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IFIP is the global non-profit federation of societies of ICT professionals that aims at achieving a worldwide professional and socially responsible development and application of information and communication technologies.

IFIP is a non-profit-making organization, run almost solely by 2500 volunteers. It operates through a number of technical committees and working groups, which organize events and publications. IFIP's events range from large international open conferences to working conferences and local seminars.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is generally smaller and occasionally by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is also rigorous and papers are subjected to extensive group discussion.

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Zhongzhi Shi · Yaochu Jin ·
Xiangrong Zhang (Eds.)

Intelligence Science IV

5th IFIP TC 12 International Conference, ICIS 2022
Xi'an, China, October 28–31, 2022
Proceedings

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Preface

This volume comprises the Fifth International Conference on Intelligence Science (ICIS). Artificial intelligence research has made substantial progress in some special areas so far. However, deeper understanding of the essence of intelligence is far from sufficient and, therefore, many state-of-the-art intelligent systems are still not able to compete with human intelligence. To advance the research in artificial intelligence, it is necessary to investigate intelligence, both artificial and natural, in an interdisciplinary context. The objective of this conference is to bring together researchers from brain science, cognitive science, and artificial intelligence to explore the essence of intelligence and the related technologies. The conference provides a platform for discussing some of the key issues that are related to intelligence science.

For ICIS 2022, we received more than 87 papers, of which 44 were included in the program as regular papers and five as short papers. All papers submitted were reviewed by three referees. We are grateful for the dedicated work of both the authors and the referees, and we hope these proceedings will continue to bear fruit over the years to come.

A conference such as this could not succeed without the help of many individuals, who contributed their valuable time and expertise. We want to express our sincere gratitude to the Program Committee members and referees, who invested many hours for reviews and deliberations. They provided detailed and constructive review reports that significantly improved the papers included in the program.

We are very grateful for the sponsorship of the following organizations: the Chinese Association for Artificial Intelligence (CAAI), IFIP TC12, and the China Chapter of the International Society for Studies of Information. ICIS 2022 was organized by Xidian University and the CAAI Intelligence Science Technical Committee, and supported by IFIP TC 12 and the Institute of Computing Technology of the Chinese Academy of Sciences. Thanks go to Biao Hou as chair of Local Organizing Committee. We specially thank Dan Zhang, Junpeng Zhang, Bo Ren, and Weitong Zhang for carefully preparing the proceedings.

Finally, we hope you find this volume inspiring and informative.

July 2022

Zhongzhi Shi
Yaochu Jin
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**Abstracts of Keynote and Invited
Talks**

Tactile Situations: A Basis for Manual Intelligence and Learning

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Abstract. Intelligence as we see it in humans and some animals appears key to enable agents to cope with situations of high variability. This is still a challenge for AI systems which currently excel in focused domains for which abundant training data is available. To bring these methods to domains such as robotics, where physical interaction is a strong bottleneck for obtaining large data sets, is still a largely unsolved problem. Comparing artificial and natural cognitive agents reveals that the latter are much more capable of generalizing their skills to novel situations - a key capability to learn and act successfully when interaction data are costly and possibly even dangerous to obtain. Therefore, a key challenge for further progress is a better understanding of how a cognitive agent can represent situations with regard to relevance and generalizability of interaction skills under conditions of data parsimony. While we begin to see encouraging progress on this question when the focus is on the visual modality, actions in the real world require to complement vision with the management of physical contact in order to move the body or even manipulate objects. We argue that this requires to understand how to sense and represent “tactile situations” and point out how these are crucial for shaping physical interactions with the environment and enabling agents to control their hands in a way that exhibits “manual intelligence”. We take a look at the challenges that are involved, how representing “tactile situations” needs to cover a hierarchy from low level sensing to high level cognition, and how we can create the necessary touch sensing and processing capabilities for dextrous robot hands. We present examples and results on different situations of tactile learning and action control in robotics contexts and point out ideas about how we can bring together these elements for creating manual intelligence anchored in the combined control of touch and vision. We finally comment on how this research fits with ideas and recent insights about how situations may be represented in the brain, and how connections between robotics and brain science can foster our scientific understanding and help to create better cognitive interaction technology in the future.

Brain-like Perception and Cognition: Challenges and Thinking

Licheng Jiao

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Abstract. The intelligent interpretation of high-resolution remote sensing images is a technological high point that countries all over the world compete for. However, the high-resolution observation requirement brings difficulties to efficient target information acquisition, and the multi-scale singularity, complexity and diversity of targets greatly increase the difficulty of target modeling and target information learning and identification. Visual perception and brain cognition (sparseness, learning, selectivity and directionality) provide ideas for efficient and accurate high-resolution remote sensing image perception and interpretation. Drawing on the mechanism of biological visual cognition and perception, the acquisition (sense), interpretation (knowledge) and application (use) of high-resolution remote sensing information are studied.

Dealing with Concept Drifts in Data Streams

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Abstract. One of the major challenges in machine learning is that future testing data are usually different from historical training data. What was learned from the historical data may or may not be appropriate for future data. In online learning of data streams, learned concepts may drift due to changes in underlying data distributions. How to detect and adapt to concept drifts have been an active research topic for many years. Such research has a wide range of real-world applications, e.g., in online fault diagnosis and condition monitoring. First, this talk introduces learning in the model space as an effective approach to deal with changes in data streams. Instead of trying to detect changes in a data stream directly, the approach first learns generative models of the data stream and then detect changes in such a model space. Second, this talk describes an ensemble learning approach, i.e., DDD (Diversity for Dealing with Drifts), to online learning with concept drift, where ensembles with different diversity levels are learned and adapted before and after a drift is detected. The impact of class imbalance is investigated in online learning with concept drift. Class evolution, i.e., class emergence and disappearance, in data streams will be discussed. An ensemble learning method, i.e., Diversity and Transfer-based Ensemble Learning (DTEL), that adapts selected base learners while maintaining ensemble diversity will be mentioned. Finally, the talk presents a Hierarchical Change Detection Test (HCDDT) for concept drift detection in data streams. Finally, concluding remarks will be made at the end of the talk.

A Novel Bionic Imaging and Its Intelligent Processing

Guangming Shi

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Abstract. To overcome the inconvenience of undesirable imaging quality of traditional cameras under extreme lighting conditions and high-speed motion scenes, the bio-inspired imaging technology, which subverts the information acquisition mode and photoelectric conversion method of traditional imaging system, is researched with an increasingly quickening developing pace. The bionic vision sensor is independent of exposure time and frame rate, which offers attractive properties: high-speed imaging (in the order of μs), very high dynamic range (greater than 100dB), low power consumption. Hence, bionic imaging has a large potential for industrial intelligence manufacturing and intelligent transportation in challenging scenarios with high speed and high dynamic range. The photosensitive chip involved in the imaging technology and the back-end intelligent processing algorithm (e.g., Denoising, Recognition and Reconstruction) are developed by our research group, with a high degree of independent controllability.

Skill Learning in Dynamic Scene for Robot Operations

Fuchun Sun

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Abstract. The robot AI is dominated by physical interaction in closed-loop form. It not only emphasizes the perception and processing of simulated human brain information, but also emphasizes brain body cooperation to solve the dynamic, interactive and adaptive problems of behavior learning in dynamic scene. As the core of robot AI, skill learning for robot operations is a difficult and hot issue in current research. In view of the problems that the existing skill learning methods do not make use of the teaching samples efficiently and cannot achieve efficient strategy learning, and the imitation learning algorithm is sensitive to the teaching preference characteristics and the local operation space. This talk studies the skill learning for robot operations in the complex dynamic environment, and proposes skill learning framework based on human preference. By using the guidance of the existing poor teaching samples, this talk proposes an optimization method of reinforcement learning based on teaching imitation, which improves the sample utilization rate and strategy learning performance of skill learning in high-dimensional space. Finally, the future development of robot skill learning is prospected.

Emerging Artificial Intelligence Technologies in Healthcare

Huiyu Zhou

School of Computing and Mathematical Sciences, University of Leicester, UK

Abstract. Artificial intelligence has significantly influenced the health sector for years by delivering novel assistive technologies from robotic surgery to versatile biosensors that enable remote diagnosis and efficient treatment. While the COVID-19 pandemic is devastating, the uses of AI in the healthcare sector are dramatically increasing and it is a critical time to look at its impact in different aspects. In this talk, Prof. Zhou will introduce the application of new deep learning models in medical image understanding. Then, he will discuss Parkinson's disease (PD) whilst investigating the behaviour analysis of PD mice. He also presents the use of machine learning technologies in sentiment analysis, followed by the discussion on several challenges.

Memory Cognition

Zhongzhi Shi

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Abstract. Memory is the core cognitive function of human beings. It is one of the most concerned topics in the field of intelligence science and artificial intelligence. Memory is the basis of learning and intelligence. It is the bridge and link between human spiritual activities and intelligent system simulation. With the support of the national 973 projects, we carried out research on memory cognition and put forward mind model CAM, cognitive model on brain computer integration, etc. In this talk, I will focus on mind model CAM, memory classifications and the integration of memory and computing.

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