TECHNOLOGY

Can Computers Think?

Computers can beat their builders at checkers and learn new techniques by comparing stored information with programmed criteria, Judy Viorst reports.

➤ CAN MACHINES OUT-THINK the men who build them?

Is it possible for a computer to come up with a new idea?

Are we in danger of being dominated by mechanical "brains" whose actions may be not only unpredictable but disastrous?

Dr. Norbert Wiener, professor of mathematics at Massachusetts Institute of Technology, has stirred up this debate by asserting that "machines can and do transcend some of the limitations of their designers, and that in doing so they may be both effective and dangerous." He rejected the notion that machines are incapable of originality and that they must inevitably remain in subjection to man.

One expert shot back that this kind of thinking threatened to make science indistinguishable from superstition.

Another computer expert, defining thinking as a creative and independent process, said that machines will do only what they are told to do—nothing more.

Still another spokesman said flatly that no machine either in existence or in the planning stage can do our thinking for us.

Arthur Samuel, consultant to the director of research, International Business Machines Corporation, estimates the disparity between computer and human speed at 100,000 to one. The checker-playing machines that he designed can beat him regularly, just as the National Bureau of Standards' SEAC can beat its human programmer 22 out of 26 times in a game of penny-matching. In both instances, the machines have been programmed to remember and analyze past plays and calculate the best move.

Machines "Out-Think" Men

Theoretically, a human player could play the machine to a draw. Given enough time and the patience to calculate, he could do exactly what the machine does. But in practical terms, on specific problems, machines must inevitably "out-think" men.

Business and Government cannot wait for man-gathered information that might be obsolete by the time it is assembled. When speed can mean the difference between usable and useless data, the time factor may be more than quantitative.

A familiar argument used against the assertion that machines can think is: "Nothing will come out of a machine that has not been put into it." But there are machines in existence that can derive totally unexpected information through procedures its builder cannot fully predict.

Although both the conclusions and the steps that led to them are, in a sense, a surprise to the programmer, he has created the conditions that make the entire process possible. The machine is set to examine every 10,000 experiences, using given criteria to measure and analyze the stored data. In testing these experiences by the criteria, it may determine that some criteria are worthless and others more important than indicated in the initial programming.

The human programmer has no way of knowing about these shifts in criteria values, but he does know that he has given the machine the capacity to make them.

While the specific result, then, is unpredictable, this unpredictability is not unexpected.

One of the chief reasons computers were put to work in the first place was to serve as information retrievers. But information retrieval by computers will not really come into its own until the machines can read a language directly.

Although words can be given abbreviations and the abbreviations, in turn, given numerical representation for computer use, this procedure would not be practical for, say, the important science literature on the shelves of the Library of Congress.

Research is now under way on the possibility of building computers capable of reading and answering questions in English. The National Bureau of Standards, the Radio Corporation of America and the University of Pennsylvania are among those working on this problem. No one has yet built such a machine, however, and no one will until the linguistics experts can furnish a computer with a complete description of exactly what constitutes a meaningful sentence.

Progress on Pattern Recognition

More progress has been made on pattern recognition. MIT, Cornell University, the Universities of Illinois and California, IBM, Bell Telephone Laboratories and the Rand Corporation are some of the places where computers are being built that can perceive simple patterns, like squares, circles and triangles. It is hoped that eventually more sophisticated patterns will be recognizable to the machines.

NBS engineers and scientists are hoping to combine a machine's capacity to handle English with a pattern-recognition ability, in order to produce a computer that could function as an intelligent researcher, able not only to describe what is on page 137 of a given book but to weigh and evaluate the material by built-in criteria. This is a long way from realization, but many computer

COMPUTER CHECKERS—Computer scientists are programming an IBM 709 to play a game of checkers. By studying such games they are able to develop improved programming techniques.

men regard it as a realistic goal capable of eventual achievement.

Obviously the key word in this whole debate is thinking, but most of the scientists who work with computers are wary of giving it a precise definition. When an engineer at NBS was asked whether a computer was really anything more than a combination of its built-in functions and its programmed capacity to learn, he simply grinned and asked: "Are people?"

Those who argue that people, unlike machines, solve problems not only by logic but by hunches may be surprised to learn that machines can do this too.

One of the ways of describing computers' "thinking" processes is to distinguish between algorithmic and heuristic functioning. In algorithmic procedures a machine is presented with a problem and given the formula necessary for its solution. Or it follows a step-by-step procedure that will eventually terminate in an answer, or in the conclusion that no answer is possible.

Heuristic thinking, in people, is what can be called reasonable hunches or intelligent guesses or the trying out of likely possibilities. To some extent this is the way a detective operates when he tries to get his man. He draws on his past experiences, his information of other crimes employing the same techniques, his knowledge of psychological types and a wide array of other factors that in total make up a good lead.

There are machines in existence that can function in this way. One or many people can develop a program for a machine that incorporates their own and other hunch capacities, enabling a computer to pick the two or three approaches out of many alternatives which may very well lead to success —though there is no guarantee.

Computers now in operation have been programmed to read an article (in numerals, not in English) and to abstract the key points in it. The programmer instructs the machine to discard words appearing a great number of times—these will be articles, conjunctions, etc.—and to select only those sentences that contain words appearing less frequently, but not rarely. Since these words tend to be the ones that describe the substance of a piece, the computer can often, though by no means always, come up with a reliable abstract. This is also a kind of heuristic functioning.

Although computers have clearly proved that they can simulate certain reasoning processes in the solution of given problems, many people are still reluctant to concede that they actually think. In this position they are supported by the cartoon scientist who turns wryly to his colleague and says, "It will never replace the human brain, Stanley, until we find a way to make it worry."

• Science News Letter, 79:234 April 15, 1961

ASTRONAUTICS

Oxygen System for Space

➤ A SYSTEM to convert an astronaut's breath into breathable oxygen is being designed at Battelle Memorial Institute in Columbus, Ohio.

It is planned for use on space voyages lasting as long as three years, Dr. John F. Foster and Justin S. McNulty of Battelle reported at the annual meeting of the Institute of Environmental Sciences in Washington.

Successful operational development of such a system is vital to extended space voyages. For long journeys away from earth, space and weight limitations would make it impossible to carry all the necessary oxygen, either in tanks or in the form of a chemical compound. One solution is to make use of the exhaled breath (carbon dioxide) of the space traveler.

Sponsored by the Air Force Air Research and Development Command, the Battelle research has resulted in a working prototype of a device to convert carbon dioxide into water. This is a major step in developing a complete oxygen recovery system.

The Battelle apparatus has carbon dioxide fed into it at the rate of 500 cubic centimeters per minute. The carbon dioxide reacts with hydrogen over a heated iron-containing catalyst (a combination of steel wool and iron oxide pellets) to produce water vapor and solid carbon.

The condensed water vapor will be fed to an electrolytic cell, now under development at Battelle, where it will be broken down into breathable oxygen and hydrogen. The latter will be used to react with more carbon dioxide. Solid carbon will be removed from the reactor every two or three days and discarded.

The Battelle system is less than five feet high, occupies about two square feet of floor space, and weighs about 200 pounds. Prior to its test in a space probe, the apparatus will be redesigned to increase the conversion rate and capacity while cutting down on weight.

• Science News Letter, 79:235 April 15, 1961

MINERALOGY

Pure Beryllium Is Not Brittle

➤ HIGH-PURITY beryllium metal produced by the Franklin Institute Laboratories has a ductility that is 50 times that of ordinary beryllium. The brittleness of ordinary beryllium is caused by the impurities present.

The Laboratories, located in Philadelphia, used a specialized floating zone refining technique to produce this ductile beryllium. Their scientists are trying to determine the nature of the impurities causing the brittleness.

Beryllium is the lightest of the metals that can be used for construction. It is 34% lighter than aluminum and 77% lighter than stainless steel. It also has very great strength. These properties make it very desirable for space age consideration.

• Science News Letter, 79:235 April 15, 1961