Intelligent Information Processing

The study of intelligent information processing seeks to establish theories, algorithms, and systematic methods and technology for dealing with complex system information and its uncertainty. It has broad applications in complex system modeling, system analysis, decision, control, optimization, and design. It is an interdisciplinary subject in computer science, involving neural networks, fuzzy systems, evolutionary computation, chaos dynamics, classification theory, wavelet transform, artificial intelligence (AI), and so on.

From information carrier to information processing, human intelligence is widely simulated to process various kinds of information. Combining AI and cognitive science will further promote human self-understanding and control. Studying the theory and method of intelligent information processing with cognitive mechanisms, exploring the mechanism of cognition, building an available computing model, and developing applications could bring a breakthrough in future information processing technology. At the present, this technology shows two tendencies: one toward using large-scale and multimedia information to make computer systems capable of handling a wider range of information; the other toward incorporating AI to make computer systems more intelligent for information processing.

Intelligent information processing research includes basic, key technology, and application investigations. It not only has high theoretical research value but also great significance for the development of the information industry and economic constructions. The basic theory of intelligent information processing covers everything from the mathematical theory of information and knowledge processing to algorithm design and analysis of complex system, parallel processing theory and algorithm, quantum computing and computational biology and other new computing modes, machine learning theory and algorithm, and bioinformatics and neural information processing. In specific fields based on Internet applications, it can be used for large-scale text processing, natural language processing, image and video information retrieval and processing, knowledge mining, refining and integration, and more.

This issue highlights four aspects of intelligent information processing: multicriteria decision-making, image processing and classification, intelligent transportation, and energy management.

Multicriteria decision-making concerns the structuring and solving of decision and planning problems involving multiple criteria. There usually is not a unique optimal solution for such problems, so it is necessary to use the decision-maker’s preferences to differentiate between solutions. The mechanism of multicriteria decision evaluation includes evaluation, queuing, and optimization for multiple solutions; for a single solution, all influence factors are treated as main criteria. They are identified through a series of information processing and extraction steps and then weighted; the results become a decision matrix. Decision discriminating methods organize information and combine it into a dynamic analysis system with a strong analytical machine.
information can then be processed rapidly using modern computer technology and intelligent algorithms. In “Information Aggregation of Hesitant Fuzzy Interval Sets for Multicriteria Decision-Making,” Decui Liang, Dun Liu, and Wei Quan propose a novel hesitant fuzzy interval set (HFIS). They use information granulation to compare HFISs and design a ranking approach for this information processing context.

Images are also a kind of signal, and intelligent information processing can be used for image processing and classification. Image processing involves transformation and processing between images, while image classification distinguishes the categories of target objects by analyzing and extracting different features. Whether the image is processed by filtering or some machine learning method, intelligence algorithms can effectively analyze images to simulate human visual interpretation to a certain extent. In “Multiperspective Image Stitching and Regularization via Hybrid Structure Warping,” Yan Lu, Zizheng Hua, Kun Gao, and Tingfa Xu propose a content-preserving image stitching and completion method that focuses on dealing with image distortions more intelligently and effectively, especially in multiperspective shooting. The authors designed an optimized local warping method and a multiconstraint hybrid structure-warping model to reduce the distortions in overlapping and nonoverlapping regions. In “Multiple VLAD Encoding of CNNs for Image Classification,” Qing Li, Qiang Peng, and Chuan Yan describe their multiple vector of locally aggregated descriptors (VLAD) encoding method with convolutional neural network (CNN) features for image classification. They explore the multiplicity of VLAD encoding with the extension of three kinds of encoding algorithms.

Intelligent transportation is an effective way to solve traffic problems such as congestion, accidents, energy consumption, and pollution. One of the most important tasks is to control and optimize traffic signals using traffic signal control, which is based on traffic data processing, traffic flow prediction, and comprehensive evaluation of traffic conditions. Traffic data are usually collected by embedded devices and sensors, and stored in a database. They can be processed appropriately by information fusion and analyzed by intelligent algorithm. The reliability of services offered by intelligent transportation systems (ITSs) is attributed to accuracy and timely availability of road-network traffic information. In “Low Dimensional Models for Traffic Data Processing using Graph Fourier Transform,” Narendra Babu Chindanur and Pallaviram Sure consider compliance to anticipated service quality requirements and consistent real-time processing of big spatiotemporal traffic data, using data graph framework (DGF) and graph Fourier transform (GFT) approaches to develop such representations.

Energy management can involve a network or a unit. For a network (such as a power, thermal, or natural gas network), the energy scheduling problem is, in fact, a constrained planning problem. It depends on the optimal control objectives of energy management, follows some physical constraints, and makes use of optimal methods to develop the optimal energy management and operation mode. For a unit (such as an energy storage unit), the output power might be volatile. When environmental conditions such as irradiation, temperature, and wind speed vary, the power generated by the renewable energy sources will have corresponding changes. This will lead to unbalanced power in the system. To stabilize power fluctuations, energy management system can use intelligent algorithms to improve the system’s reliability. In “Multiagent-based Coordination Consensus Algorithm for State-of-Charge Balance of Energy Storage Unit,” Hanqing-Yang, Liangzhen Yin, Qi Li, Weirong Chen, Lijun Zhou focus on simultaneously handling the problem of state-of-charge (SoC) consensus and DC bus voltage stability. They establish a multiagent model of a distributed energy storage system and design a discrete consensus algorithm to obtain the entire system’s average voltage and SoC to calculate its virtual resistance.

These articles will hopefully inspire others to investigate their own ideas and methods and serve as good references for research on intelligent information processing.

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