Enabling Technologies for Very Large Scale Synaptic Electronics:Learning in Energy-Efficient Neuromorphic Computing: Algorithm and Architecture Co-DesignMethods and Applications of Intelligent ControlMembranesThe Making of a Neuromorphic Visual SystemIndex to IEEE PublicationsUnderstanding and Bridging the Gap between Neuromorphic Computing and Machine LearningMemorive Devices for Brain-Inspired ComputingArtificial Neural Networks and Machine Learning – ICANN 2019: TheoreticalNeural ComputationNeuromorphic Engineering Systems and ApplicationsEmerging Topics in Hardware SecurityEmerging Technology and Architecture for Big-data AnalyticsEvent-Based Neuromorphic SystemsKI 2016: Advances in Artificial IntelligenceVLSIMolecular Electronics, Devices and ApplicationsMedicus Neural Computations in Embodied Closed-Loop Systems for the Generation of Complex Behavior: From Biology to TechnologyArtificial Intelligence in Industrial Decision Making, Control and AutomationEmerging Nanoelectronic DevicesUltraThin Two-Dimensional Semiconductors for Novel Electronic ApplicationsNeuromorphic Information ProcessingThe Brain and Its DiseasesCMOS Circuits for Biological Sensing and ProcessingCybersecurity Systems for Human Cognition Augmentation,Neuromorphic Computing and BeyondNeuromorphic Information ProcessingArtificial Neural Networks and Machine Learning – ICANN 2017:Neural Networks in Robotics: Neuromorphic Nanoelectronic Devices for Neuromorphic SystemsPhotonic Neuromorphic ThinkingEvolutionary Cybersecurity for the Internet of ThingsMind in ArchitectureProceedings of the First Asian Control Conference, Tokyo Metropolitan Institute of Technology, Tokyo, July 27-30, 1994Resistive Switching: Switching: Oxide Materials, Mechanisms, Devices and OperationsNeural Networks in Robotics is the first book to present an integrated view of both the application of artificial neural networks to robot control and the neuromuscular models from which robots were created. The behavior of biological systems provides both the inspiration and the challenge for robotics. The goal is to build robots which can emulate the ability of living organisms to integrate perceptual inputs smoothly with motor responses, even in the presence of novel stimuli and changes in the environment. The ability of living systems to learn and to adapt provides the standard against which robotic systems are judged. In order to emulate these abilities, a number of investigators have attempted to create robot controllers which are modelled on known processes in the brain and musculo-skeletal system. Several of these models are described in this book. On the other hand, connectionist (artificial neural network) formulations are attractive for the computation of inverse kinematics and dynamics of robots, because they can be trained for this purpose without explicit programming. Some of the computational advantages and problems of this approach are also presented. For any serious student of robotics, Neural Networks in Robotics provides an indispensable reference to the work of major researchers in the field. Similarly, since robotics is an outstanding application area for artificial neural networks, Neural Networks in Robotics is equally important to workers in connectionism and to students for sensormotor control in living systems. An important part of the colonial effort associated with the understanding of the brain involves using electronic hardware technology in order to reproduce biological behavior in "silicon". The idea revolves around leveraging decades of experience in the electronics industry that can be brought to bear to technologies that are harnessed to reproduce key brain-inspired functions. Although silicoenvironments are used by the electronics industry, the main goal can be achieved for the given level of modelling detail. So far, the field of neuromorphic engineering has proven itself as a major source of innovation towards the "silicon brain", goal, with the methods employed by its community largely focused on circuit design (analogue, digital and mixed signal) and standard, Complementary Metal-Oxide-Silicon (CMOS) technology as the preferred "tools of choice" when trying to simulate or emulate biological behavior. However, alongside the circuit-oriented sector of the community there exists another community developing new electronic technologies with the express aim of creating advanced devices, beyond the capabilities of CMOS, that can intrinsically simulate neuron- or synapse-like behavior. A notable example concerns nanoelectronic devices responding to well-defined input signals by suitably changing their internal state ("weight"), thereby exhibiting "synaptic-like" plasticity. This is in stark contrast to circuit-oriented approaches where the "synaptic weight" variable has to first be stored, typically as charge on a capacitor or digitally, and then appropriately changed via complicated circuitry. The shift of very much complexity from circuitry to devices could potentially be a major enabling factor for very-large scale "synaptic electronics", particularly if the new devices can be operated at much lower power budgets than their corresponding "traditional" circuit replacements. To bring this promise to fruition, synergy between the well-established practices of the circuit-oriented approach and the vastness of possibilities opened by the advent of novel nanoelectronic devices with rich internal dynamics is absolutely essential and will create the opportunity for radical innovation in both fields. The result of such synergy can be of potentially staggering impact to the progress of our efforts to both simulate the brain and ultimately understand it. In this Research Topic, we wish to provide an overview of what constitutes state-of-the-art in terms of enabling technologies for very large scale synaptic electronics, with particular stress on innovative nanoelectronic devices and circuit/system design techniques that can facilitate the development of very large scale brain-inspired electronic systems. The proceedings set LNCS 11727, 11728, 11729, 11730, and 11731 constitute the proceedings of the 28th International Conference on Artificial Neural Networks, ICANN 2019, held in Munich, Germany, in September 2019. The total of 277 full papers and 43 short papers presented in these proceedings was carefully reviewed and selected from 494 submissions. They were organized in 5 volumes focusing on theoretical neural computation; deep learning; image processing; text and time series; and workshop and special sessions. This book constitutes the refereed proceedings of the 39th Annual German Conference on Artificial Intelligence, Ki 2016, in conjunction with the Österreichische Gesellschaft für Artifizielle Intelligenz, ÖGAI, held in Klagenfurt, Austria, in September 2016. The 8 revised full technical papers presented together with 12 technical communications, and 16 extended abstracts were carefully reviewed and selected from 44 submissions. The conference provides the opportunity to present a wider range of results and ideas that are of interest to the KI audience, including reports about recent own publications, position papers, and previews of ongoing work. This book sets out to build bridges between the domains of photonic device physics and neural networks, providing a comprehensive overview of the emerging field of "neuromorphic photonics". It includes a thorough discussion of emission and absorption characteristics of silicon nanophotonic devices and integrated nanophotonic networks, along with key functionalities that are currently of interest to the emerging intelligent control systems. The book is concerned with giving a real and practical result demonstrating how such a new solid body of knowledge can be used. Numerous results have been obtained through the synergistic fusion of concepts and techniques from a variety of fields such as automatic control, systems science, computer science, neurophysiology and operational research. Intelligent control systems have to perform anthropomorphic tasks autonomously or functionally with the human under known or uncertain environments. Therefore, the basic components of any intelligent control system include cognition, perception, learning, sensing, planning, numeric and symbolic processing, fault detection/repair, reaction, and control action. These components must be linked in a systematic, ergonomic and efficient way. Preadecors of intelligent control are adaptive control, self-organizing control, and learning control which are well within the systems in the literature. Typical example applications of intelligent controls are intelligent robotic systems, intelligent manufacturing systems, intelligent medical systems, and intelligent space teleoperators. Intelligent controllers must employ both quantitative and qualitative information and must be able to cope with severe temporal and spatial variations, in addition to the fundamental task of achieving the desired transient and steady-state performance. Of course, the level of intelligence required in each particular application is a matter of discussion between the designers and users. The current literature on intelligent control is increasing, but the information is still available in a dispersed and disorganized way. This book discusses and compares several new trends that can be used to overcome Moore's law limitations, including Neuromorphic, Approximate, Parallel, In Memory, and Quantum Computing. The author shows how these paradigms are used to enhance computing capability as developers face the practical and physical limitations of scaling, while the demand for computing power keeps increasing. The discussion includes a state-of-the-art overview and the essential details of each of these paradigms. Emerging Neuromorphic Devices focuses on the future direction of semiconductor and emerging nanoscale device technology. As the dimensional scaling of CMOS approaches its limits, alternative information processing devices and microarchitectures are being explored to sustain increasing functionality at decreasing cost into the indefinite future. This is driving new paradigms of information processing enabled by innovative new devices, circuits, and architectures, necessary to support an increasingly interconnected world through a rapidly expanding internet. This original title provides a fresh perspective on emerging research devices in 25 up-to-date chapters written by the leading researchers in their respective areas. It supplements and extends the work performed by the Emerging Research Devices working group of the International Technology Roadmap for Semiconductors (ITRS). Key features: Serves as an authoritative tutorial on innovative devices and architectures that populate the dynamic world of "Beyond CMOS" technologies. Provides a realistic assessment of the strengths, weaknesses and key enablers associated with each technology. Suggests guidance for the directions of research and development. Enables real-world physical concepts and techniques for the development of neuromorphic devices. Explains current co-design and simulation methodologies for building hardware neuromorphic architectures and algorithms for machine learning applications. This book focuses on how to build energy-efficient hardware for neural networks with learning capabilities—and provides co-design and co-optimization methodologies for building hardware neural networks that can learn. Presenting a complete picture from high-level algorithm to low-level implementation details, Learning in Energy-Efficient Neuromorphic Computing: Algorithm and Architecture Co-Design also covers many fundamentals and essentials in neural networks (e.g., deep learning), as well as hardware implementation of neural
networks. The book begins with an overview of neural networks. It then discusses algorithms for utilizing and training rate-based artificial neural networks. Next comes an introduction to various options for executing neural networks, ranging from general-purpose processors to specialized hardware, from digital to analog accelerators. A design example on building energy-efficient analog accelerators for adaptive dynamic programming with neural networks is also presented. An examination of fundamental aspects of neuromorphic computing and learning algorithms for analog neuromorphic networks follows. Of these, two most design elements are described. The first is the use of emerging nanotechnology and one on emerging on neuromorphic architectures to implement the learning algorithm found in the previous chapter. The book concludes with an outlook on the future of neuromorphic hardware hardware. Includes cross-layer survey of hardware accelerators for neuromorphic algorithms Covrs the co-design of analog architectures with algorithms for much-improved computing efficiency Focuses on the co-design of algorithms and hardware, which is especially critical for using emerging devices, such as traditional memristors or diffusive memristors, for neuromorphic computing Learning in Energy-Efficient Neuromorphic Computing: Algorithm and Architecture Co-Design is an ideal resource for researchers, scientists, software engineers, and hardware engineers dealing with the ever-increasing requirement on power consumption and response time. It is also excellent for teaching and training undergraduate and graduate students about the latest generation neural networks with powerful learning capabilities.Thinking Machines: Machine Learning and Its Hardware Implementation covers the theory and application of machine learning, neuromorphic computing and neural networks. This is the first book that focuses on machine learning accelerators and hardware development for machine learning. It presents not only a summary of the latest trends and examples of machine learning hardware and basic knowledge of machine learning in general, but also the main issues involved in its implementation. Readers will learn what is required for the design of machine learning hardware for neuromorphic computing and/or neural networks. This is a recommended book for those who have basic knowledge of machine learning or those who want to learn more about the current trends of machine learning. Presents a clear understanding of various available machine learning hardware accelerator solutions that can be applied to selected machine learning algorithms Offers key insights into the development of hardware. From algorithms, software, logic circuits and hardware accelerators to new silicon products, explaining how to find a balance between the new trend of research and the best use of existing technology. The book provides a comprehensive overview of the latest research trends in this emerging research topic including materials and device aspects, algorithmic aspects, circuits and architectures and target applications. This book provides a full picture of research studies that can be applied to selected machine learning algorithms. The book provides a balanced view of industrial and academic developments beyond silicon and complements traditional neuromorphic computing. The book provides a good overview of the most advanced developments in the design of diverse forms of plasticity, from the single circuit to complex network. For this reason, the neuromorphic community at large has put substantial effort in the design of new plasticity forms. In addition, the neuromorphic community has also focused on the practical use of these plasticity forms. These plasticity forms comprise, among others, Short Term Depression and Facilitation, modification of the strength of synaptic connections that gate the flow of information across neurons. Plasticity is an essential property that enables the brain to adapt to changing conditions, allowing it to learn and remember. The brain is able to learn and adapt to ever-changing environmental conditions, tasks and stimuli. It emerges from a number of different forms of plasticity, which change the properties of the computing substrate, mainly acting on the modification of the strength of synaptic connections that gate the flow of information across neurons. Plasticity is an essential ingredient for building artificial autonomous cognitive agents that can learn to reliably and meaningfully interact with the real world. This book provides a comprehensive overview of the latest research trends in this emerging research topic including materials and device aspects, algorithmic aspects, circuits and architectures and target applications. This book provides a full picture of research studies that can be applied to selected machine learning algorithms. The book provides a balanced view of industrial and academic developments beyond silicon and complements traditional neuromorphic computing. The book provides a good overview of the most advanced developments in the design of diverse forms of plasticity, from the single circuit to complex network.
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research community. This eBook collects 17 cutting edge research articles, covering neural and morphological computations as well as the transfer of results to real world applications, like prosthesis and orthosis control and neuromorphic hardware implementation. Explore the cutting-edge of neuromorphic technologies with applications in Artificial Intelligence In Neuromorphic Devices for Brain-Inspired Computing: Artificial Intelligence, Perception, and Robotics, a team of expert engineers delivers a comprehensive discussion of all aspects of neuromorphic electronics designed to assist researchers and professionals to understand and apply all manner of brain-inspired computing and perception technologies. The book covers both memristive and neuromorphic devices, including spintronic, multi-terminal, and neuromorphic perceptual applications. Summarizing recent progress made in five distinct configurations of brain-inspired computing, the authors explore this promising technology's potential applications in two specific areas: neuromorphic computing systems and neuromorphic perceptual systems. The book also includes: A thorough introduction to two-terminal neuromorphic memristors, including memristive devices and resistive switching mechanisms Comprehensive explorations of spintronic neuromorphic devices and multi-terminal neuromorphic devices with cognitive behaviors Practical discussions of neuromorphic devices based on chalcogenide and organic materials In-depth examinations of neuromorphic computing and perceptual systems with emerging devices Perfect for materials scientists, biochemists, and electronics engineers, Neuromorphic Devices for Brain-Inspired Computing: Artificial Intelligence, Perception, and Robotics will also earn a place in the libraries of neurochemists, neurobiologists, and neurophysiologists. This book is concerned with Artificial Intelligence (AI) concepts and techniques as applied to industrial decision making, control and automation problems. The field of AI has been expanded enormously during the last years due to that solid theoretical and application results have accumulated. During the first stage of AI development most workers in the field were content with illustrations showing ideas at work on simple problems. Later, as the field matured, emphasis was turned to demonstrations that showed the capability of AI techniques to handle problems of practical value. Now, we arrived at the stage where researchers and practitioners are actually building AI systems that face real-world and industrial problems. This volume provides a set of twenty four well-selected contributions that deal with the application of AI to such real-life and industrial problems. These contributions are grouped and presented in five parts as follows: Part 1: General Issues Part 2: Intelligent Systems Part 3: Neural Networks in Modelling, Control and Scheduling Part 4: System Diagnostics Part 5: Industrial Robotic, Manufacturing and Organizational Systems Part 1 involves four chapters providing background material and dealing with general issues such as the conceptual integration of qualitative and quantitative models, the treatment of timing problems at system integration, and the investigation of correct reasoning in interactive man-robot systems.

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