

THE AGE OF ARTIFICIAL INTELLIGENCE

AN EXPLORATION

Edited by

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Cognitive Science and Psychology



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LIST OF ACRONYMS

ACM = Agent cognitive model

ADM = Agent dialogue model

AGI = Artificial General Intelligence

AI = Artificial Intelligence

AIML = Artificial intelligence markup language

AISE = Artificial intelligence safety engineering

ALAMO = Atelier de Littérature Assistée par la Mathématique et les Ordinateurs

ALICE = Artificial linguistic internet computer entity

APMA = Amino-3-hydroxy-5-methyl-4-isoxazole propionic acid

AKM = Agent knowledge model

A.R.T.A = Atelier de Recherches et Techniques Avancées

BCI = Brain-computer interfaces

BDI = Belief–desire–intention model

BNC = British national corpus

BSC = Bodily self-consciousness

CSs = Constructional schemes

CD = Compact disc

CERN = European organization for nuclear research

CEV = Coherent extrapolated volition

CGs = Conceptual graphs

CL = Computational linguistics

CNS = Central nervous system

COGUI = Conceptual graphs user interface

CP = Cognitive phenomenology

CREB = cAMP response element-binding protein

CRISPR = Clustered regularly interspaced short palindromic repeats

CS = Computational structures

CSA = Conversational software agent

DARPA = Defense advanced research projects agency
DDD = Distributed, decentralized, and democratic
DLT = Distributed ledger technology
DM = Discourse management
DNA = deoxyribonucleic acid
DIY = Do it yourself
DRM = Digital rights management
DRT = Discourse representation theory
ELO = Electronic literature organization
EMI = Experiments in musical intelligence
EQ = Embodiment question
FAI = Friendly artificial intelligence
FEP = Free-energy principle
FOOM = Recursively self-improving artificial intelligence engendered singularity
FOS = Free and open source
GANs = Generative adversarial networks
GM = Grand masters (of chess)
GOFAI = Good old-fashioned artificial intelligence
GPS = Global positioning system
HIS = Hazardous intelligent software
HOT = higher-order thought theory of consciousness
HS = Hazardous software
IBM = International business machines
IEEE = Institute of electrical and electronics engineers
IQ = Intelligence quotient
IoT = Internet of things
KL = Kullback-Leiber
KR = Knowledge representation
LS = Logical structure
LSc = Layered structure of the clause
LSDB = Liveset database

MAI = Malevolent artificial intelligence
MEG = Magnetoencephalography
MIRI = Machine intelligence research institute
MS = Mental states
MT = Machine translation
MW = Musical work
NL = Natural language
NLP = Natural language processing
NLU = Natural-language understanding
NGO = Non-governmental organization
NOC = Non-ordinary consciousness
NCC = Neural correlates of consciousness
NSA = National security agency
OR = Ockham's razor
Orch-OR = Orchestrated objective reduction
PCR = Polymerase chain reaction
PHEN = Phenomenological independence implies metaphysical independence
POS = Part-of-speech
QHOT = Quotational higher-order thought theory of consciousness
R&D = Research and development
RDF = Resource description framework
RNA = Ribonucleic acid
RRG = Role and reference grammar
SA = Simulation argument
SAC = Speech act constructions
SAT = Speech act theory
SH = Simulation hypothesis
SP = Sensory processing
STAGE = Science, technology and governance in europe
TOC = Theatre of consciousness
TOTE = Test-operate-test-exit

TREC = Text retrieval conferences

TT = Turing test

WSD = Word sense disambiguation

XML = Extensible markup language

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INTRODUCTION

“Computers are useless because they can only give you answers”
(Pablo Picasso)¹

"Chess... is eminently and emphatically the philosopher's game"
(Paul Morphy)²

On May 11th, 1997, in the emblematic city of New York, on the 9th floor of the Equitable Center, a major event happened that can be considered as one of the most decisive moments for humanity:³

1.e4 c6 2.d4 d5 3.Cc3 dxe4 4.Cxe4 Cd7 5.Cg5 Cgf6 6.Ad3 e6 7.C1f3 h6
8.Cxe6 De7 9.O-O fxe6 10.Ag6+ Rd8 11.Af4 b5 12.a4 Ab7 13.Te1 Cd5
14.Ag3 Rc8 15.axb5 cxb5 16.Dd3 Ac6 17.Af5 exf5 18.Txe7 Axe7 19.c4 1-0.

If you don't know the history of some of the most famous chess games, you will not immediately recognize this sequence. But if you do, you will notice that this is the sum-up of all the 19 moves made in the sixth game of the second match between Garry Kasparov (one of the most brilliant chess players in the world - alongside M. Carlsen, B. Fisher, V. Anand, A. Karpov and P. Morphy) and the computer created by International Business Machines (IBM) named DeepBlue. In the 8th move, after Kasparov played h6 – something he would regret later – DeepBlue decided to sacrifice a knight for a pawn, playing e6, something that Kasparov would never have expected.

What happened next was the pure dominance of the computer, forcing Kasparov to resign on the 19th move and to lose the match.⁴ Kasparov would

¹ Different versions of this are cited in William Fifield's original interview with Picasso, "Pablo Picasso: A Composite Interview," published in the *Paris Review* 32, Summer–Fall 1964 and in Fifield's 1982 book *Search of Genius*, New York: William Morrow.

² As quoted in *Testimonials to Paul Morphy*, Presented at University Hall, New York, May 25, 1859 (cf. <https://play.google.com/books/reader?id=aEZAAAAAYAAJ>).

³ *Time* magazine had claimed something similar regarding the first game of the first match between Kasparov and DeepBlue in 1996. Kasparov had lost the first game (although he would end up winning the match): the first-game defeat was more than "world historical. It was species-defining".

⁴ The match was composed by six games and the result after the first five games was a tie, 2½–2½. The match's result was, after the win of DeepBlue in the sixth and last game, 3½–2½.

never have played h6 against a human opponent, nevertheless, since he was playing against a computer, he chose that move: “I didn't want to play. I was sorry about my decision to play h6. Normally computers don't take on e6”.

Although DeepBlue was built with 256 co-processors capable of calculating approximately 200 million positions per second, for Kasparov, the reason for his loss was simple: no computer would use a tactical move such as sacrificing a knight so early in the game. At the time, there were some suspicions that the research team behind the development of DeepBlue was being helped (live in action) by Grand Masters (GM), namely, Bobby Fisher.

In the late eighteenth century, there was a famous chess-playing mechanical automaton called “the Turk⁵”. It was an engraved figure made of wood that could move its pieces and it could play a competent chess game. The “Turk” was branded as the very first artificial system. Touring through America and Europe, it played against professional players, including renowned historical celebrities such as Napoleon Bonaparte and Benjamin Franklin, who were themselves chess aficionados. Of course, this was a hoax, an elaborate, but nevertheless, a fake artificial system with a person cleverly hidden inside the wood structure playing all the moves (cf. Kasparov, 2017: 7).

IBM had one purpose only: to prove that they could build a machine that could defeat the best chess player in the world, the reigning champion. The team responsible for the development of DeepBlue was composed by Murray Campbell (IBM, Thomas J. Watson Research Center), Joel Benjamin (Chess GM and consultant), Feng-hiung Hsu (who started developing DeepBlue while he was at Carnegie Mellon University), Thomas Anantharaman as well as a few others, all managed by Chung-Jen Tan, who was known as the spokesman and the “resident philosopher” of the team.

Kasparov had won the first match against DeepBlue in the previous year, 15 months prior in Philadelphia - this was the second one. The preparation for this second match was difficult because he couldn't study previous games played by DeepBlue since there were none: he had to play against a black box without any chance of studying and analyzing previous games made by the computer. Worse than that, there was a clause in the contract for the second match that Kasparov completely overlooked: the machine could be rebooted during or after each game. This would make the post-analysis of its games impossible, therefore, eliminating any chances of studying specific games or to recognize any patterns in DeepBlue's approach to chess.

⁵ The machine was nicknamed the Turk because it played its moves through a turbaned marionette attached to a cabinet (cf. Campbell, 1997: 83).

Newsweek's cover called this match “The Brain’s Last Stand”. The match was covered in all newspapers and broadcasted live on television: the world was seeing firsthand that artificial machines could potentially surpass a game in which human beings had excelled for centuries. After this first conquest, Artificial Intelligence research focused on building computers that could defeat humans in other more complex games, like Go (with AlphaGo), Scrabble (with Quackle) or Jeopardy (with Watson). The artificial system won in every one of these games.

The 1997 match was announced as Kasparov representing Humanity versus the Machine. If he lost the match, then everything could be achievable for AI: it would officially give rise to the “Age of Artificial Intelligence”. For contemporary science, chess was seen as the ultimate test of intelligence. In cinema, there are also many chess references along these lines: for example, in Stanley Kubrick’s *2001: a Space Odyssey*, there is a scene where the computer HAL9000 plays a chess game against Frank Poole - the game is an actual recreation of a tournament game from 1913 between A. Roesch and W. Schlage (cf. Campbell, 1997: 79).

It’s very interesting to notice that the birth of Computer Science and AI is associated with the first reflections and thoughts about creating a machine that could play chess. One of the first discussions happens in Charles Babbage’s *The Life of a Philosopher* (1845). In 1945, one century later, Konrad Zuse describes a program that could generate legal moves in chess. Claude Shannon, founder of information theory, wrote a paper titled “A Chess-Playing Machine” (1950) where he describes two main approaches in building a competent chess-program: Type A was about creating a program based on brute-force, that is, a program that could analyze and calculate in seconds all the millions of potential positions for a specific move; and Type B, a program that would have a strategic and goal-focused approach, more like humans’ beings play chess. Shannon believed that the Type B approaches would be more successful in beating a human, but it was eventually the Type A approach which won the race, culminating in the development of DeepBlue.

Alan Turing also thought about whether an artificial system that could play chess, called “Turochamp”, famously known as the “Turing’s paper machine”. The program, created in 1952,⁶ was written with his colleague David Champernowne and was composed by a specific set of instructions. The only problem is that there were no digital computers in that time, so Turing wrote

⁶ See the original publication here: see <https://en.chessbase.com/post/reconstructing-turing-s-paper-machine>).

the program by hand - it was later recreated in an actual computer, where it turned out to not be a very competent chess player.

In 1950, one of the founders of Artificial Intelligence, Herbert Simon, stated it would only take 10 years for a machine to become the world champion of chess – he was just mistaken by 30 years (cf. Campbell, 1997: 83-85).

In 1956, John McCarthy, owing to Alexander Kronrod, described chess as the “drosophila of Artificial Intelligence” (cf. McCarthy, 1990). Like the common fruit fly, which juxtaposed to more complex organic systems, its research is quite “simple” to do. Nevertheless, it can produce significant knowledge about further complex systems. Just as at its base, chess is a “simple” game, and therefore, it can teach us an ample amount about human cognition and intelligence (cf. Ensmenger, 2012).

As we can see, there was a great, almost obsessive focus on chess in the first days of AI research because it was believed that chess was the ultimate pinnacle of human intelligence. Nowadays, this seems, a tiny bit exaggerated. At present, Artificial Intelligence is focused on what is called “weak AI”: it excels at very specific tasks – like playing games, facial recognition or driverless cars – but it is not even close to achieving human-level intelligence. The reason is quite simple: Artificial Intelligence’s research methods are more about imitating human performances – the Turing Test is a very good example of this idea – than to look for its own achievements and goals.

Consequently, all the tasks we can describe and codify can be outperformed by machines. But the real achievement of a fully conscious machine seems far still. Because we do not know anything about consciousness, Artificial Intelligence conceived as “strong AI”, that is, a conscious A.I., may never be fully achieved. For that, we need the right theoretical framework – we need better and more philosophical research.

The book is divided into five main sections. Section I is dedicated to reflections on the Intelligence of AI and will open with a chapter by Soenke Ziesche and Roman V. Yampolskiy, which discuss the mathematics of intelligence for grouped minds, nested minds as well as deducted minds. The following chapter, by Stevan Harnad, debates if the existence of feelings is a real caveat for a system that would pass the Turing’s Test. Next, Daniel Dennett argues against the mysterianism position that we cannot study our conscious mind and explain why AI, although theoretically possible to be achieved, may never be practically accomplished because of its costs and the lack of epistemic advantages of such an achievement. Finally, closing Section I, David Pearce discusses three different ways to connect human and artificial intelligence: by fusion, replacement or co-evolution, arguing that only the third process may be plausible.

Section II follows, dedicated to discussion on the relationship between consciousness, simulation and artificial intelligence. Gabriel Axel Montes and Ben Goertzel present the concept of a ‘mindplex’ as a way of enhancing the connection between human and artificial minds; for which, they use the concept of non-ordinary consciousness (NOC) and show how that perspective can be relevant for understanding the mind and cognition in general. Cody Turner follows offering two arguments in favor of the thesis that a phenomenology of cognition is neither reducible to, nor dependent upon, sensory phenomenology. If this thesis is plausible, then it follows that AI consciousness may not require embodiment to be emulated, as commonly assumed. The next chapter by Nicole Hall argues that aesthetic experience is a fundamental feature of human consciousness and separates human from artificial intelligence. She argues further that it is a mistake to confuse the mere possibility of achieving “conscious singularity”, as she defines it, with human consciousness and its capacity for aesthetically experiencing natural environments. To conclude Section II, Steven S. Gouveia introduces an intriguing idea that we may be living in a computer simulation, briefly debating the main reasons in favor and against this hypothesis.

Section III, dedicated to aesthetical creativity and language in artificial intelligence, opens with a chapter by Caterina Moruzzi where in the light of recent developments in AI music software generators discusses the question, “Can a computer create a musical work?” On the same topic, René Mogensen proposes a formal representation of content in computational creativity of music, noting that in order to achieve complete computational music creativity, aesthetic experience appears to be necessary. Mariana Chinellato Ferreira follows, applying the same discussion about aesthetical creativity in computer-generated literature, analyzing specific software such as PoeTryMe. Closing Section III, Kulvinder Panesar presents a functional linguistic perspective on natural language processing in artificial intelligence.

The subsequent Section IV is on the Ethics of the Bionic Brain Peter A. DePergola II opens by offering the argument that neurocognitive enhancement can be justified as morally plausible if it (a) promotes general moral character, (b) complements human nature and (c) effects a deeper sense of individual and social identity. Next, Tomislav Miletić and Frederic Gilbert discuss the potential harms of brain-computer interfaces (BCI) on self-determination, warning that any patient who accepts the use of such future AI medical technology should be sufficiently prepared for the symbiotic relation before the implementation. Following on the same topic of the ethics of BCI, Aníbal M. Astobiza, Txetxu Ausin, Ricardo M. Ferrer and Stephen Rainey focus on some issues raised by BCI research, identifying some dangers, challenges and opportunities for the elaboration of a common ethical and legal framework concerning issues of

safety, ethics and data protection. To conclude Section IV, Natasha Vita-More argues that Artificial General Intelligence (AGI) can be used as a tool to improve our knowledge about ourselves and the world.

Finally, to close the book, Section V follows on the Ethics of Artificial Intelligence, starting with a chapter by Federico Pistono and Roman V. Yampolskiy that provides some general guidelines for the creation of a Malevolent Artificial Intelligence (MAI) with the goal of challenging the AI Safety Community to continue its effort by discovering and reporting specific problems. Following, Hasse Hämäläinen attempts to find the most plausible answer to the question of whether a machine could be attributed moral and legal rights and obligations, arguing that if a machine can perform a specific task or set of capacities as human beings do, then the rights and obligations of humans should also be applied to machines. The next chapter by Vernon Vinge discusses the ethical implications of the Singularity, offering a set of ethical guidelines to avoid the extinction of human race. Finally, to conclude both Section V and the book, Eray Özkural discusses the ethical and epistemological implications of the Free Energy Principle: the idea that a self-organization occurs through minimization of free energy.

The Age of Artificial Intelligence is imminent, if it's not already here. We should make sure that we invest in the right people and the right ideas in order to create the best solutions possible. My hope is that this book will help to influence the right minds. If Reason killed god in the 20th and 21st century, Reason – philosophy, science and technology – may resurrect it in form of an Artificial General Intelligence: an AI that may know everything about anything. We should make sure that we create the right kind of god and that we keep it in the right hands.

I would like to finish this introduction by deeply thanking all the people who made this project feasible.⁷

Steven S. Gouveia
Ottawa, 10/09/2019

⁷ I would like to acknowledge the precious help offered by Jessica Clarke and, to Susan Schneider for her valuable feedback.

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research questions: 'How does the development of computer-generated music affect the ontology of musical works?' and 'Do we deem computer-generated music as creative as human-generated music? If not, why?'. The scope of this research is to fill the existing gap in the literature in regard to the impact that cutting-edge developments in AI have on aesthetic and ontological debates on music and art.

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