneficial environment.

The students interest in their work is best displayed by the fact that at least half of the class are continuing their project work. They no longer need external academic pressure but are selfmotivated by their genuine interest in the work they are doing.