Meetings

Intelligent Verbal Behavior

Progress in the study of intelligent verbal behavior was the topic of a 2-week conference on artificial intelligence, linguistics, and psychology, held at the summer conference center of the National Academy of Sciences in Woods Hole, Massachusetts (11 to 23 July 1971). Although the participants from the three fields differ in goals, the recognition of their common interests in the study of natural language, memory, and cognitive processes offers an encouraging sign of progress.

The conference participants examined the basic processes needed to model human knowledge, linguistic interactions, and thought capability. The ability to understand an input from the context of its appearance (rather than from internal sentence components alone) requires the consideration of knowledge that may not have been mentioned in the discourse, but that is assumed by the speaker of the language. An organized memory system seems to be necessary; the format discussed most frequently during the conference was that of a directed, labeled network of information. Memory processes should permit the network to acquire new information, both by adding new concepts and experiences and by recombining, discriminating, and generalizing the knowledge already present in the network. In addition, it should be possible for an intelligent system to perform logical deductions on the information contained within the memory.

The ability to process natural language by computers was viewed as entering its second generation of development. Parsers now use procedures that combine both syntactic and semantic information in order to determine the most likely interpretation of a sentence, rather than the characteristic earlier approach of enumerating all possible interpretations. These new parsers offer prospects for placing heavy reliance on general semantic and conceptual structures and are capable of using the context of the discourse, as well as a general knowledge of the problem under discussion, to perform their analyses. Although current systems are adequate only for models of specialized content areas, considerable discussion was given to the analyses of conceptual paradigms that might be involved in more extensive human cognitive systems.

The further development of semantic networks and natural language parsers will provide potential bases for new directions in the use of the computer as an educational tool. Thus, in the teaching of a particular content area, it appears to be possible to provide the system with a rich universe of knowledge. Students could then freely probe and question such knowledge structures. Moreover, it may ultimately be possible for the system to model the strengths and weaknesses in the growing knowledge structure of the student, thus permitting it to adapt teaching strategy accordingly.

The group felt that the social consequences of present endeavors should continually be under examination as the power of these systems increases. It was generally agreed that the understanding of intelligent behavior, whether it be of man or of machine, has important potential benefits to society, such as the educational uses discussed above. But negative consequences are also likely to accompany such developments, the most obvious being the use of these systems to collect and evaluate large files of political and personal data on individuals. Although the participants did not foresee simple resolution of the dilemmas in weighing potential benefits and dangers of scientific knowledge, it was felt that the social implications of the creation of intelligent systems must be faced willingly by both the researchers themselves and by those who support the research.

The conference was sponsored by the Mathematical Social Science Board within a grant from the National Science Foundation. The participants, listed by institution, were R. P. Abelson, chairman (Yale University); J. D. Becker, D. G. Bobrow, J. R. Carbonell, W. A. Woods (Bolt Beranek and Newman, Inc.); R. Quillian (Bolt Beranek and Newman, Inc., and University of California, Irvine); S. Baranofsky, R. Simmons (University of Texas); K. Colby, H. Enea, R. Schank (Stanford University); A. Fink, E. Kelley, P. Stone (Harvard University); M. Kibens, R. Lindsay (University of Michigan); D. A. Norman (University of California, San Diego); B. Raphael, A. E. Robinson (Stanford Research Institute); J. Weizenbaum (Massachusetts Institute of Technology); R. M. Kaplan (Rand Corporation); and G. A. Miller (Institute for Advanced Study).

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Prospects of Gene Therapy

The prospects of developing gene therapy to treat inherited diseases were discussed by specialists of different disciplines at a meeting jointly sponsored by the National Institute of Neurological Diseases and Stroke and by the Fogarty International Center at the Stone House at the National Institutes of Health (NIH). Medical researchers have the following concern. More than 2 percent of humans suffer from diseases or defects in vitality that are inherited according to Mendelian laws (that is, have alterations within single chromosomes, resulting in, for example, homocysteinuria, sickle cell anemia, and the like). In addition, more than 5 percent have familial disorders whose tendency to develop depends both on the environment and on the cumulative effect of two or more genetic defects (diabetes, schizophrenia, and certain cancers). In fibroblasts, shed by the growing embryo and obtained through amniocentesis, some hereditary diseases can be detected either by the cytological analysis of chromosome anomalies (mongolism) or by biochemical tests (Lesch-Nyhan syndrome). If such an analysis clearly indicates the presence of a hereditary disease, the fetus can be aborted. Whether this kind of eugenics will be extensively employed depends on each society's ethical decisions, influenced by religious attitudes and economic affluence. But only a small fraction of all hereditary defects can be discovered by amniocentesis because most do not show up in fibroblasts. Most hereditary diseases will therefore persist in the human population and, with certain glamorous ex-

ceptions, will not yield to treatment with diets or drugs. In some of these cases gene therapy appears to be the only hope.

If foreign cells were not rejected, one could modify the genetic makeup of a tissue by transplanting cells or organs from a normal person into a person with a hereditary disease. Such transplantation of erythropoietic cells or whole organs has been successfully performed in inbred mice. In humans, however, transplants are rejected in almost all cases (except identical twins). But one could take cells from the sick person, genetically transform them (by reversion, isolated DNA, virus transduction, cell fusion, and so forth) into cells expressing the normal genetic information, grow a larger number of them in tissue culture, and then return them to the donor. One would hope that their surface antigens would not have changed by this manipulation. (For polygenic diseases replacement of one defective gene by a normal one may be sufficient.) Or one could use certain artificial transducing viruses to treat the patient directly. Recent discoveries have made it probable that transfer of specific genetic information in humans will be feasible within one or two decades. This gene therapy would be initially useful only for mobile multiplying cells (such as those in bone marrow). But when more is known about the differentiation of cells, the replacement of other cell types, which can still multiply in the adult, may become feasible (for example, liver).

The possibilities and potential hazards of gene therapy were the subjects of the conference. Several speakers presented evidence indicating that human cells can express some genetic information contained in the DNA or RNA of animal or bacterial viruses and that the transferred information can be inherited from cell to cell. It is even feasible to link desirable genetic information to a nonpathogenic virus DNA and convey it by a virus into the cell. Furthermore, genetically normal human DNA can be taken up by human cells either directly or packaged into a virus coat, or whole chromosomes can be transferred via cell fusion. It is still not clear which conditions are necessary to allow the replication of the transferred DNA. Instead of transferring normal genetic information, one could possibly subject tissue cultures of deficient cells to mutations and isolate revertants that have regained the normal biochemical property. In principle, it would even be possible to manipulate eggs or sperms genetically, or to produce chimeras by mixing blastocysts, but these possibilities have been disapproved because they would create many new problems and possibly increase, or at least perpetuate, undesirable mutations in the population.

A detailed summary of the meeting will be printed by NIH and can be obtained from the Fogarty International Center, National Institutes of Health, Bethesda, Maryland 20014.

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