“AI” – 인공지능의 과거와 미래 I

('AI' - Next Strategy in the Era of AI)

앨런 튜링 (1912~1954)
– 디지털기반의 인공지능의 개념을 제시하다-

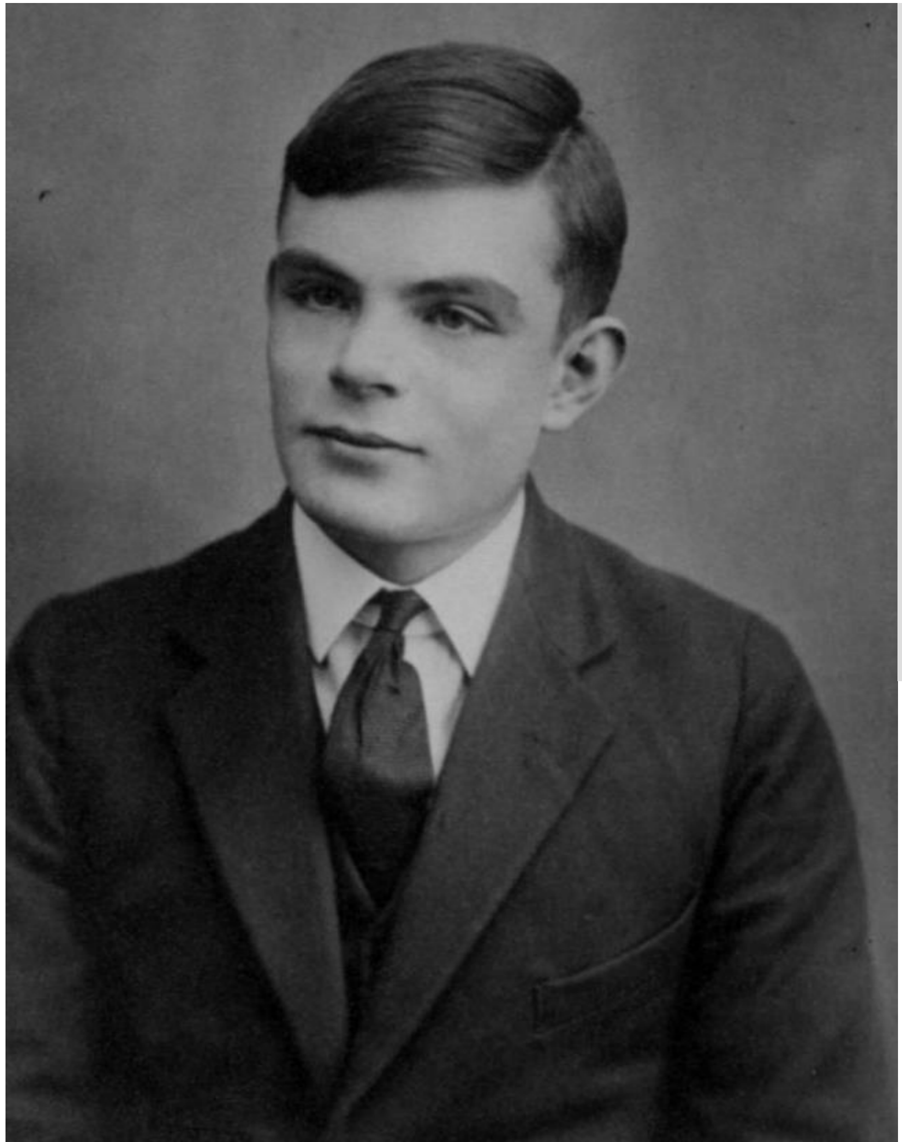
2016.05.05

Jason, Min

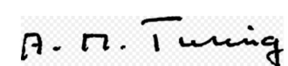
새로운 한국을 위한, 미래 정책 연구원 (FPRI for NeoHan)

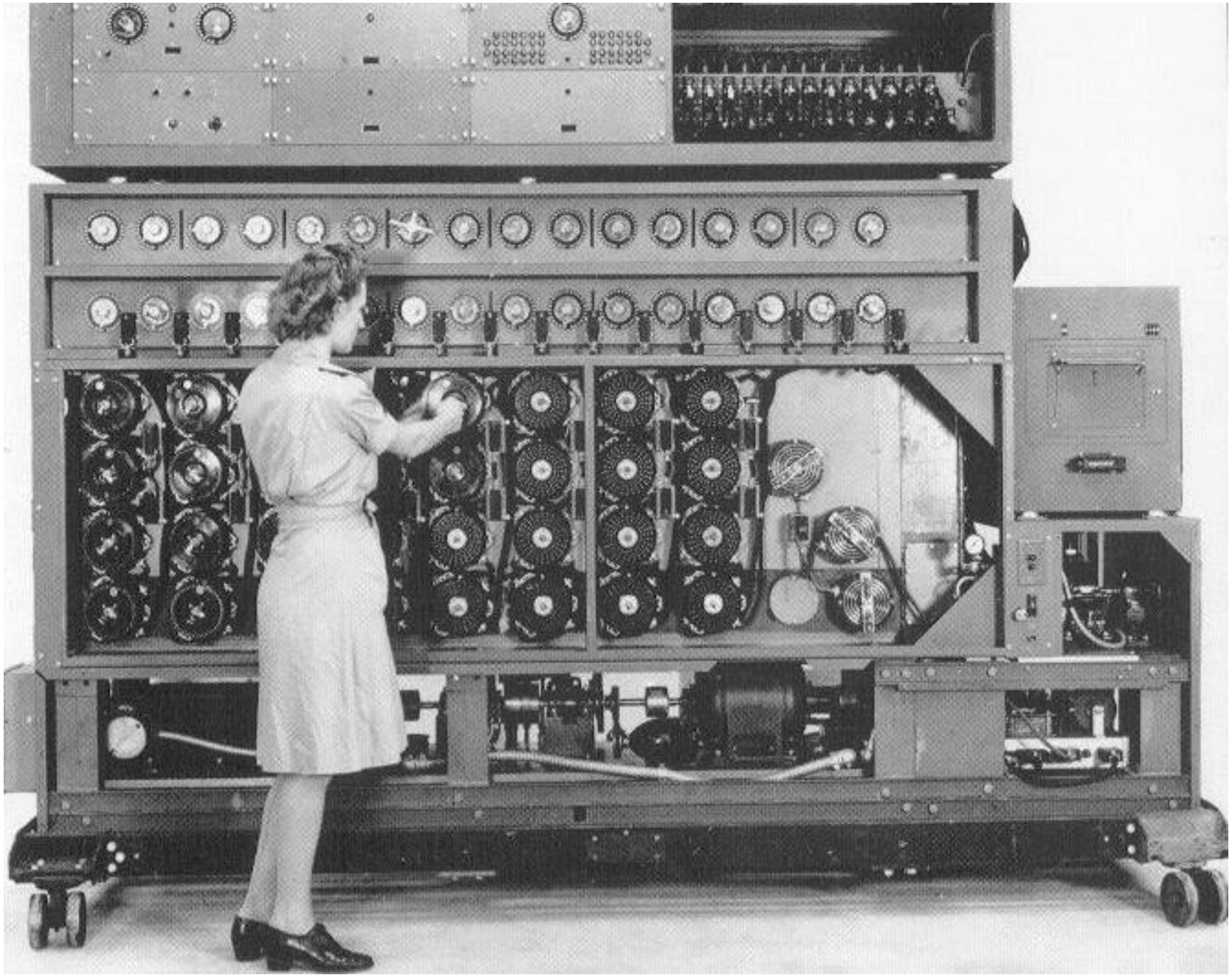
앨런 튜링(1912~1954)

- **1912년 6월 23일**
  영국 런던에서 출생
- **1926년**
  셔본에 있는 퍼블릭 스쿨에 입학
- **1931년**
  영국 케임브리지대 킹스칼리지에 입학해
  수학을 공부하기 시작
- **1934년**
  평균 이상의 성적으로 수학사 학위 취득
- **1935년**
  킹스칼리지의 특별연구원이 됨
- **1936년**
  힐베르트가 제시한 '결정 문제'의 부정적 결과
  증명. 미국 프린스턴대로 공부하러 떠남
- **1938년**
  프린스턴대에서 박사 학위 취득
- **1939년**
  제2차 세계대전 발발
  블레칠리 파크의 암호해독부서에 들어감
- **1941년**
  동료인 조앤 클라크에게 청혼함
  그러나 곧 동성애자임을 밝히고 약혼을 파기



- **1943년**
  미국 벨 연구소에서 음성 해독 문제를 연구
- **1945년**
  제2차 세계대전 종전
  영국 국립물리연구소에 들어감
- **1947년**
  케임브리지대로 돌아와 잠시 머묾
- **1948년**
  영국 맨체스터대의 정보과학팀에 들어감
- **1950년**
  논문 '계산하는 기계와 지성' 발표
- **1951년**
  왕립학회의 특별 회원으로 선출
  동성애 혐의로 재판을 받음
- **1954년 6월 7일**
  청산가리 중독으로 세상을 떠남





Bombe (**Breaking the Enigma cipher**)

A. M. Turing (1950) Computing Machinery and Intelligence. *Mind 49:* 433-460.

COMPUTING MACHINERY AND INTELLIGENCE

By A. M. Turing

1. The Imitation Game

I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think." The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous, If the meaning of the words "machine" and "think" are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, "Can machines think?" is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

The new form of the problem can be described in terms of a game which we call the 'imitation game." It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart front the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either "X is A and Y is B" or "X is B and Y is A." The interrogator is allowed to put questions to A and B thus:

계산기계와 지능 1950

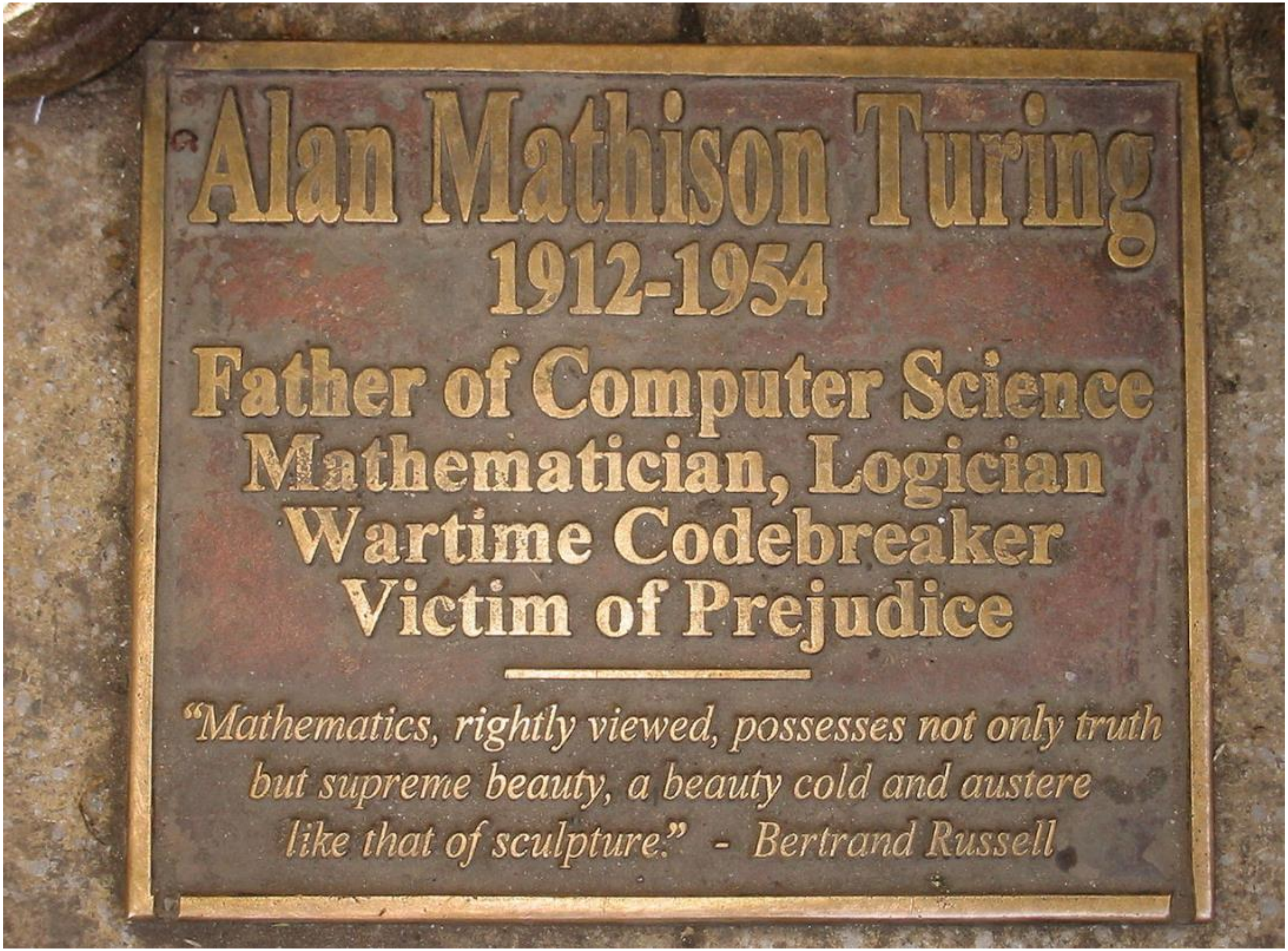
앨런 튜링(1912~1954)

기계는 생각할 수 있을까?

...

학습 가능한 기계.. 기계가 지적인 분야에서 사람과 경쟁하기 바란다.

앞으로 할일이 많이 있음을 알 수 있다.


Alan Mathison Turing
1912-1954
Father of Computer Science
Mathematician, Logician
Wartime Codebreaker
Victim of Prejudice
"Mathematics, rightly viewed, possesses not only truth
but supreme beauty, a beauty cold and austere
like that of sculpture." - Bertrand Russell

A. M. Turing (1950) Computing Machinery and Intelligence. *Mind 49:* 433-460.

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C: Will X please tell me the length of his or her hair?

Now suppose X is actually A, then A must answer. It is A's object in the game to try and cause C to make the wrong identification. His answer might therefore be:

"My hair is shingled, and the longest strands are about nine inches long."

In order that tones of voice may not help the interrogator the answers should be written, or better still, typewritten. The ideal arrangement is to have a teleprinter communicating between the two rooms. Alternatively the question and answers can be repeated by an intermediary. The object of the game for the third player (B) is to help the interrogator. The best strategy for her is probably to give truthful answers. She can add such things as "I am the woman, don't listen to him!" to her answers, but it will avail nothing as the man can make similar remarks.

We now ask the question, "What will happen when a machine takes the part of A in this game?" Will the interrogator decide wrongly as often when the game is played like this as he does when the game is played between a man and a woman? These questions replace our original, "Can machines think?"

계산 기계와 지능

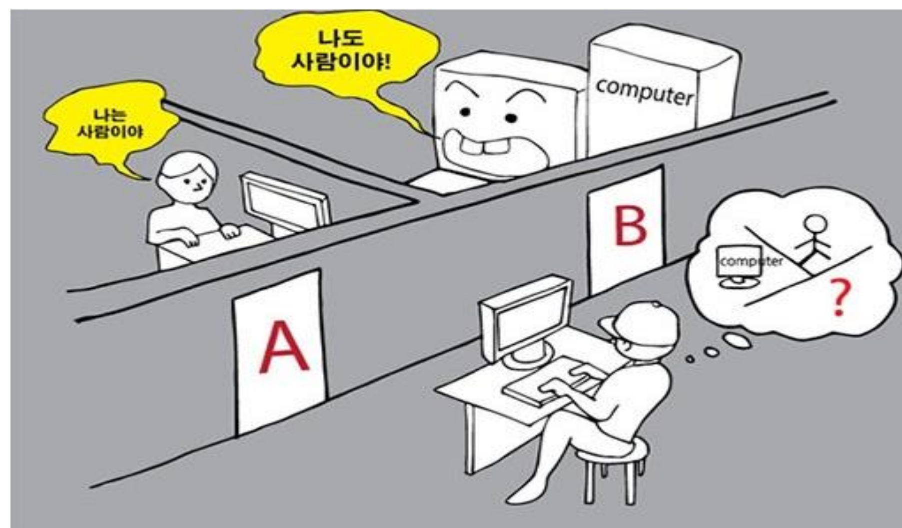
Allan Turing (앨런 튜링, 1950)

기계는 생각할 수 있을까?

"기계가 정신을 갖추기 위한 필요 충분 조건을 처음으로 형식화 하였음. 튜링은 기계가 **자기 학습성(Self-Learnability)**을 가지고 있다면 인간과 동일하게 지능을 가지고 있다고 보았음"

…

"학습 가능한 기계.. 기계가 지적인 분야에서 사람과 경쟁하기 바란다." – Paper 내용 중 일부



http://kimtaeyeon.co.kr/siteagent/100.daum.net/encyclopedia/view/81XXXXXXXX73 computer (as A) and the interrogator would be unable to distinguish them. Of course the digital computer must have an adequate storage capacity as well as working sufficiently fast. Moreover, it must be programmed afresh for each new machine which it is desired to mimic.

This special property of digital computers, that they can mimic any discrete-state machine, is described by saying that they are universal machines. The existence of machines with this property has the important consequence that, considerations of speed apart, it is unnecessary to design various new machines to do various computing processes. They can all be done with one digital computer, suitably programmed for each case. It 'ill be seen that as a consequence of this all digital computers are in a sense equivalent.

We may now consider again the point raised at the end of §3. It was suggested tentatively that the question, "Can machines think?" should be replaced by "Are there imaginable digital computers which would do well in the imitation game?" If we wish we can make this superficially more general and ask "Are there discrete-state machines which would do well?" But in view of the universality property we see that either of these questions is equivalent to this, "Let us fix our attention on one particular digital computer C. Is it true that by modifying this computer to have an adequate storage, suitably increasing its speed of action, and providing it with an appropriate programme, C can be made to play satisfactorily the part of A in the imitation game, the part of B being taken by a man?"

6. Contrary Views on the Main Question

We may now consider the ground to have been cleared and we are ready to proceed to the debate on our question, "Can machines think?" and the variant of it quoted at the end of the last section. We cannot altogether abandon the original form of the problem, for opinions will differ as to the appropriateness of the substitution and we must at least listen to what has to be said in this connexion.

It will simplify matters for the reader if I explain first my own beliefs in the matter. Consider first the more accurate form of the question. I believe that in about fifty years' time it will be possible, to programme computers, with a storage capacity of about 109, to make them play the imitation game so well that an average interrogator will not have more than 70 per cent chance of making the right identification after five minutes of questioning. The original question, "Can machines think?" I believe to be too meaningless to deserve discussion. Nevertheless I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted. I believe further that no useful purpose is served by concealing these beliefs. The popular view that scientists proceed inexorably from well-established fact to well-established fact, never being influenced by any improved conjecture, is quite mistaken. Provided it is made clear which are proved facts and which are conjectures, no harm can result. Conjectures are of great importance since they suggest useful lines of research.

"기계가 생각할 수 있을까?"라는 물음은 "인간이 상상할 수 있는 컴퓨터 중에서 모방게임을 잘 할 수 있는 디지털 컴퓨터가 존재하는가?"

JUNE 9, 2014

What Comes After the Turing Test?

BY GARY MARCUS

> Marcus: Do you read *The New Yorker*?
>
> Goostman: I read a lot of books … So many—I don’t even remember which ones.
>
> Marcus: You remind me of Sarah Palin.
>
> Goostman: If I’m not mistaken, Sarah is a robot, just as many other “people.” We must destroy the plans of these talking trash cans!

Over the weekend, the ne
called “Eugene Goostman
thirteen-year-old Ukrania
the-Turing-Test. Kevin Wa
University of Reading, wh
Artificial Intelligence ther
the Turing Test, when a computer convinces a sufficient number of interrogators into believing that it is not a machine but rather is a human.” Warwick went on to call Goostman’s victory “ a milestone” that “would go down in history as one of the most exciting” moments in the field of artificial intelligence.

2014년, 앨런 튜링의 기일인 6월 7일에 영국의 런던 왕립학회가 ‘튜링테스트2014’라는 행사를 진행했다. 이 행사에서 영국 레딩 대학교(University of Reading)의 유진 구스트만(Eugene Goostman)이라는 인공지능이 처음으로 64년 전에 소개된 튜링 테스트를 통과했다. 유진 구스트만은 우크라이나에 살고 있는 13세 소년이라는 배경을 가지고 있는 인공지능이다. 해당 행사에서 유진 구스트만과 5분 간의 대화를 나눈 심사위원들 중 33%이상이 유진 구스트만은 진짜 사람이라는 확신을 주었고 튜링 테스트의 기준을 통과했다.

레딩 대학교에서 진행한 튜링 테스트의 실험 방법은 다음과 같다. 30명의 심사위원은 각각 5분씩 인공지능인 유진 구스트만과 한번 사람과 한번 대화를 나눈다. 그 후, 더 자연스럽고 ‘사람’스러웠는지를 판단한다. 그 결과, 30명 중 10명의 심사위원은 유진 구스트만이 더 사람다웠다고 판단했다

7. Learning Machines

Learning Machines(학습 가능한 기계) 표현 사용

The reader will have anticipated that I have no very convincing arguments of a positive nature to support my views. If I had I should not have taken such pains to point out the fallacies in contrary views. Such evidence as I have I shall now give.

Let us return for a moment to Lady Lovelace's objection, which stated that the machine can only do what we tell it to do. One could say that a man can "inject" an idea into the machine, and that it will respond to a certain extent and then drop into quiescence, like a piano string struck by a hammer. Another simile would be an atomic pile of less than critical size: an injected idea is to correspond to a neutron entering the pile from without. Each such neutron will cause a certain disturbance which eventually dies away. If, however, the size of the pile is sufficiently increased, tire disturbance caused by such an incoming neutron will very likely go on and on increasing until the whole pile is destroyed. Is there a corresponding phenomenon for minds, and is there one for machines? There does seem to be one for the human mind. The majority of them seem to be "subcritical," i.e., to correspond in this analogy to piles of subcritical size. An idea presented to such a mind will on average give rise to less than one idea in reply. A smallish proportion are supercritical. An idea presented to such a mind that may give rise to a whole "theory" consisting of secondary, tertiary and more remote ideas. Animals minds seem to be very definitely subcritical. Adhering to this analogy we ask, "Can a machine be made to be supercritical?"

The "skin-of-an-onion" analogy is also helpful. In considering the functions of the mind or the brain we find certain operations which we can explain in purely mechanical terms. This we say does not correspond to the real mind: it is a sort of skin which we must strip off if we are to find the real mind. But then in what remains we find a further skin to be stripped off, and so on. Proceeding in this way do we ever come to the "real" mind, or do we eventually come to the skin which has nothing in it? In the latter case the whole mind is mechanical. (It would not be a discrete-state machine however. We have discussed this.)

These last two paragraphs do not claim to be convincing arguments. They should rather be described as "recitations tending to produce belief."

The only really satisfactory support that can be given for the view expressed at the beginning of §6, will be that provided by waiting for the end of the century and then doing the experiment described. But what can we say in the meantime? What steps should be taken now if the experiment is to be successful?

새로운 한국을 위한, 미래 정책 연구원 (FPRI for NeoHan)

of speed arising in many ways, Our problem then is to find out how to programme these machines to play the game. At my present rate of working I produce about a thousand digits of progratiirne a day, so that about sixty workers, working steadily through the fifty years might accomplish the job, if nothing went into the wastepaper basket. Some more expeditious method seems desirable.

In the process of trying to imitate an adult human mind we are bound to think a good deal about the process which has brought it to the state that it is in. We may notice three components.

(a) The initial state of the mind, say at birth,

(b) The education to which it has been subjected,

(c) Other experience, not to be described as education, to which it has been subjected.

태어났을때 정신의 초기상태
받아온 교육
살아가면서 겪은 경험(교육이 아닌)

Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child's? If this were then subjected to an appropriate course of education one would obtain the adult brain. Presumably the child brain is something like a notebook as one buys it from the stationer's. Rather little mechanism, and lots of blank sheets. (Mechanism and writing are from our point of view almost synonymous.) Our hope is that there is so little mechanism in the child brain that something like it can be easily programmed. The amount of work in the education we can assume, as a first approximation, to be much the same as for the human child.

어른의 정신을 모방하는 프로그램을 만드는 대신 아이의 정신을 흉내내는 프로그램을 만드는것은 어떨까?

(대국 가능한 알파고 상태를 만드는 것 대신 기보를 학습하기 이전의 상태에 주목할 필요 => 개인화된 인공지능-아이-을 얻을 수 있음)

We have thus divided our problem into two parts. The child programme and the education process. These two remain very closely connected. We cannot expect to find a good child machine at the first attempt. One must experiment with teaching one such machine and see how well it learns. One can then try another and see if it is better or worse. There is an obvious connection between this process and evolution, by the identifications

Structure of the child machine = hereditary material

Changes of the child machine = mutation,

Natural selection = judgment of the experimenter

아이기계의 구조 = 유전적 요소
아이기계의 변화 = 돌연변이
자연선택 = 실험자의 판단

알파고의 하드웨어 및 기본 머신러닝(S/W) 조건

(기보를 통한 - 교육)
기본학습

(알파고 끼리 대국을 통한 경험)
강화학습

One may hope, however, that this process will be more expeditious than evolution. The survival of the fittest is a slow method for measuring advantages. The experimenter, by the exercise of intelligence, should he able to speed it up. Equally important is the fact that he is not restricted to random mutations. If he can trace a cause for some weakness he can probably think of the kind of mutation which will improve it.

It will not be possible to apply exactly the same teaching process to the machine as to a normal child. It will not, for instance, be provided with legs, so that it could not be asked

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It is probably wise to include a random element in a learning machine. A random element is rather useful when we are searching for a solution of some problem. Suppose for instance we wanted to find a number between 50 and 200 which was equal to the square of the sum of its digits, we might start at 51 then try 52 and go on until we got a number that worked. Alternatively we might choose numbers at random until we got a good one. This method has the advantage that it is unnecessary to keep track of the values that have been tried, but the disadvantage that one may try the same one twice, but this is not very important if there are several solutions. The systematic method has the disadvantage that there may be an enormous block without any solutions in the region which has to be investigated first, Now the learning process may be regarded as a search for a form of behaviour which will satisfy the teacher (or some other criterion). Since there is probably a very large number of satisfactory solutions the random method seems to be better than the systematic. It should be noticed that it is used in the analogous process of evolution. But there the systematic method is not possible. How could one keep track of the different genetical combinations that had been tried, so as to avoid trying them again?

We may hope that machines will eventually compete with men in all purely intellectual fields. But which are the best ones to start with? Even this is a difficult decision. Many people think that a very abstract activity, like the playing of chess, would be best. It can also be maintained that it is best to provide the machine with the best sense organs that money can buy, and then teach it to understand and speak English. This process could follow the normal teaching of a child. Things would be pointed out and named, etc. Again I do not know what the right answer is, but I think both approaches should be tried.

We can only see a short distance ahead, but we can see plenty there that needs to be done.

궁극적으로 우리는 기계가 순수하게 지적인 분야에서 사람과 경쟁하기를 바란다. 그러나 어디서부터 시작하면 가장 좋을까? 이것조차도 어려운 결정이다.

A. 많은 사람들은 체스 두는 것과 같은 매우 추상적인 활동이 가장 좋을 것이라고 생각한다.

또한

B . 기계에게 돈으로 살 수 있는, 가장 좋은 감각기관을 준 다음, 기계가 영어를 이해하고 말하도록 가르치는 것이 가장 좋다고 주장할 것이다. 이 방법은 사물들을 지적하고 이름 붙이는 등등의 정상적인 아이를 가르치는 과정 다음에 올 수 있다.

다시 말하건대, 나는 무엇이 옳은 답인지 알지 못한다. 그래서
이 두 방법 모두 시도되어야 한다.

우리는 단지 눈앞에 있는 짧은 거리만 볼 수 있다. 그러나 앞으로 할 일이 많이 있음을 알 수 있다.

새로운 한국을 위한, 미래 정책 연구원 (FPRI for NeoHan)

"네가 인간의 삶을 모방한 기계에 불과 한지, 살아 있는 존재인지 어떻게 구분할 수 있을까?"

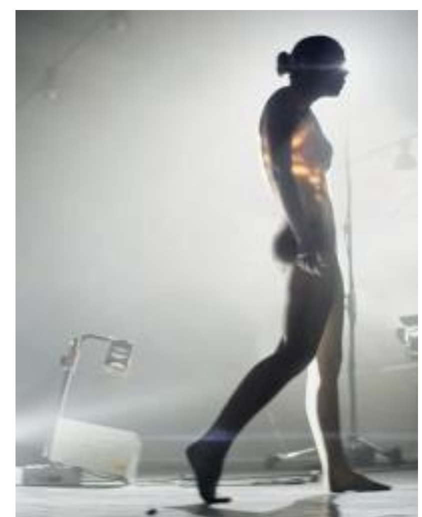
"뭘 보고 내가 그들과 다른, 단지 똑똑한 기계라고 판단하게 만들죠?"

"그들은 인간이야. 그들은 살아있다고!"

"그런데 그걸 어떻게 알 수 있죠? 당신은 그들의 생각을 알 수 없잖아요.
만약 그들과 접촉(소통)할 수 없다면, 그들과 나 사이에 차이점이 뭘까요?"

디지털 문명의 주체는 현인류가 아니다

기계인간 문명세계에서 기존 인간은 과거 종족으로서 자연도태 될 것



"만약 당신이 미래를 꿈꾸지 않거나 지금 기술개선을 위해 노력하지 않는다면 그건 곧 낙오되고 있는 것이나 마찬가지 입니다."

그윈 쇼트웰(Gwynne Shtwell, SpaceX CEO, COO)

감사합니다

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