NEW AREAS OF APPLICATION OF COMPUTERS

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The population of computer applications behaves in many ways like a population of evolving organisms. It grows continually, even exponentially. This growth is autonomous -- the natural product of a vigorous segment of the economy and culture. Variation is mostly by combinations of features already existing in the population. It occurs continually because our professional orientation is toward exploiting the new technology. Improvement and innovation are not only economic necessities of the computer industry, but provide the programmer and engineer some measure of intrinsic satisfaction from their work. Selection of the fittest is easily documented.

According to theory successful branches of the evolutionary tree undergo adaptive radiation, fanning out to occupy all available environmental situations which can support some variant. Applied to computers this means that any application you can imagine will eventually occur. Many applications will not prove successful, but every environmental niche in which information technology can be used will be occupied, to be reoccupied by more successful processes or abandoned if economically too inhospitable. This evolution, like biological evolution, will appear highly extravagant and wasteful. However, in the long run it may yield highly satisfactory results, far in excess of those obtainable in an environment so harsh that success must be assured before an application is born.

The current range of applications suggests no other pattern. Engineering calculation and business data processing do constitute continuing mainstreams. But the range is much broader: preparation of Bible concordances, prediction of election returns, discovery of new chemical names, composition of elementary music, solution of double-crostics--even a program that plays solitaire. Seemingly esoteric, these provide much of the variation from which the next generation of more practical programs will come.

The far future is then too easy to predict. More intriguing is the immediate course of evolution (a task the biologist sensibly tries to avoid). It is an entirely local consideration, like the kids' game of guessing how runoff from a sprinkler will spread over a cracked sidewalk. Nutrient environments such as nuclear energy practically guarantee adaptation in the direction necessary to fit into them. Thus the ability to handle large hydrodynamic problems has been a strong guide in the most advanced generation of computers. Barriers force compensating developments. We cannot yet recognize the printed word directly, so a great proliferation has occurred in punched card devices.

A fascinating possibility is the handling of raw language. Ordinary human technical prose is much too variable, too prone to error, and too convoluted for current computers. We cannot instruct them easily; we cannot even give them data without careful preparation. They cannot even comprehend an ordinary bibliographic citation or a function table in an ordinary reference.

A measure of this barrier is the now complete destruction of the myth that computers are easy to use. Getting anything into a computer is tolerated only because of the very large gains that come from mass processing of information. Removing this barrier might well mark the shift from burden to ease in the use of computers. Besides transforming many applications already made it would open a host of new ones, such as real time executive decision making.

My interest is compelled not only by the opportunities if the mutation could ever occur, but by the indications of its possibility. Three major ingredients seem required, each of which seems already well advanced in separate branches of the evolutionary tree. First, by any reckoning large quantities of information must be accessible if arbitrary statements in technical language are admissible. Concern with information retrieval has already spurred development of large stores and provided experience with indexing and accession schemes. Second, basic techniques for recognizing and manipulating the structures implied in free language are required -- e.g., parsing sentences. Mechanical translation, faced with the same need, has gone a long way toward meeting it. In retrospect this may prove its most vital contribution. Finally, the sophistication necessary to extract the meaning from expressions -- to recognize the intent of the writer -- is needed. Here there has been twofold preparation: the programs for interpreting increasingly complex languages like ALGOL and COBOL; and the programs for solving problems by heuristic methods in elementary theorem proving and game playing. These parts combine to yield a problem solving interpreter working from a cleaned-up version of the input expression into a model of the things the writer might intend.

Given the evolving nature of information processing, elementary language-understanding programs will eventually exist. Whether they will maintain a foothold in economic competition with humans is an entirely different question. I already know of three efforts to pass beyond mere language data processing to language interpretation: a program to converse about baseball; a program to assimilate information from Basic English; and a program to do word problems in elementary algebra. Undoubtedly there are others. These serve as cues that the combination is beginning.