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The Perfect Robot

As Professor Fontaine came into the board room, the eyes of all the directors converged on the corrugated and voluminous cranium that housed the Company's most precious assets.

'Well?' the Board anxiously enquired.

A flame of triumph glittered in the old scientist's eyes.

'*Eureka*, gentlemen,' was all he said.

A tremor of relief went down the green baize table, and the prince of science was asked to report on his findings.

In its early days the EBC (Electronic Brain Company) used to manufacture modest calculating machines capable of carrying out simple arithmetical operations. The scope of these machines had been enormously enlarged, and their ingenuity had reached a degree of perfection unequalled by any rival concern, ever since the EBC had obtained the full-time services of Professor Fontaine, one of the most expert and enthusiastic pioneers of the young science of cybernetics.

After the directors had voted him a princely salary and installed him in a laboratory equipped with the latest research apparatus, the scientist, sheltered from all material worry, had devoted himself to the study of robots with the combination of patience, audacity, lucidity and imagination of which his genius was composed.

He had first concentrated on improving the old calculating machines. As a result of his endeavours these had contrived to carry out simultaneously and with absolute accuracy a multitude of complicated operations involving thousands of

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figures, and in a progressively shorter space of time. At this heroic period there had been fierce rivalry in this field and competitions were held every year at which the companies' various models came to grips. Thanks to Professor Fontaine's ingenuity, the EBC had always outclassed its rivals and its machines had established records which were expressed in millions of figures worked out in a fraction of a second.

In fact there appeared to be no theoretical limit to the performances accomplished by the professor's machines. The Board of Directors had had to confine him to a ceiling, above which the results were too abundant to be put to practical use. Once this ceiling was reached, the machines of the other companies had slowly attained it. But long before they did so, the scientist had immersed himself in fresh researches, no longer aimed at perfecting the old machines but at creating others, capable of solving problems of a more delicate nature than arithmetical operations.

He had obtained such results that the EBC's publicity had long since ceased to refer to 'calculation' and instead used the word 'thought'.

This claim had given rise to heated controversy. The objectors asserted that the most ingenious achievements in the field of cybernetics would always remain mechanical, that's to say they would never be able to solve anything but problems whose solution was explicitly or implicitly contained in the data. The machine, they said, combines the elements of these data and reproduces them in a different form known as result or conclusion. It was merely a 'formal' transformation and in no way a creative process comparable to that of the human mind.

But to this Professor Fontaine replied that properly speaking there was no such thing as 'creation', since this word should *always* be understood in the sense of 'combination' or potential rearrangement of former facts. According to him, in all operations of the human mind the solution or outcome was *always* contained, at least implicitly, in previous data. The brain had never done otherwise than modify

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the disposition of these data and present them in a new aspect. Consequently, between the aforesaid human brain and the artificial electronic brain there was a difference only of quality and not of nature. By a systematic improvement of the machine, he claimed, one would eventually be able to obtain all the manifestations generally regarded as being within the exclusive realm of intellect.

In support of this thesis he quoted several examples taken from extremely varied branches of human activity, frequently stretching his argument to the point of absurd paradox, and occasionally indulging in a childish play on words. He claimed, for instance, that there existed no difference in 'substance' between primary education and secondary, the latter being merely a modification in form of the former, just as, in an electric transformer, the energy of the 'secondary' circuit is equal to that of the 'primary' in a new guise. Similarly, he saw in higher education a third presentation of the same fact and asserted that the three so-called degrees of mind corresponding to these three classes were differentiated only by their capacity to combine severally the immediate data of sensory knowledge.

He added:

'The number of cells in a human brain being finite, whereas the number of the circuits in a machine is unlimited, mere calculation of probabilities shows that machines will one day attain more complicated forms of arrangement than those within the scope of the human mind, and therefore more profound speculations and original "creations" (as you call them) exceeding human capacity.'

This postulate being acknowledged, he had set to work, both to verify his theories by practical experiment and to satisfy the demands of the Board of Directors of the EBC.

His first robot superior to the calculating machine was a scientific curiosity which gave him intense personal satisfaction but which enjoyed only mediocre success with the customers. It was a 'mathematician' and not a mere calculator. It was furnished, by means of a series of knobs and

levers, with the fundamental postulates, the definition of the numbers and the symbols of analysis. Various electronic circuits combined these data and it then entered upon the multiple branches of this science, extending its deductions in each branch as far as the latest conclusions formulated by the greatest mathematical minds, and rediscovering the most famous theorems. By means of more and more complicated permutations and arrangements of the data, it had even reached the stage of stating theorems that had never before been formulated, the accuracy of which had been verified *a posteriori* but the demonstration of which had defeated the leading authorities.

Professor Fontaine's opponents had maintained that the so-called 'new' theorems had existed for all eternity in the basic axioms and definitions, in which point they were in agreement with the scientist. But they added that mathematical analysis, being precisely the science of formal transformations, involved only a minute and purely mechanical fraction of the intellect. The robot mathematician provided no proof as to the actual intelligence of a machine. The professor had shrugged his shoulders and pursued his research.

Since his employers wanted models capable of rousing widespread interest by means of spectacular demonstrations, he had concentrated his prodigious faculties on the game of chess. Several authorities on cybernetics had already been drawn to this subject, and some special situations, carefully prepared, which were played out with only three or four chessmen in a succession of well defined moves, had already been solved successfully by machines. This was obviously elementary. The genius of Professor Fontaine lay in tackling the problem as a whole.

That the so-called Maelzel automaton was a fake and that in actual fact a human being was concealed in the mechanical body, the Professor had readily admitted. The state of science at the time at which Maelzel was working led inevitably to this conclusion. But that the principle of the invention

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was Utopian, that a machine capable of playing chess was inconceivable, the scientist had fiercely denied. During the period of cogitation that preceded his undertaking, he had applied himself to destroying the arguments put forward against the possibility of such an achievement, reproving their authors for an unforgivable confusion between the qualifications 'infinite' and 'immensely large', accusing them of applying the former term implicitly and erroneously to the combinations of a game of chess.

Addressing his inner demon of contradiction, which permanently haunted him as it haunts all scientific minds, Professor Fontaine had said:

'Consider a game of chess at a given stage, which I call the 'initial moment'. It is White to play. The sum total of possible moves is high, I don't deny. But you must agree with me that it is finite and perfectly determined. To verify this, you need only take each white chessman one after the other and number the squares to which they can move according to the rules of the game. You must admit there's nothing simpler than to visualize a machine designed to carry out this purely mechanical operation.

'It is now Black to play. As *several* possible moves of the black chessmen correspond to *each* possible move of the white ones, it is obvious that the number of possible combinations after the second move is considerable. It is none the less obvious, however, that being the product of two perfectly determined factors, this number is likewise *finite*.

'Progressing by degrees, let us pass straight on, if you don't mind, to the *n*th move. You will see that the number of possible arrangements for the chessmen, albeit immensely large, and being expressed by a numerical symbol covering several pages, remains in every case absolutely definite. To say that the *n*th move depends entirely on the whim or skill of the player is a gross error. The latter has only the choice between a large number of determined moves and, after he has made a move, the consequent position is none other than a selection from an ineluctably fixed total.'

In his subsequent reasoning, the scientist enlarged ingeniously on the meaning of the word 'necessity'.

'So far,' he went on, 'I have considered all the combinations compatible with the displacement of the chessmen and the position of the squares. Now imagine a game between two beginners who know only the elementary moves. You will perceive that this total is already reduced by the tendency of both players to avoid a manifestly and immediately dangerous position such as would gratuitously place the queen in jeopardy or stupidly lay open the king. You call this the human factor. I say—and if you think it over, you'll readily agree—that the volition of the player in the act of eliminating these manifestly risky moves, which are characterized by a limited number of definite positions, may well be replaced, as to its effect, by a machine. A necessity of a mechanical order will take the place of the impulse induced by elementary prudence. The *law* will automatically avoid any combination resulting in the *immediate* loss of the game.

'Now observe two expert players. The number of favourable combinations is limited in a far higher proportion by what you call their skill and which is again related, I maintain, to a sort of mechanical necessity, even though this characteristic is less distinct than in the first case—the necessity of avoiding disaster in the future which does not appear clearly to the beginner because his brain is not trained to consider a large number of positions. This necessity will reveal itself to him only after the fifth move, for instance, but it is nevertheless contained in its entirety, in a potential state, in the fatal moves. If the opponents are first-class players, the limitation of their judgement will be even more pronounced (the necessity more imperative), being based on the more distinct, keener perception of arrangements possible in a more distant future. If you consult a champion on this matter, he will tell you that for him there exists only a small number of advantageous moves—what I call the only moves *possible* for him as a champion.

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'I maintain,' Professor Fontaine had concluded, after pondering the question at great length, 'I maintain that a super-champion, or the robot I intend to build, must in every case reduce this number of possible moves to a single one, by automatically considering all the subsequent arrangements resulting from a certain position, right up to the end of the game, and by eliminating every fatal move. I intend to construct a robot which, being furnished with data corresponding to some position or other in a game of chess, will resolve the following problem—how to determine and make *the* right move, that's to say the one which contains no potential danger of losing.'

The application of this theory had led to astonishing results. The professor had created a robot which did indeed always make the right move and invariably beat any opponent. But this success had galvanized the research workers of the rival companies. One of them, working on similar principles, had then produced a second robot as ingenious as the first which likewise made no mistakes and invariably countered *a* good move by *the* good move. It then became apparent that all the possible games of chess were reduced to a single one: the ideal game, always identical with itself, and which invariably resulted, by an identical process, in a draw. Chess had thus been deprived of a great deal of its interest and the craze for electronic players had come to an end. Professor Fontaine had re-immersed himself in his speculations to discover something new.

'Mechanical,' Professor Fontaine's opponents had said, referring to the chess-player. 'Mechanical indeed,' the scientist had readily acknowledged, 'but everything human is mechanical—language, for instance.' And without heeding the sarcastic remarks that had ridiculed these claims or the songs that celebrated the coming of a robot-writer, he had gone more deeply into this idea by thrashing it out with his own demon.

'For the time being,' he had said, 'there is no question of composing a story, even though this should not be dismissed

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as a future possibility. . . . We shall make a modest start and confine ourselves to a few short sentences.

‘It is not particularly difficult to imagine a machine capable of producing words. Words are only combinations, finite in number, of consonants and vowels, and their synthesis may be reduced to a purely mechanical operation starting from an initial letter. Consider a robot which is furnished with data consisting of a very large number of these consonants and vowels. It is child’s play to imagine an apparatus connecting every word in the language to the machine and in such a way that all non-existing combinations of letters are automatically eliminated. Supposing that the first circuit happens to start off with the letter *s*. A second circuit then comes into action and proposes *d* as the second letter. The combination *sd* is impossible as the first two letters of a word. It will be rejected by the apparatus, the *d* will be discarded, and the machine will successively suggest other letters until one of these is admissible. If *h* is suggested it will be admitted. The combination *sh* will be selected; further circuits will yield a third letter, and so on. Starting from the fortuitous initial letter, then proceeding by trial and error and without intervention from the human mind, the robot will compose a group necessarily corresponding to an existing word beginning with *sh*—“sheep” for instance. When such a combination has thus been “found”, then, and only then, will my apparatus automatically halt the process.

“It is equally easy to imagine specialized compartments for the formation of nouns, adjectives, verbs, articles and other parts of speech, singulars and plurals, persons and tenses. We may then conceive a second stage at which an initial conjunction of words will be made. If the noun “sheep” has been chosen, it is obviously within the possibilities of a mechanism to combine it with a grammatically suitable article and adjective—to select, for instance, phrases such as “the fluid sheep”, or “the sombre sheep” or “the white sheep”, to the exclusion of any that conflict with the

strict rules of agreement in gender and number. Up to this point we have encountered no difficulty. . . .

“‘The fluid sheep’ doesn’t make sense,” interjected the demon of contradiction.

‘Let me go on. Everything in its own time. We shall not find much more difficulty at the following stage, which will see the complete construction of a simple sentence in agreement with the rules of syntax, which are determined and which a machine can apply just as well as and even better than a human brain. We shall thus see the formation of a certain number of grammatically correct phrases such as “the fluid sheep flies under the pointed sky”, or “the white sheep eats grass”. . . .’

‘That’s what I’m getting at,’ the demon once more broke in. ‘Most of your sentences, though grammatically correct as you say, will be absurd.’

‘They will be irreproachable from the point of view of construction. That’s the essential point, which I wanted to make you admit. Among them there are bound to be some that will make sense. We shall then only need to proceed with a fresh selection. This is where my theory of “primary truths” comes in.’

‘Primary truths?’

‘Follow closely. The problem is of the same order as that of the game of chess, albeit slightly more subtle.

‘In this case it’s a question of eliminating any expression that is meaningless. You think perhaps this is beyond the capacities of a machine? Nothing of the sort. Every meaning is merely a transformation of a previous meaning. The most erudite pronouncement is merely a permutation of the elementary findings of a primary pronouncement. Proceeding by degrees, we arrive at a statement of fact, or what I call a “primary truth”. These are limited in number and may well be electronically connected to the selective organs of a machine which, after carrying out the necessary permutations, will ruthlessly eliminate from the expressions it is given anything that conflicts with any of these statements or

even anything that is not connected with any of them. Only the sentences which really make sense will be produced. I maintain that the human mind does not proceed in any other way when it tries to express itself.'

The professor had built his machine. The construction of his sense selector had seemed a tricky business at first. But in the process of determining the primary truths, he had noticed that their number was less great than he had supposed. It needed only a suitable classification to reduce them all to a few fundamental axioms such as 'A is A' or 'A is not non-A', and to a small number of immediate sense perceptions. Starting from these data alone, and by combining them, the machine managed to discern any expression that did not make sense. Thus sentences such as 'the fluid sheep flies under the pointed sky' or 'the white sheep eats veal' were eliminated. Partial groups such as 'fluid sheep' or 'pointed sky' were discarded by a preliminary selector. A verb like 'fly' or an outlandish complement like 'veal' were rejected by the final apparatus, until finally there appeared a combination such as 'the white sheep walks under the blue sky' or 'a white sheep eats grass', statements which were compatible with all the primary truths and which the robot produced automatically.

The ingenious professor had devoted several years to perfecting his electronic writer.

"'Progress" in this field,' he explained, 'consists in obtaining expressions which, even though being transformations of primary truths, as they all are, carefully conceal this fact under the complexity or the originality of their construction, thereby demanding a lengthy process of unravelling to arrive at the source.'

Thus it was that, having started from statements of fact such as 'the white sheep is white', then, after being given the translation of the various data in several languages, having continued with '*Ego sum qui sum*', the robot writer had gradually elaborated its expressions and managed to produce more complex statements. It had produced: '*Ex nihilo*

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nihil fit, 'The cat eats the mouse', 'Nevertheless it turns', 'I think, therefore I am', and one day, which was a red-letter day for Professor Fontaine, 'To be or not to be, that is the question'.

The scientist's rivals having likewise contrived to build robot writers, and the EBC still wishing to maintain its lead in this field, he had attempted to reproduce other features of human activity by mechanical means. Since circulation, respiration, alimentation and digestion had long since been achieved by machines, he had aimed higher and made an intensive study of the laws of sexual attraction and of the biological factors, considered as initial data, which had as their outcome the carnal act. He had concluded that there was nothing to prevent robots from having sexual intercourse.

He had given an experimental demonstration of this. Several male and female automata, which he had constructed, had been placed at random in a room. At first they had wandered about aimlessly, then, after a certain length of time, appeared to be attracted one to another as though by a magnetic force. The attraction always occurred between robots of the opposite sex, and the couples went through the movements of sexual intercourse with a realism which caused intense emotion among the directors of the EBC when they first witnessed the spectacle. For these automata, to which he had given a human aspect, not only imitated to perfection all the attitudes of living creatures but also, as he had foreseen, invented new combinations thanks to the subtle complexity of the electronic brain which controlled their movements.

As Professor Fontaine foresaw, these latest achievements were to lead in the long run to 'sentiment'. But above all they gave him the idea for a new machine which would mark one of the most important stages of cybernetics, by reducing to nought the objections of its everlasting detractors.

'Your mechanisms,' the latter said in so many words, 'are the most ingenious in the world, we don't deny it. But they

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merely testify to your scientific knowledge, to your inventive genius. All the qualifications of these robots must be attributed to you, who created them. As we have always maintained, they prove the power of human intellect and nothing else.'

The professor had then had the brainwave of constructing a robot capable of engendering other robots. He had succeeded, as in everything else he had so far attempted. Combining this new invention with the previous one, he had constructed a machine in the depths of which, after sexual intercourse, there developed a cell which grew and multiplied by a mechanical process, became the foetus of a robot, was born and grew up, eventually appearing as a machine similar to its parents.

When he had verified this marvel, the professor had intoned a hymn of victory, but his opponents had not declared themselves beaten. They had said:

'It's all very well, but the creator of this uterus is still you—you, a human being.'

Then the scientist had constructed a machine capable itself of engendering a uterus and, to save time and forestall a lot of pointless argument, he had straight away created a robot capable of perpetuating itself indefinitely through an unlimited series of descendants. After which, at a conference which had made history, he had demonstrated beyond all shadow of doubt that any term in this series was strictly equivalent to zero in relation to the infinite succession of future creatures, that, since his own role could now be eliminated, the creative spirit should consequently be attributed to the robot considered as an eternal entity.

His detractors had been unable to think of any reasonable objection to this demonstration. They had not admitted defeat, however, and had taken refuge behind the inexpressible. They had shaken their heads and stubbornly declared:

'Call them anything you like, but your robots are not human. They lack some element or other which we are unable to define but of which we sense the absence.'

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At this, Professor Fontaine had been deeply disturbed. His own demon of contradiction, never so powerful as at this time, kept repeating over and over again:

'They're right. Your robots are not human. They lack some indefinable characteristic.'

He had feverishly set to work again and, with a final effort, had succeeded in creating a sort of mechanism, the successive generations of which 'evolved'. This evolution, which followed a strict course, was slow but nevertheless perceptible thanks to the extreme speed of reproduction which the scientist had bestowed on the species. In this way he artificially obtained robot birds from robot reptiles, robot mammals from robot fish, and robot men from robot primates, without any intervention on his part other than the initial regulation of the mechanism. He went further. Starting from robot men, and by combining the organs in two different ways, he produced two species, which evolved in a clear-cut manner, on the one hand towards Good, on the other towards Evil.

After performing these miracles, the professor once again questioned his inner demon.

'You're not there yet,' the latter replied.

It then looked as though the genius of Professor Fontaine had reached its limits. Several years went by, during which he exhausted himself in fruitless endeavours to take a step forward and eliminate the subtle difference which still separated, as he was now convinced, his machines from human beings. The Board of Directors of the EBC were worried at not seeing any fresh marvels emerge from his laboratory which was once so fecund, and some of them began to mutter that he was somewhat too old to hold such an important position.

This year, at last, breaking a long silence, the scientist had declared he had an announcement of the greatest importance to make. The Board had met.

'*Eureka*,' the professor said again.

'Go on,' said the Board with bated breath.

'I have found,' the scientist translated.

'Yes, but what?' the Board enquired.

'The ideal machine. The human machine. The solution was there all the time, staring me in the face, within the reach of the veriest ignoramus. It had escaped me!'

'Go on, go on!' said the Board.

'Listen, gentlemen,' said the man of science in a voice trembling with emotion. 'No one can have any further objection to raise against my robots. I now possess the secret which will crown my career of arduous labour and meditation. I can give you palpable proof of my theories. My machine now acts exactly like a human being. It "thinks" like a human being. It possesses an intellect similar to our own. This characteristic was already contained at the latent stage in all my previous inventions. It needed only a minute detail, which was too simple—that's why it had escaped me. To endow my robots with this indefinable quality which they still lacked, gentlemen, I merely had to . . .'

'What?' yelled the Board.

'Sabotage them, gentlemen,' the prince of science bellowed in triumph.

'Sabotage them!' exclaimed the Board, dreadfully disillusioned and convinced that their great man had taken leave of his senses.

'Sabotage them,' Professor Fontaine insisted vehemently. 'That's what I've done. I have *unhinged* them. Do you understand? My calculators, for instance, now make mistakes. They no longer invariably give the accurate answer. Do you follow? They go wrong. They only occasionally produce a correct solution.'

This announcement was greeted by a long contemptuous silence. Then the Board thought it over and asked to see the prototypes. Professor Fontaine produced them. He first of all showed his calculating machines which gave wrong results. At this sight the more sensitive directors experienced an incipient pang of emotion.

But the enthusiasm grew general and turned to delirium

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when the scientist exhibited his other models, which he had built according to the same principle. So much so that when he had revealed the prodigiously 'human' characteristics with which they had been endowed, the Board, ashamed of ever having doubted him, apologized profusely to Professor Fontaine and unanimously voted the necessary funds for the mass production of the perfect robots.

The mathematician went astray in a maze of contradictions and only exceptionally arrived at an answer. The chess player lost most of the games it played. The robots in love confused the sexes. The evolutive species oscillated between incoherent states, so that it was impossible to tell if they tended towards Good or Evil.

As for the electronic writer, Professor Fontaine had merely had to do away with its primary truth mechanism, its sense selector, for it to produce to its heart's content such sentences as 'The fluid sheep flies under the pointed sky' or 'The white sheep eats veal', manifestations to which the fiercest detractors were obliged to yield, acknowledging at last the appearance of the final human characteristics that were still lacking: an artistic sense and a sense of humour.