

The Emperor's new mind concerning computers, mind, and laws of physics

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R. Penrose. *The Emperor's New Mind Concerning Computers, Mind, and Laws of Physics* (Foreword by Martin Gardner). Oxford University Press, Oxford; New York; Melbourne, 1989. 466 p.

Man was created on the sixth day of creation. The computer was created considerably later. And could the real world manage without man (more precisely, without his brain)? Could the computer replace man in the picture of creation? Such a hypothesis is good for a science fiction story, but it is very difficult to think it through to the end. The fairly thick book by Roger Penrose is devoted just to consideration of this theme. A computer operates according to some specified program. A good computer can also compile a program itself. Much effort is being expended on the creation of artificial intelligence, of a computer which would possess intelligence, the capability to think. Penrose attempted to discuss this problem. But from the very beginning, one question generates another one. Thus, the attempt to discuss just what is thinking leads to the questions: "Is thinking subject to the laws of physics? And just what are the laws of physics?" A computer needs a program to operate; the problem which it solves must be presented as a sequence of a finite number of elementary problems, which must be the (final) algorithm. But such a restriction is psychologically unacceptable if the discussion will be about those problems where not simply logic, but something that is called enlightenment or intuition, operates. It is difficult (and if you please, unpromising) to speak of predicting the future; better, let us turn to the past.

Let us suppose that everything which Faraday knew in his time has been put into the memory of a computer (which is imagined to be as complicated as one pleases). May one hope that, after a finite time, Maxwell's equations will appear on the display?

Einstein, who had thought deeply on the nature of thinking, wrote that even composers are different. Some of them innovated (as Beethoven did), others just did no innovation; they discovered that which exists in nature (as Mozart did). For people of the second type, music comes from somewhere outside (out of the blue, as the English say). It seems to be obvious that there is no such way for a computer. Is it sufficient to turn to quantum mechanics in order to explain thinking (the brain) going over into a new state? Most likely no, but this way also deserves analysis.

Penrose passes through the most diverse fields in discussing all this.

The titles of the ten chapters of which his book consists can serve (with short commentaries) as a guide. The fore-

The time has come, Penrose said,
To talk of many things,
But what is right and what is wrong
Don't know even Kings.

Lewis Carroll (?) (unpublished)

word written by Martin Gardner, a man who was able to become a master of mathematical recreations, ends with the words: "For me, Penrose, that taciturn man sitting in the third row behind the leader of AI (artificial intelligence), is he who is capable of stating that the Emperor of the land of the strong (i.e., of computers which compute according to a specified algorithm) is simply naked!"

The confidence of Penrose comes down to the fact that thinking does not come down to an algorithm (one may not write a self-instructor on how to write Mozart's music). All the rest is explanation, arguments and, in the final analysis, intuition.

The chapters after this are in this order:

1. *Can a computer possess a mind.*

(May it be, nevertheless, the English word "mind" is more than just thinking?)

2. *Algorithms and the Turing machine.*

3. *Mathematics and reality.*

The problem of reality becomes especially paradoxical in the development of mathematics. Just what is a series of natural numbers (or, for that matter, of numbers in general)? Is this a product of human thought or a reality of the external world? One may ask "external to what?"

4. *Truth, proof, and foresight.*

The most mysterious questions are discussed here. What is truth? The question posed two thousand years ago still lacks an answer.

5. *The classical world.*

The world of simple (customary) logic and of customary laws.

6. *Quantum mechanics and the quantum mystery.*

This new science which arose in the 1920s has perplexed philosophers. The obvious became incorrect, and the paradoxical became part of reality. Reality in quantum mechanics acquired new and (as it seems to many) contradictory features. Penrose seeks the key to understand the functioning of the brain in quantum problems. But such a course also does not save the situation very much.

7. *Cosmology and time's arrow.*

Cosmology has added new objects; black holes, quasars, supernovae, ...

8. *In search of quantum gravity.*

It requires a great amount of thinking to understand what the cosmos gives us. Could a computer construct by itself a

theory of the Big Bang (or of any other model)?

9. *The real brain and the model of the brain.*

At the end of the chapter, Penrose returns to algorithmic and non-algorithmic (or conscious and unconscious) opinions, illustrating their differences by making contrasts; common sense vs acting automatically, understanding vs programming, etc.

And, finally, there is Chapter 10, "*Just where is the place of physics in thinking?*" In this final chapter there are arguments as to whether or not the laws of physics are sufficient for the understanding of consciousness and thinking. But here too the answer is lost in questions. Nevertheless, the reader will learn from this chapter about the subdivision of a plane and of space, and about quasicrystals that are associated with the existence of fifth order axes, which are impossible from the point of view of elementary geometry.

The end of the book is not very optimistic. Penrose's conclusion is: "In this book I suggested many arguments favoring the position that the point of view, according to which our thinking is basically analogous to the action of a complicated computer, is incorrect. But a theory of con-

sciousness is needed in order to clarify the entire confused tangle of questions. But how can we begin to explain the essence of the problem to a system which, alone by itself, does not possess consciousness"?

In conclusion, a few words are said about the reference index. Of the more than 150 titles, only a few are well known to our young scientists. We shall hardly find many people who think about such problems. In caring for the young generation and for maintaining the activity of science in the very near future, one must publish books with very diverse contents, and also without neglecting those of which a large part is truly science fiction.

Books such as those which we have discussed need timely publication, even if their publication will be made at a loss. A "collapse" of science will be even more costly. The books of Mandelbrot, Hofstadter, and other authors which are referred to in thousands of papers, and which are little known to some of our young scientists, have not been published in Russian.

Translated by Frederick R. West