

## **Made-Up Minds: A Constructivist Approach to Artificial Intelligence**

by Gary L. Drescher. The MIT Press, Cambridge (1991). ISBN 0-262-04120-0

Reviewed by Marco C. Bettoni, Basel Institute of Technology, CIM Zentrum Muttensz, Switzerland

*L'intelligence organise le monde  
en s'organisant elle-même  
Jean Piaget, 1937*

### **1. Introduction**

Two of the main goals of Artificial Intelligence, a) understanding human cognition and b) building computer systems that perform as well as humans in tasks requiring intelligence, can be mutually supportive. For instance, an engineer who wants to enable a computer at performing tasks requiring intelligence may be aided in this aim by a viable model of human intelligence. And a researcher who wants to develop a viable model of human intelligence may use experiments with an artificial realisation of her model as a source of ideas for verifying and further improving the model.

#### **1.1 Understanding human cognition**

Throughout the occidental phylogenesis of ideas and right down to our days, especially in Cognitive Science and AI research, two requisites have been considered fundamental in all established theories of knowing [von Glasersfeld, 1990, p.21]. The first of these requisites demands that whatever we would like to call "true knowledge" has to be independent of the knowing subject. The second requisite is that knowledge is to be taken seriously only if it claims to represent a world of "things-in-themselves", a world of "real things", in a more or less veridical fashion. In other words, Cognitive Science and AI research are based on an implicit 'dogmatic' position [Kant, 1787/1966, p.XXXV]: they tacitly take for granted that the patterns and structures of objects, attributes, relations etc. which we consider to be our knowledge, should be as much as possible independent from us because they have to be as much as possible true copies of 'original' objects, attributes, relations etc. in the world [Charniak, McDermott, 1985]. But some non-established, 'dissident' theories of cognition have challenged this traditional and modern 'cognitive dogmatism'. One of these theories is 'Constructivism', a contemporary trend whose ideas have spread particularly in the last twenty years but whose sources can be traced back to Kant, Vico, Berkeley, Montaigne, Phyrro and finally the Pre-Socratics. In our century, the great pioneer of the constructivist theory of knowing has been Jean Piaget with his 'Genetic Epistemology'. And Jean Piaget is also one of the thinkers who most incisively influenced Ernst von Glasersfeld, who coordinated and integrated the ideas of several ancient and recent dissident thinkers into the theory of knowing called 'Radical Constructivism' [von Glasersfeld, 1981, 1991].

#### **1.2 Piaget's model of human intelligence**

Piaget's Constructivism, one of the most advanced alternatives to contemporary 'cognitive dogmatism' is best summarized in the basic principle of his model of human intelligence: "Intelligence organizes the world by organizing itself" [Piaget, 1937/1971, p. 400]. In his theory Piaget refutes the established approach which implicitly reduces knowledge to an 'inert copy of reality' [Piaget in: Evans, 1973]. If, as he says, in order to make a copy, one should know the original and in order to know the original one should copy it, then we would have a vicious circle between the original and the knowledge of it. His view opposes to the traditional and current notion of 'knowledge as copy' that of 'construct' and says, that 'to know is to construct'. But to construct what? In knowing, he says, we construct actions and

# Made Up Minds A Constructivist Approach To Artificial Intelligence

**Matthew Iklé, Arthur Franz, Rafal  
Rzepka, Ben Goertzel**



## **Made Up Minds A Constructivist Approach To Artificial Intelligence:**

*Made-up Minds* Gary L. Drescher, 1991 *Made Up Minds* addresses fundamental questions of learning and concept invention by means of an innovative computer program that is based on the cognitive developmental theory of psychologist Jean Piaget Drescher uses Piaget's theory as a source of inspiration for the design of an artificial cognitive system called the schema mechanism and then uses the system to elaborate and test Piaget's theory The approach is original enough that readers need not have extensive knowledge of artificial intelligence and a chapter summarizing Piaget's work assists readers who lack a background in developmental psychology

Knowing our World: An Artificial Intelligence Perspective George F. Luger, 2021-07-02 *Knowing our World An Artificial Intelligence Perspective* considers the methodologies of science computation and artificial intelligence to explore how we humans come to understand and operate in our world While humankind's history of articulating ideas and building machines that can replicate the activity of the human brain is impressive Professor Luger focuses on understanding the skills that enable these goals Based on insights afforded by the challenges of AI design and program building *Knowing our World* proposes a foundation for the science of epistemology Taking an interdisciplinary perspective the book demonstrates that AI technology offers many representational structures and reasoning strategies that support clarification of these epistemic foundations This monograph is organized in three Parts the first three chapters introduce the reader to the foundations of computing and the philosophical background that supports the AI tradition These three chapters describe the origins of AI programming as iterative refinement and the representations and very high level language tools that support AI application building The book's second Part introduces three of the four paradigms that represent research and development in AI over the past seventy years the symbol based connectionist and complex adaptive systems Luger presents several introductory programs in each area and demonstrates their use The final three chapters present the primary theme of the book bringing together the rationalist empiricist and pragmatist philosophical traditions in the context of a Bayesian world view Luger describes Bayes theorem with a simple proof to demonstrate epistemic insights He describes research in model building and refinement and several philosophical issues that constrain the future growth of AI The book concludes with his proposal of the epistemic stance of an active pragmatic model revising realism

*Artificial General Intelligence* Bas Steunebrink, Pei Wang, Ben Goertzel, 2016-06-24 This book constitutes the refereed proceedings of the 9th International Conference on Artificial General Intelligence AGI 2016 held in New York City NY USA in July 2016 as part of HLA 2016 the Joint Multi Conference on Human Level Artificial Intelligence 2016 The 24 full papers 2 short papers and 10 poster papers presented were carefully reviewed and selected from 67 submissions AGI research differs from the ordinary AI research by stressing on the versatility and wholeness of intelligence and by carrying out the engineering practice according to an outline of a system comparable to the human mind in a certain sense

**Artificial General Intelligence** Matthew Iklé, Arthur Franz, Rafal Rzepka, Ben Goertzel, 2018-08-02 This book constitutes

the proceedings of the 11th International Conference on Artificial General Intelligence AGI 2018 held in Prague Czech Republic in August 2018 The 19 regular papers and 10 poster papers presented in this book were carefully reviewed and selected from 52 submissions The conference encourage interdisciplinary research based on different understandings of intelligence and exploring different approaches As the AI field becomes increasingly commercialized and well accepted maintaining and emphasizing a coherent focus on the AGI goals at the heart of the field remains more critical than ever

Computational Logic in Multi-Agent Systems João Leite, 2004-11-16 Over recent years the notion of agency has claimed a major role in defining the trends of modern research Involving a broad spectrum of disciplines such as sociology psychology philosophy and many more the agent paradigm virtually invaded every subfield of computer science because of its promising applications for the Internet and in robotics Multi agent systems MAS are communities of problem solving entities that can perceive and act upon their environments to achieve their individual goals as well as joint goals The work on such systems integrates many technologies and concepts in artificial intelligence and other areas of computing There is a full spectrum of MAS applications that have been and are being developed from search engines to educational aids to electronic commerce and trade Although commonly implemented by means of imperative languages mainly for reasons of efficiency the agent concept has recently increased its influence in the research and development of computational logic based systems Computational logic by virtue of its nature both in substance and method provides a well defined general and rigorous framework for systematically studying computation be it syntax semantics and procedures or implementations environments tools and standards Computational logic approaches problems and provides solutions at a sufficient level of abstraction so that they generalize from problem domain to problem domain ordered by the nature of its very foundation in logic both in substance and method which constitutes one of its major assets *Encyclopedia of the Sciences of Learning* Norbert M. Seel, 2011-10-05 Over the past century educational psychologists and researchers have posited many theories to explain how individuals learn i.e. how they acquire organize and deploy knowledge and skills The 20th century can be considered the century of psychology on learning and related fields of interest such as motivation cognition metacognition etc and it is fascinating to see the various mainstreams of learning remembered and forgotten over the 20th century and note that basic assumptions of early theories survived several paradigm shifts of psychology and epistemology Beyond folk psychology and its naive theories of learning psychological learning theories can be grouped into some basic categories such as behaviorist learning theories connectionist learning theories cognitive learning theories constructivist learning theories and social learning theories Learning theories are not limited to psychology and related fields of interest but rather we can find the topic of learning in various disciplines such as philosophy and epistemology education information science biology and as a result of the emergence of computer technologies especially also in the field of computer sciences and artificial intelligence As a consequence machine learning struck a chord in the 1980s and became an important field of the learning

sciences in general As the learning sciences became more specialized and complex the various fields of interest were widely spread and separated from each other as a consequence even presently there is no comprehensive overview of the sciences of learning or the central theoretical concepts and vocabulary on which researchers rely The Encyclopedia of the Sciences of Learning provides an up to date broad and authoritative coverage of the specific terms mostly used in the sciences of learning and its related fields including relevant areas of instruction pedagogy cognitive sciences and especially machine learning and knowledge engineering This modern compendium will be an indispensable source of information for scientists educators engineers and technical staff active in all fields of learning More specifically the Encyclopedia provides fast access to the most relevant theoretical terms provides up to date broad and authoritative coverage of the most important theories within the various fields of the learning sciences and adjacent sciences and communication technologies supplies clear and precise explanations of the theoretical terms cross references to related entries and up to date references to important research and publications The Encyclopedia also contains biographical entries of individuals who have substantially contributed to the sciences of learning the entries are written by a distinguished panel of researchers in the various fields of the learning sciences

*Evolvable Designs of Experiments* Octavian Iordache, 2009-02-17 Adopting a groundbreaking approach the highly regarded author shows how to design methods for planning increasingly complex experiments He begins with a brief introduction to standard quality methods and the technology in standard electric circuits The book then gives numerous examples of how to apply the proposed methodology in a series of real life case studies Although these case studies are taken from the printed circuit board industry the methods are equally applicable to other fields of engineering

Qualitative Reasoning Benjamin Kuipers, 1994 Qualitative models are better able than traditional models to express states of incomplete knowledge about continuous mechanisms Qualitative simulation guarantees to find all possible behaviors consistent with the knowledge in the model This expressive power and coverage is important in problem solving for diagnosis design monitoring explanation and other applications of artificial intelligence

Adaptive Agents and Multi-Agent Systems II Daniel Kudenko, Dimitar Kazakov, Eduardo Alonso, 2005-03-04 Adaptive agents and multi agent systems is an emerging and exciting interdisciplinary area of research and development involving artificial intelligence software engineering and developmental biology as well as cognitive and social science This book presents 17 revised and carefully reviewed papers taken from two workshops on the topic as well as 2 invited papers by leading researchers in the area The papers deal with various aspects of machine learning adaptation and evolution in the context of agent systems and autonomous agents

*Explainable Artificial Intelligence for Intelligent Transportation Systems* Amina Adadi, Afaf Bouhoute, 2023-10-20 Artificial Intelligence AI and Machine Learning ML are set to revolutionize all industries and the Intelligent Transportation Systems ITS field is no exception While ML especially deep learning models achieve great performance in terms of accuracy the outcomes provided are not amenable to human scrutiny and can hardly be explained This can be very problematic especially

for systems of a safety critical nature such as transportation systems Explainable AI XAI methods have been proposed to tackle this issue by producing human interpretable representations of machine learning models while maintaining performance These methods hold the potential to increase public acceptance and trust in AI based ITS FEATURES Provides the necessary background for newcomers to the field both academics and interested practitioners Presents a timely snapshot of explainable and interpretable models in ITS applications Discusses ethical societal and legal implications of adopting XAI in the context of ITS Identifies future research directions and open problems

### **The Turing Test** James H.

Moor,2012-12-06 In 1950 Alan Turing 1912 1954 published his famous article Computing Machinery and Intelligence in the journal Mind This article is arguably the most influential and widely read article in the philosophy of artificial intelligence Indeed most of the debate in the philosophy of artificial intelligence over the last fifty years concerns issues that were raised and discussed by Turing Turing s genius was not only in developing the theory of computability but also in understanding the impact both practical and philosophical that computing machinery would have Turing believed that computers if properly designed and educated could exhibit intelligent behavior even behavior that would be indistinguishable from human intelligent behavior His vision of the possibility of machine intelligence has been highly inspiring and extremely controversial In this classic article Turing presented his well known imitation game and predicted that about the year 2000 an average interrogator will not have more than 70 per cent chance of making the right identification after five minutes of questioning in the imitation game Based on the results of the Loebner 2000 contest and the accomplishments in the field of AI as impressive as they are Turing s prediction remains unfulfilled

### **Human Attention in Digital Environments** Claudia

Roda,2011-02-03 Digital systems such as phones computers and PDAs place continuous demands on our cognitive and perceptual systems They offer information and interaction opportunities well above our processing abilities and often interrupt our activity Appropriate allocation of attention is one of the key factors determining the success of creative activities learning collaboration and many other human pursuits This book presents research related to human attention in digital environments Original contributions by leading researchers cover the conceptual framework of research aimed at modelling and supporting human attentional processes the theoretical and software tools currently available and various application areas The authors explore the idea that attention has a key role to play in the design of future technology and discuss how such technology may continue supporting human activity in environments where multiple devices compete for people s limited cognitive resources

### Computational Theories of Interaction and Agency Philip Agre,Stanley J.

Rosenschein,1996 Over time the field of artificial intelligence has developed an agent perspective expanding its focus from thought to action from search spaces to physical environments and from problem solving to long term activity Originally published as a special double volume of the journal Artificial Intelligence this book brings together fundamental work by the top researchers in artificial intelligence neural networks computer science robotics and cognitive science on the themes of

interaction and agency It identifies recurring themes and outlines a methodology of the concept of agency The seventeen contributions cover the construction of principled characterizations of interactions between agents and their environments as well as the use of these characterizations to guide analysis of existing agents and the synthesis of artificial agents Artificial Intelligence series Special Issues of Artificial Intelligence

**Computational Intelligence for Modelling, Control & Automation** Masoud Mohammadian,1999 This edited Book is dedicated to the theory and applications of Evolutionary Computation and Fuzzy Logic for Intelligent Control Knowledge Acquisition and Information Retrieval The book consists of 86 selected research papers from the 1999 International Conference on Computational Intelligence for Modelling Control and Automation CIMCA 99 The research papers presented in this book cover new techniques and applications in the following research areas Evolutionary Computation Fuzzy Logic and Expert Systems with their applications for Optimisation Learning Control Scheduling and Multi Criteria Analysis as well as Reliability Assessment Information Retrieval and Knowledge Acquisition

*Advances in Artificial Intelligence -- IBERAMIA 2004* Christian Lemaitre,Carlos A. Reyes,Jesus A. Gonzalez,2004-11-18 This book constitutes the refereed proceedings of the 9th Ibero American Conference on Artificial Intelligence IBERAMIA 2004 held in Puebla Mexico in November 2004 The 97 revised full papers presented were carefully reviewed and selected from 304 submissions The papers are organized in topical sections on distributed AI and multi agent systems knowledge engineering and case based reasoning planning and scheduling machine learning and knowledge acquisition natural language processing knowledge representation and reasoning knowledge discovery and data mining robotics computer vision uncertainty and fuzzy systems genetic algorithms and neural networks AI in education and miscellaneous topics

**Toward Artificial Sapience** Rene V. Mayorga,Leonid Perlovsky,2008 A diverse international set of authors discuss Artificial Computational Sapience and Sapient Systems in this unique and useful volume The reader is guided through the subject in a structured and comprehensive manner that begins with chapters discussing philosophical historical and semiotic ideas about what properties are expected from Sapient Wise systems Following that chapters describe mathematical and engineering views on sapience relating these to philosophical semiotic cognitive and neuro biological perspectives

**Anticipatory Behavior in Adaptive Learning Systems** Martin V. Butz,Olivier Sigaud,Giovanni Pezzulo,Gianluca Baldassarre,2007-08-22 This book presents the refereed post proceedings of the Third International Workshop on Anticipatory Behavior in Adaptive Learning Systems Twenty full papers were chosen from among the many submissions Papers are organized into sections covering anticipatory aspects in brains language and cognition individual anticipatory frameworks learning predictions and anticipations anticipatory individual behavior and anticipatory social behavior

*The Challenge of Anticipation* Giovanni Pezzulo,Martin V. Butz,Cristiano Castelfranchi,Rino Falcone,2008-09-25 The general idea that brains anticipate the future that they engage in prediction and that one means of doing this is through some sort of inner model that can be run of ine hasalonghistory SomeversionoftheideawascommontoAristotle aswell as to

many medieval scholastics to Leibniz and Hume and in more recent times to Kenneth Craik and Philip Johnson Laird One reason that this general idea recurs continually is that this is the kind of picture that introspection paints When we are engaged in tasks it seems that we form images that are predictions or anticipations and that these images are isomorphic to what they represent But as much as the general idea recurs opposition to it also recurs The idea has never been widely accepted or uncontroversial among psychologists cognitive scientists and neuroscientists The main reason has been that science cannot be satisfied with metaphors and introspection In order to gain acceptance an idea needs to be formulated clearly enough so that it can be used to construct testable hypotheses whose results will clearly support or cast doubt upon the hypothesis Next those ideas that are formulable in one or another sort of symbolism or notation are capable of being modeled and modeling is a huge part of cognitive neuroscience If an idea cannot be clearly modeled then there are limits to how widely it can be tested and accepted by a cognitive neuroscience community

**Solving Geometric Constraint Systems** Glenn A. Kramer, 1992 Solving Geometric Constraints records and explains the formal basis for graphical analysis techniques that have been used for decades in engineering disciplines It describes a novel computer implementation of a 3D graphical analysis method degrees of freedom analysis for solving geometric constraint problems of the type encountered in the kinematic analysis of mechanical linkages providing the best computational bounds yet achieved for this class of problems The technique allows for the design of algorithms that provide significant speed increases and will foster the development of interactive software tools for the simulation optimization and design of complex mechanical devices as well as provide leverage in other geometric domains

**Do the Right Thing** Stuart Jonathan Russell, Eric Weisfeld, 1991 Like Mookie the hero of Spike Lee's film Do the Right Thing artificially intelligent systems have a hard time knowing what to do in all circumstances Classical theories of perfect rationality prescribe the right thing for any occasion but no finite agent can compute their prescriptions fast enough In Do the Right Thing the authors argue that a new theoretical foundation for artificial intelligence can be constructed in which rationality is a property of programs within a finite architecture and their behaviour over time in the task environment rather than a property of individual decisions



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## **Table of Contents Made Up Minds A Constructivist Approach To Artificial Intelligence**

1. Understanding the eBook Made Up Minds A Constructivist Approach To Artificial Intelligence
  - The Rise of Digital Reading Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Advantages of eBooks Over Traditional Books
2. Identifying Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Made Up Minds A Constructivist Approach To Artificial Intelligence
  - User-Friendly Interface
4. Exploring eBook Recommendations from Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Personalized Recommendations
  - Made Up Minds A Constructivist Approach To Artificial Intelligence User Reviews and Ratings
  - Made Up Minds A Constructivist Approach To Artificial Intelligence and Bestseller Lists
5. Accessing Made Up Minds A Constructivist Approach To Artificial Intelligence Free and Paid eBooks
  - Made Up Minds A Constructivist Approach To Artificial Intelligence Public Domain eBooks
  - Made Up Minds A Constructivist Approach To Artificial Intelligence eBook Subscription Services

- Made Up Minds A Constructivist Approach To Artificial Intelligence Budget-Friendly Options
- 6. Navigating Made Up Minds A Constructivist Approach To Artificial Intelligence eBook Formats
  - ePub, PDF, MOBI, and More
  - Made Up Minds A Constructivist Approach To Artificial Intelligence Compatibility with Devices
  - Made Up Minds A Constructivist Approach To Artificial Intelligence Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Highlighting and Note-Taking Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Interactive Elements Made Up Minds A Constructivist Approach To Artificial Intelligence
- 8. Staying Engaged with Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Made Up Minds A Constructivist Approach To Artificial Intelligence
- 9. Balancing eBooks and Physical Books Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Made Up Minds A Constructivist Approach To Artificial Intelligence
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Setting Reading Goals Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Fact-Checking eBook Content of Made Up Minds A Constructivist Approach To Artificial Intelligence
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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