

Reverse-engineering Mammalian Brains for building Complex Integrated Controllers

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ABSTRACT: The ICEA project (www2.his.se/icea/) is a four-year project on bio-inspired integrated cognitive control, bringing together cognitive scientists, neuroscientists, psychologists, roboticists and control engineers. The primary objective of the whole project is to develop a new cognitive systems architecture to be used in technical systems and that integrates cognitive, emotional and autonomic control processes. The ICEA generic architecture will be based on the extraction of control design patterns from bioregulatory, emotional and cognitive control loops based on the architecture and physiology of the rat brain. The work of the ASLab team is focused in i) the development of a unified theory of integrated intelligent autonomous control, ii) the development of a cognitive architecture with self-awareness mechanisms and iii) the analysis of the applicability of such a technology in a broad domain of embedded, real-time systems. This paper describes the ICEA projects and the ongoing ASLab work.

KEYWORDS: Autonomous systems, integrated control, layered control, control design patterns, mammalian brain, emotion, cognition, autonomy.

THE ICEA PROJECT

The ICEA project (www2.his.se/icea/) is a four-year project funded by the European Commission Cognitive Systems Unit. The project is focused on bio-inspired integrated cognitive control, bringing together cognitive scientists, neuroscientists, psychologists, roboticists and control engineers. The primary objective of the whole project is to develop a novel cognitive systems architecture inspired by rat brains.

The ICEA project will develop the first cognitive systems architecture integrating cognition, emotion and autonomy (bioregulation and self-maintenance), based on the architecture and physiology of the mammalian brain. A key hypothesis underlying this four-year collaboration between cognitive scientists, neuroscientists, psychologists, computational modellers, roboticists and control engineers, is that emotional and autonomic mechanisms play a critical role in structuring the high-level thought processes of living cognitive systems.

The robots and autonomous systems developed will perceive and act in the real world, learn from that interaction developing situated knowledge (representations of their environments in spatial, emotional and behavioural terms), and use this knowledge in anticipation, planning and decision-making. The brain and behaviour of the rat will be an important starting point because of the large scientific literature available for this species. Rat cognition will be studied and emulated both through an ambitious program of empirical studies in real animals and through computational modelling, at different levels of abstraction, on several, real and simulated, robot platforms.

The project will develop two central, integrated platforms, rat-like in appearance, perceptual, and behavioural capacities. First, the ICEAbot robot platform, equipped with multimodal sensory systems will serve as a real-world testbed and demonstrator of the behavioural and cognitive capacities derived from models of rat biology. Second, a 3-D robot simulator, ICEAsim, based on the physical ICEAbot, but also offering richer opportunities for experimentation, will demonstrate the potential of the ICEA architecture to go beyond the rat model and support cognitive capacities such as abstraction, feelings, imagination, and planning. ICEAsim will serve as the main platform for exchange and technical integration of models developed in different parts of the project, but it will also be made freely available to the research community as a potential standard research tool. Other, more specialized platforms will be developed to investigate issues of energy autonomy, to model active whisker touch, and to evaluate the ICEA architecture's applicability to non-biomimetic robots.

Reverse Engineering Mammalian Brains For Building Complex

José Mira, José R. Álvarez



Reverse Engineering Mammalian Brains For Building Complex

From Brains to Systems Carlos Hernández, Ricardo Sanz, Jaime Gómez Ramirez, Leslie S. Smith, Amir Hussain, Antonio Chella, Igor Aleksander, 2011-07-12 Brain Inspired Cognitive Systems BICS 2010 aims to bring together leading scientists and engineers who use analytic and synthetic methods both to understand the astonishing processing properties of biological systems and specifically of the brain and to exploit such knowledge to advance engineering methods to build artificial systems with higher levels of cognitive competence BICS is a meeting point of brain scientists and cognitive systems engineers where cross domain ideas are fostered in the hope of getting emerging insights on the nature operation and extractable capabilities of brains This multiple approach is necessary because the progressively more accurate data about the brain is producing a growing need of a quantitative understanding and an associated capacity to manipulate this data and translate it into engineering applications rooted in sound theories BICS 2010 is intended for both researchers that aim to build brain inspired systems with higher cognitive competences and for life scientists who use and develop mathematical and engineering approaches for a better understanding of complex biological systems like the brain Four major interlaced focal symposia are planned for this conference and these are organized into patterns that encourage cross fertilization across the symposia topics This emphasizes the role of BICS as a major meeting point for researchers and practitioners in the areas of biological and artificial cognitive systems Debates across disciplines will enrich researchers with complementary perspectives from diverse scientific fields BICS 2010 will take place July 14 16 2010 in Madrid Spain **The Future of the Brain** Gary Marcus, Jeremy Freeman, 2014-04-30 The world s top experts take readers to the very frontiers of brain science Includes a chapter by 2014 Nobel laureates May Britt Moser and Edvard Moser An unprecedented look at the quest to unravel the mysteries of the human brain The Future of the Brain takes readers to the absolute frontiers of science Original essays by leading researchers such as Christof Koch George Church Olaf Sporns and May Britt and Edvard Moser describe the spectacular technological advances that will enable us to map the more than eighty five billion neurons in the brain as well as the challenges that lie ahead in understanding the anticipated deluge of data and the prospects for building working simulations of the human brain A must read for anyone trying to understand ambitious new research programs such as the Obama administration s BRAIN Initiative and the European Union s Human Brain Project The Future of the Brain sheds light on the breathtaking implications of brain science for medicine psychiatry and even human consciousness itself Contributors include Misha Ahrens Ned Block Matteo Carandini George Church John Donoghue Chris Eliasmith Simon Fisher Mike Hawrylycz Sean Hill Christof Koch Leah Krubitzer Michel Maharbiz Kevin Mitchell Edvard Moser May Britt Moser David Poeppel Krishna Shenoy Olaf Sporns Anthony Zador Handbook of Research on Methodologies and Applications of Supercomputing Milutinovi?, Veljko, Kotlar, Miloš, 2021-02-19 As computers continue to remain essential tools for the pursuit

of physics medicine economics social sciences and more supercomputers are proving that they can further extend and greatly enhance as of yet undiscovered knowledge and solve the world's most complex problems. As these instruments continue to lead to groundbreaking discoveries and breakthroughs, it is imperative that research remains up to date with the latest findings and uses. *The Handbook of Research on Methodologies and Applications of Supercomputing* is a comprehensive and critical reference book that provides research on the latest advances of control flow and dataflow supercomputing and highlights selected emerging big data applications needing high acceleration and/or low power. Consequently, this book advocates the need for hybrid computing where the control flow part represents the host architecture and dataflow part represents the acceleration architecture. These issues cover the initial eight chapters. The remaining eight chapters cover selected modern applications that are best implemented on a hybrid computer in which the transactional parts (serial code) are implemented on the control flow part and the loops (parallel code) on the dataflow part. These final eight chapters cover two major application domains: scientific computing and computing for digital economy. This book offers applications in marketing, medicine, energy systems, and library science among others and is an essential source for scientists, programmers, engineers, practitioners, researchers, academicians, and students interested in the latest findings and advancements in supercomputing.

Bio-inspired Modeling of Cognitive Tasks José Mira, José R. Álvarez, 2007-06-30. The first of a two-volume set, this book constitutes the refereed proceedings of the Second International Work Conference on the Interplay between Natural and Artificial Computation (IWINAC 2007) held in La Manga del Mar Menor, Spain, in June 2007. It includes all the contributions mainly related with theoretical, conceptual, and methodological aspects linking AI and knowledge engineering with neurophysiology, clinics, and cognition.

Pratiyogita Darpan, 2009-07. Pratiyogita Darpan monthly magazine is India's largest read General Knowledge and Current Affairs Magazine. Pratiyogita Darpan English monthly magazine is known for quality content on General Knowledge and Current Affairs. Topics ranging from national and international news, issues, personality development, interviews of examination toppers, articles, write-ups on topics like career, economy, history, public administration, geography, polity, social environment, scientific, legal, etc. solved papers of various examinations, Essay and debate, contest, Quiz, and knowledge testing features are covered every month in this magazine.

Future of Airplane Factory George Nicholas Bullen, 2019-05-28. The Future of Airplane Factory Digitally Optimized Intelligent Airplane Factory defines the architecture, key building blocks, and roadmap for actualizing a future airplane factory (FAF) that is digitally optimized for intelligent airplane assembly. They fit and integrate with other FAF building blocks that aggregate to a Digitally Optimized Intelligent Airplane Factory (DOIAF). The word intelligent refers to the ability of a system to make right decisions and take right action in the highly dynamic and fluid environment of the modern airplane manufacturing space. The event-driven dynamics inherent in the complexity of this environment drive the need for expert knowledge which resides in intelligence systems incorporating the experience of experts. Expert knowledge need not be smart, brilliant, or possess genius as long as

the outcomes are derived from right decisions resulting in right actions applied rapidly to sustain an optimized factory enterprise Complete factory enterprise visibility requires a higher order of decision capability that current operating systems do not have A highly visible factory collects and displays data and information as it happens at a rate beyond the ability of humans and current systems to analyze process decide and act upon Expert systems are constructed to present humans with right decisions in the form of optimal choices for right actions by incorporating the knowledge of experts into the logic for the decision Structured Knowledge Based Expert Systems SKBES are incorporated in this book and defined as a critical component for full enterprise actionable visibility The power of the Digitally Optimized Intelligent Airplane Factory not only is found in its ability to unify the factory reduce touch labor improve quality and streamline throughput but it also enables a significant reduction in above the shop floor support and management Such an ecosystem frees the human to focus on the complexity of interpersonal responsibilities If the use of a DOIAF can be viewed as a holistic mechanism then the human can be the agent engaging with that mechanism improving negotiations for pricing contracts or other person to person events that require instinct and relationship

Neuroscience Notes Stephen Gislason MD,2018-03-14 In this book I have selected topics that are representative of neuroscience inquiry retaining brief references to a larger context that includes the study of neurology anthropology paleontology computer science and philosophy There have been several attempts to develop a theory of brain function that incorporates a large collection of observations experimental results and a growing understanding of the innate features of human nature I doubt that a single theory is feasible and suggest that the goal is integration of knowledge from diverse disciplines into a comprehensive understanding of who we are and why we are the way we are

Neuromorphic and Brain-Based Robots Jeffrey L. Krichmar,Hiroaki Wagatsuma,2011-09-01 Neuromorphic and brain based robotics have enormous potential for furthering our understanding of the brain By embodying models of the brain on robotic platforms researchers can investigate the roots of biological intelligence and work towards the development of truly intelligent machines This book provides a broad introduction to this groundbreaking area for researchers from a wide range of fields from engineering to neuroscience Case studies explore how robots are being used in current research including a whisker system that allows a robot to sense its environment and neurally inspired navigation systems that show impressive mapping results Looking to the future several chapters consider the development of cognitive or even conscious robots that display the adaptability and intelligence of biological organisms Finally the ethical implications of intelligent robots are explored from morality and Asimov s three laws to the question of whether robots have rights

Thinking Machines and the Philosophy of Computer Science Jordi Vallverdú,2010-01-01 This book offers a high interdisciplinary exchange of ideas pertaining to the philosophy of computer science from philosophical and mathematical logic to epistemology engineering ethics or neuroscience experts and outlines new problems that arise with new tools Provided by publisher

Our Final Invention James Barrat,2013-10-01 Elon Musk named Our Final Invention one of 5 books everyone should read about the

future A Huffington Post Definitive Tech Book of 2013 Artificial Intelligence helps choose what books you buy what movies you see and even who you date It puts the smart in your smartphone and soon it will drive your car It makes most of the trades on Wall Street and controls vital energy water and transportation infrastructure But Artificial Intelligence can also threaten our existence In as little as a decade AI could match and then surpass human intelligence Corporations and government agencies are pouring billions into achieving AI s Holy Grail human level intelligence Once AI has attained it scientists argue it will have survival drives much like our own We may be forced to compete with a rival more cunning more powerful and more alien than we can imagine Through profiles of tech visionaries industry watchdogs and groundbreaking AI systems Our Final Invention explores the perils of the heedless pursuit of advanced AI Until now human intelligence has had no rival Can we coexist with beings whose intelligence dwarfs our own And will they allow us to

Foundations on

Natural and Artificial Computation José M. Ferrández, José Ramón Álvarez, Félix de la Paz, Fco. Javier Toledo, 2011-05-12

The two volumes LNCS 6686 resp LNCS 6687 constitute the refereed proceedings of the 4th International Work Conference on the Interplay between Natural and Artificial Computation IWINAC 2011 held in La Palma Canary Islands Spain in May June 2011 The 108 revised full papers presented in LNCS 6686 resp LNCS 6687 were carefully reviewed and selected from numerous submissions The first part LNCS 6686 entitled Foundations on Natural and Artificial Computation includes all the contributions mainly related to the methodological conceptual formal and experimental developments in the fields of neurophysiology and cognitive science The second part LNCS 6687 entitled New Challenges on Bioinspired Applications contains the papers related to bioinspired programming strategies and all the contributions related to the computational solutions to engineering problems in different application domains specially Health applications including the CYTED Artificial and Natural Computation for Health CANS research network papers

Consciousness Genesis In Artificial Intelligence professor ibrahim elnoshokaty , Consciousness Genesis In Artificial Intelligence by Professor Ibrahim El Noshokaty I can provide a preliminary review that outlines the structure and content captured within the initial pages available to me Below is an overview based on the table of contents and some introductory text

Title *Consciousness Genesis In Artificial Intelligence* Author Professor Ibrahim El Noshokaty Overview The academic work delves into the complex topic of artificial intelligence and its relation to human like consciousness It explores whether AI can be creative how numerical data and programming languages can emulate human sensory experiences and emotions and the potential implications of such advances Chapters and Themes Introduction and Fuzzy Logic System Initiates the discussion with fundamental questions about AI creativity and creation followed by the exposition of fuzzy logic systems Existential Threat and AI in Hollywood Examines AI s potential to disrupt industries such as Hollywood the feasibility of generative AI in original content production and copyright issues in AI outputs Hierarchical Fuzzy Deep Learning Discusses advanced AI techniques to enhance learning and decision making addressing the concepts of consciousness and fuzzy logic in AI Algorithms for Modern

Fuzzy Logic Systems Delves into the technical aspects of fuzzy logic systems and algorithms highlighting methods for system optimization
Development of Conscience in AI Contemplates the moral aspects and decision making capabilities of AI systems along with the incorporation of ethical considerations and human values
Artificial Cognition Analyzes the notion of machine learning and cognition transparency within AI mechanisms and the ethical implications of artificial minds
Artificial Sensations Explores the development of AI systems capable of mimicking human senses and responses using advanced materials and devices
Artificial Brain Concludes with an investigation into mimicking human brain function within AI systems and the potential capacity for AI to evolve with environmental interaction
The work appears to be an exploration of the frontier where technology meets human cognition emotion and ethical considerations
The book may offer expertise in several domains including AI algorithms deep learning neuromorphic computing and the philosophical implications of imbuing AI with aspects of human consciousness
The manuscript s purpose is likely to probe the theoretical boundaries of AI and its future potential as well as to identify and confront some of the ethical dilemmas that arise as AI systems become increasingly sophisticated
This preliminary review only scratches the surface of what the book contains
For a full review including critical analysis and conclusions it would be necessary to read the document in its entirety
If you have any specific areas you d like me to focus on or if there are particular chapters you want to examine in more detail please let me know

25 Things You Need to Know About the Future Christopher Barnatt,2012-01-19
The essential book for understanding the challenges and technologies that will shape the next few decades
How will we live in the future
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Intelligence Unbound Russell Blackford,Damien Broderick,2014-05-29
Intelligence Unbound explores the prospects promises and potential dangers of machine intelligence and uploaded minds in a collection of state of the art essays from internationally recognized philosophers AI researchers science fiction authors and theorists
Compelling and intellectually sophisticated exploration of the latest thinking on Artificial Intelligence and machine minds
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consider the pros and cons of a variety of intriguing possibilities Considers classic philosophical puzzles as well as the latest topics debated by scholars Covers a wide range of viewpoints and arguments regarding the prospects of uploading and machine intelligence including proponents and skeptics pros and cons *Rhythms of the Brain* Gyorgy Buzsaki,2006-08-03 This book provides eloquent support for the idea that spontaneous neuron activity far from being mere noise is actually the source of our cognitive abilities In a sequence of cycles Gyrgy Buzski guides the reader from the physics of oscillations through neuronal assembly organization to complex cognitive processing and memory storage His clear fluid writing accessible to any reader with some scientific knowledge is supplemented by extensive footnotes and references that make it just as gratifying and instructive a read for the specialist The coherent view of a single author who has been at the forefront of research in this exciting field this volume is essential reading for anyone interested in our rapidly evolving understanding of the brain **Event-Based Neuromorphic Systems** Shih-Chii Liu,Tobi Delbruck,Giacomo Indiveri,Adrian

Whatley,Rodney Douglas,2015-02-16 Neuromorphic electronic engineering takes its inspiration from the functioning of nervous systems to build more power efficient electronic sensors and processors Event based neuromorphic systems are inspired by the brain s efficient data driven communication design which is key to its quick responses and remarkable capabilities This cross disciplinary text establishes how circuit building blocks are combined in architectures to construct complete systems These include vision and auditory sensors as well as neuronal processing and learning circuits that implement models of nervous systems Techniques for building multi chip scalable systems are considered throughout the book including methods for dealing with transistor mismatch extensive discussions of communication and interfacing and making systems that operate in the real world The book also provides historical context that helps relate the architectures and circuits to each other and that guides readers to the extensive literature Chapters are written by founding experts and have been extensively edited for overall coherence This pioneering text is an indispensable resource for practicing neuromorphic electronic engineers advanced electrical engineering and computer science students and researchers interested in neuromorphic systems Key features Summarises the latest design approaches applications and future challenges in the field of neuromorphic engineering Presents examples of practical applications of neuromorphic design principles Covers address event communication retinas cochleas locomotion learning theory neurons synapses floating gate circuits hardware and software infrastructure algorithms and future challenges **Sensorimotor Integration in the Whisker System** Patrik Krieger,Alexander Groh,2015-10-01 Sensorimotor integration the dynamic process by which the sensory and motor systems communicate with each other is crucial to humans and animals ability to explore and react to their environment This book summarizes the main aspects of our current understanding of sensorimotor integration in 10 chapters written by leading scientists in this active and ever growing field This volume focuses on the whisker system which is an exquisite model to experimentally approach sensorimotor integration in the mammalian brain In this book authors

examine the whisker system on many different levels ranging from the building blocks and neuronal circuits to sensorimotor behavior Neuronal coding strategies comparative analysis as well as robotics illustrate the multiple facets of this research and its broad impact on fundamental questions about the neurobiology of the mammalian brain [The Rise Of The Antichrist](#) Kamran Faqir,2019-04-02 The Rise of The Antichrist carefully investigates the measurable effects of politics religion science and technology on the human psyche All mainstream religions traditionally share similar perspectives regarding the Antichrist and his developing systems which have been foretold by all prophets or messengers dutifully sent to every nation over time This book carefully explores the much debated topic of the Antichrist regarding his future emergence Will he lead humanity to eternal darkness or enlightenment Although modern science and human history popularly refer to the last 5 000 15 000 years of development in reality there are signs and evidence that human development is considerably older with possibilities of supernatural or otherworldly intervention This book explores stories such as the Nimrod who meticulously researched into longevity and occult magic with a possibility of alien or supernatural influence which was captured on stone glyphs Throughout history there have been developed mighty empires whose chosen kings proclaimed to be Gods But were they actually inter dimensional beings This book will ideally suit readers with an active interest in religion historical events and those interested in a thought provoking read **Introduction to Biological Networks** Alpan Raval,Animesh Ray,2016-04-19 The new research area of genomics inspired network biology lacks an introductory book that enables both physical computational scientists and biologists to obtain a general yet sufficiently rigorous perspective of current thinking Filling this gap Introduction to Biological Networks provides a thorough introduction to genomics inspired network bi **A Thousand Brains** Jeff Hawkins,2021-03-02 A bestselling author neuroscientist and computer engineer unveils a theory of intelligence that will revolutionize our understanding of the brain and the future of AI For all of neuroscience s advances we ve made little progress on its biggest question How do simple cells in the brain create intelligence Jeff Hawkins and his team discovered that the brain uses maplike structures to build a model of the world not just one model but hundreds of thousands of models of everything we know This discovery allows Hawkins to answer important questions about how we perceive the world why we have a sense of self and the origin of high level thought A Thousand Brains heralds a revolution in the understanding of intelligence It is a big think book in every sense of the word One of the Financial Times Best Books of 2021 One of Bill Gates Five Favorite Books of 2021

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