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EDITORIAL

# IEEE ACCESS SPECIAL SECTION EDITORIAL: BIG DATA LEARNING AND DISCOVERY

## I. INTRODUCTION

We are now witnessing a dramatic growth of heterogeneous data, consisting of a complex set of cross-media content, such as texts, images, videos, audio, graphics, spatio-temporal data, and multivariate time series. The inception of modern techniques from computer science have offered very robust and hi-tech solutions for data and information analysis, collection, storage, and organization, as well as product and service delivery to customers. Recently, technological advancements, particularly in the form of big data, have resulted in the storage of enormous amounts of potentially valuable data in a wide variety of formats. This situation is creating new challenges for the development of effective algorithms and frameworks to meet the strong requirements of big data representation and analysis, knowledge understanding, and discovery.

The time is now ripe to explore advanced theories and techniques for heterogeneous big data learning and discovery and that is the focus of this Special Section. This includes theories related to data acquisition, feature representation, time series analysis, knowledge understanding, data-based modeling, dimension reduction, semantic modeling, and the novel and promising big data analytic research direction, e.g., image/video captioning, affection computing, multimedia storytelling, internet commerce, healthcare, earth system, communications, and augmented/virtual reality.

The submissions for this Special Section came from an open Call for Papers. Sixty-seven articles were eventually accepted after a rigorous peer review. From the aspect of applications, these articles cover multiple scenarios for big data analysis, such as motor imagery, networked healthcare system, publicity translations, network security communication, image encryption, stock market, social media understanding, image recognition, and other applications. From the aspect of techniques, they cover diverse aspects of computer vision, time series analysis, and machine learning, such as complex network, multimodal feature fusion, deep learning, principal component analysis, and similarity diffusion.

The following is a summary of the articles in this Special Section:

In [A1], Liu *et al.* constructed a complex network from time series by exploring the evolutionary relationship among the volatility patterns. They selected six stock indices around the world as sample data. The results indicated that for the six networks, they all showed a ''petal-shaped'' structure which consists of a core and loops. Through analyzing the topological characteristics of the six networks, they discovered distinguished results of their overall characteristics and loop length distributions which provided a novel perspective to understand the evolutionary dynamic mechanism.

In [A2], Muhammed *et al.* proposed a ubiquitous healthcare framework, UbeHealth, which leverages edge computing, deep learning, big data, high-performance computing (HPC), and the Internet of Things (IoT) to address the challenges hindering the realization of next-generation healthcare. The framework enabled an enhanced network quality of service using its three main components and four layers. Three widely used datasets were used to evaluate the UbeHealth system.

In [A3], Wang *et al.* chose 1000 pieces of Chinese and English publicity materials as study objects to examine similarities and differences between English and Chinese language publicity material networks and to reveal the core factors manifested in these materials. They discussed appropriate contemporary translation theories that were suitable for guiding China's publicity translations and explored a new research perspective for the study of China's publicity translations.

In [A4], Wang *et al.* investigated the synchronization in the mean square sense of memristive, multidirectional associative memory neural networks with mixed, time-varying delays, and stochastic perturbations. A secure communication scheme to realize secure data transmission was designed. Meanwhile, the effectiveness of the proposed theories was validated with numerical experiments.

In [A5], Wang *et al.* proposed a novel memristive multidirectional associative memory neural network (MAMNN) model with mixed time-varying delays. To illustrate the chaotic characteristics of the memristive MAMNNs, an image encryption scheme was designed. Meanwhile, the effectiveness of the proposed theories was validated with numerical experiments.

In [A6], Chen *et al.* used a combination of a deep-learning-based stock index futures prediction model, an autoencoder, and a restricted Boltzmann machine to further improve the predictive performance for stock index futures. They found that the deep learning method to predict stock index futures outperformed the backpropagation, the extreme learning

machine, and the radial basis function neural network in its fitting degree and directional predictive accuracy. They also found that increasing the amount of data increased the predictive performance. This indicated that deep learning captured the nonlinear features of transaction data and can serve as a powerful stock index futures prediction tool for financial market investors.

In [A7], Mitrea *et al.* analyzed and upgraded the performances of the Baxter intelligent robot through data mining methods. The explored data comprised the parameters registered during the activities of the Baxter intelligent robot. Based on the experiments, important relationships among the robot parameters were discovered, the obtained accuracy for predicting the target variables being always above 96%.

In [A8], Wang *et al.* investigated the consensus problem for multi-agent systems subjected to sampled data and packet losses. A novel nonlinear function was introduced in the construction of the piecewise differentiable Lyapunov functions, and the Wirtinger inequality was applied as well. The validity, the effectiveness, and the practical applicability of their results were verified in the simulation examples.

In [A9], Yu *et al.* proposed a streaming algorithm that achieved a $((1/1+2\mathrm{d})-\varepsilon)$ approximation of the optimal value which only needed one single pass through the dataset without storing all the data in the memory. In their experiments, they extensively evaluated the effectiveness of their proposed algorithm via two applications: news recommendation and scientific literature recommendation. It was observed that the proposed streaming algorithm achieved both execution speedup and memory saving by several orders of magnitude, compared with existing approaches.

In [A10], Wang *et al.* proposed a chaotic color image encryption algorithm based on memristor-based bidirectional associate memory neural networks (MBAMNNs) in order to realize the image encryption. Illustrative examples were provided to verify the developed finite-time projective synchronization results. Analysis of the encryption effect demonstrated the security of the proposed image encryption algorithm, and the potential applications of their models in secure image transmission were analyzed.

In [A11], Cheng *et al.* proposed a method based on a space-filling Hilbert curve to linearize and embed the network into a ring structure, visualizing the data traffic as flowlines in the ring interior. They compared their method with traditional 2-D embedding techniques designed for high-dimensional data and showed that traditional methods were inferior to theirs in this application. As a demonstration of their approach, they visualized the data flow of a massively parallel scientific code on a 5-D torus network.

In [A12], Liu *et al.* proposed a 2-D-slice-based segmentation method. In particular, they used multi-spectral MRIs, i.e., diffusion-weighted image, apparent diffusion coefficient, and T2-weighted image, as input, and proposed a residual-structured fully convolutional network (Res-FCN). The proposed Res-FCN was further evaluated on a public dataset, i.e., ISLES2015-SISS, which presented a very competitive result among all 2-D-slice-based segmentation methods.

In [A13], Ke *et al.* proposed a score-based criteria fusion feature selection method (SCF) for cancer prediction. The SCF method was evaluated on five open gene microarray datasets and three low-dimensional datasets. Experiments verified that SCF was able to find more discriminating features than competing methods and can be used as a preprocessing algorithm to combine with other methods effectively.

In [A14], Lao *et al.* proposed a novel multimodal feature fusion approach named multimodal local perception bilinear (MLPB) pooling, which can retain the second-order interactions between visual and textual features with limited learning parameters. Extensive experiments showed that the proposed method can achieve competitive or better performance than the state of the art.

In [A15], Zhang *et al.* developed a novel algorithm which did not need to map the original data to the space of other dimensions for processing, but realized the dimension reduction by analyzing the correlation between the dimensions, and therefore, the physical meaning of the original dataset was retained. Experimental results demonstrated that the algorithm provided promising accuracy, a greater ability to reduce dimension and preservation of the original data.

In [A16], Gao *et al.* designed and conducted experiments to record electroencephalograph (EEG) signals during left and right hand movement imagery tasks and then probed into brain activities by analyzing multichannel motor imagery signals from the perspective of complex networks. Results demonstrated that when subjects imagined left-hand movements, the node betweenness centrality (BC) of the right sensorimotor area was greater than that of the left sensorimotor area. The node BC distribution was roughly opposite when imagining right-hand movements.

In [17], Liu *et al.* achieved the all-in-focus image via the computational imaging method by designing the data acquisition process under the condition of maintaining the signal-to-noise ratio. In the simulated experiments, the computational imaging results in different object planes were analyzed based on the structural similarity index to verify the all-in-focus sweep imaging method. In the real data experiments, the resolution targets placed in two different depths can be imaged with extended depth of field via the all-in-focus imaging method proposed in this article.

In [A18], Gao *et al.* explored the cross-domain action recognition problem by three different kinds of aspects: feature learning, unsupervised cross-domain learning, and supervised cross-domain learning. Moreover, they contributed a novel multi-view and multi-modality human action recognition dataset (abbreviated as ''MMA''). The extensive experimental results showed that the deep feature learning method had much better generalization ability than the hand-crafted feature. Both unsupervised cross-domain learning method and supervised cross-domain learning method can improve the performance, but the latter can obtain much bigger improvement.

In [A19], Song *et al.* proposed a merge iteration computing model (MIM) which stated how to execute iterative algorithms effectively through reusing the existing results without sacrificing the accuracy; this mechanism was suitable for most iterative algorithms. Under the various test cases, the maximum optimization ratio of Mim was 25% and 56% compared with regular iteration on PageRank and K-means, respectively. The errors were negligible.

In [A20], Xu *et al.* investigated the disappearing link prediction problem. They proposed a novel method called modified preferential attachment (MPA) for predicting disappearing links. The experimental results showed that MPA achieved better performance than other classical similarity indices, which verified the effectiveness of MPA.

In [A21], Wang *et al.* proposed a virtual image points-based geometrical parameters' calibration for a focused light field camera. They used a checkerboard for the calibration experiment and validated the calculation via the reprojection of the checkerboard corners.

In [A22], Zhao *et al.* investigated the quadrotor tracking control by designing an adaptive sliding mode controller based on the backstepping technique, with the advantages of simplicity in design and ease of application. The authors employed a Kalman filter for sensor data fusion and state estimation. Gazebo was applied by creating a 3-D dynamic environment to recreate complex environments potentially encountered in the real world.

In [A23], Kemeth *et al.* first validated this ''emergent space'' reconstruction for time series sampled without space labels in known PDEs. Then, they presented actual emergent space ''discovery'' illustrations. They also discussed how data-driven ''spatial'' coordinates can be extracted in ways invariant to the nature of the measuring instrument. Such gauge-invariant data mining can go beyond the fusion of heterogeneous observations of the same system, to the possible matching of apparently different systems.

In [A24], Qiu *et al.* proposed the affine Radon transform for generating the focal stack by a light field. The experimental results showed that the high-precision light field can be reconstructed from focal stack based on the approximated inverse affine Radon transform.

In [A25], Xiong *et al.* proposed a hybrid resource pool model to reduce the complexity of VM migration planning by limiting the scope of VM migration decisions. Results showed that HirePool improved average resource usage by 13%, saved the number of PMs used by 12%, and reduced the average number of migrations (compared with contrast mechanisms) by 31%.

In [A26], Zhang *et al.* compared the forecasting accuracy of two typical univariant econometric models and three artificial neural networks (ANNs)-based algorithms. They found that when using daily data, econometric forecasting models produced better one-step-ahead predictions than ANN-based algorithms. When forecasting weekly and monthly data, ANN-based algorithms produced fewer errors and a higher direction matching rate than econometric models. They also compared the predictive power of a number of different models when applied to the 2008 financial crisis and found that the generalized autoregressive conditional heteroskedasticity model and the backpropagation neural network algorithm produced the best one-step-ahead and seven-steps ahead predictions, respectively.

In [A27], Cong *et al.* proposed a principal component analysis-based algorithm for reducing the gene data dimension in order to cluster SNP sites in the low-dimensional space. Moreover, an oriented graph theory-based tagSNPs selection algorithm was designed. Finally, relying on the real-world 1000 Genomes Project dataset, they can achieve fewer tagSNPs than the traditional methods by invoking the complete process of their designed SNP classifier.

In [A28], He *et al.* studied the intraday return and volatility spillovers of Chinese CSI 300 industry indices with high-frequency data over the period from May 2012 to June 2016. The result showed that correlations between the CSI 300 industry indices were high, but they were susceptible to the fluctuation of the index. Furthermore, spillover indicators were calculated with the generalized variance decomposition method with intraday return and volatility, respectively. They concluded that the dynamic characteristics of return and volatility spillover had strong early warning effects on systemic risk, especially the spillover dynamics of the finance and real estate industry. Finally, additional tests were performed with different sample frequencies and forecast steps to prove the robustness of their results.

In [A29], Du *et al.* employed convolutional neural networks (CNNs) to identify oil-water two-phase flow patterns. The results showed that networks with deeper structures preserved relatively high flow pattern recognition accuracy.

In [A30], Lin *et al.* proposed a novel game theory-based model, called Equal Responsibility Rumor Diffusion Game Model (ERRDGM), to simulate the rumor diffusion process. Their experimental results indicated that their ERRDGM model can give a more accurate rumor diffusion predication result not only from the diffusion scale but also from the social network structure.

In [A31], Xiao *et al.* proposed two novel trajectory similarity measurements, i.e., maximum–minimum trajectory distance and the sum of minimum trajectory distance, and analyzed the correlation among the spatial–temporal similarity and textual similarity. Finally, the measurement validity was verified and visualized through clustering, by both a simulation dataset and a real dataset.

In [A32], Yang *et al.* performed data mining from the velocity vector fields, measured by the particle image velocimetry and structural analysis on the selected POD-based reconstructed turbulent flows in front of and on top of smooth and roughness-resolved forward-facing steps (FFSs).

In [A33], Wen *et al.* introduced a new method to simplify noisy-filled financial temporal series via sequence reconstruction by leveraging motifs (frequent patterns), and then utilized a convolutional neural network to capture spatial

structure of time series. The experimental results showed the efficiency of their proposed method in feature learning and outperformance with 4%–7% accuracy improvement compared with the traditional signal process methods and frequency trading patterns modeling approach with deep learning in stock trend prediction.

In [A34], Yang *et al.* explored whether the introduction and enforcement of relevant laws and regulations will affect the financing decisions of SMEs based on the analysis of the distribution of degree value in financing complex networks. They also studied the impact of relevant regulatory changes on the critical factors of enterprises' financing decisions. This article provided a new perspective for quantitative analysis of the empirical study on the effective regulation state of the financing law for technology-based SMEs.

In [A35], Su *et al.* designed a hierarchical framework for human-action recognition. Different features were selected according to the level of action, and specific classifiers were selected for different features. Ten-fold cross-validations were used in their performance evaluation on public and self-built datasets, achieving average recognition rates of 95.69% and 97.64%, respectively. These outstanding results implied that the hierarchical step-wise precise classification can well reflect the inherent process of human action.

In [A36], Zhu *et al.* proposed a temporal difference Bayesian knowledge tracing model (TD-BKT) to incorporate temporal difference information into knowledge tracing. Experiments were done on a Junyi academy math practicing log dataset, comparing the diagnostic precision of knowledge state between a TD-BKT model and existing knowledge tracing models. The result was that their proposed TD-BKT model quantitatively showed great improvement in assessing online examinees' knowledge state.

In [A37], Sakri *et al.* compared the accuracy of few existing data mining algorithms in predicting breast cancer (BC) recurrence. In this article, they embedded a particle swarm optimization as feature selection into three renowned classifiers, namely, naive Bayes, K-nearest neighbor, and fast decision tree learner, with the objective of increasing the accuracy level of the prediction model.

In [A38], Yu *et al.* proposed a subjective–objective evaluation method. Experiments were performed with 300 testers who played mobile parkour games for at least five minutes. The accuracy and efficiency of the proposed method have been verified through real experiments and objective measures. In addition, this article provided an effective sampling method and a data analysis algorithm to obtain crucial user experience factors for mobile applications.

In [A39], Li *et al.* proposed a novel framework that can select the discriminative part in the spatial dimension and enrich the modeling action of motion in the temporal dimension. Their results were evaluated on the standard benchmarks UCF101 and HMDB51 and showed that the proposed architecture achieved state-of-the-art results.

In [A40], Zhang and Xiao discussed previous research about keyphrase generation, and how these approaches belong to an extractive method, by which they cannot effectively use the semantic meaning of the source text and are unable to generate keyphrases that do not appear in the source text. The authors proposed a sequence-to-sequence framework with attention mechanism, copy mechanism, and coverage mechanism, which can effectively deal with the above-mentioned drawbacks. The experimental results on five datasets revealed that their proposed model can achieve a better performance than the traditional extraction approaches and can also generate absent keyphrases which did not appear in the source text.

In [A41], Jin *et al.* proposed a novel algorithm for sparsity-based image inpainting detection. Experimental results on three publicly available datasets demonstrated their method's superiority over other competitors. Particularly, compared with previous inpainting detection methods, the proposed framework gave better performance in the cases of JPEG compression and Gaussian noise addition. The proposed method also showed promising results when employed to detect other types of inpainting.

In [A42], Jin *et al.* proposed an adversarial network for median filtering detection in RGB images. Their method was extensively evaluated in several publicly available datasets. The experimental results presented an obvious improvement compared with other competitors. Particularly, the proposed framework obtained better performances in the case of the small blocks with JPEG compression.

In [A43], Mohammadi and Al-Fuqaha investigated the creation of a dynamic ensemble from distributed deep learning models by considering the spatiotemporal patterns embedded in the training data. Their evaluation experiments using three real-world datasets in the context of the smart city showed that their proposed dynamic ensemble strategy led to an improved error rate of up to 33% compared to the baseline strategy even when using 1/3 of the training data. Moreover, using only 20% of the training data, the error rate of the model slightly increased by up to 2 in terms of mean square error. This increase was 82% less than the 11.3 increase seen in the baseline model.

In [A44], Chen *et al.* aimed at introducing the recent hybrid CF-based recommendation techniques, fusing social networks to solve data sparsity and high dimensionality. The authors provided a novel point of view to improve the performance of RS, thereby presenting a useful resource in the state-of-the-art research for future researchers.

In [A45], Liu *et al.* proposed a fine-grained spatial-temporal attention model (FSTA). They tested the proposed model on two benchmark datasets, namely, MSVD and MSR-VTT. The results indicated that their proposed FSTA model can achieve competitive performance against the state of the art on both datasets.

In [A46], Zhang *et al.* proposed an attention-based word-level interaction model (ABWIM) to alleviate the information loss issue caused by aggregating the sequence into a fixed-dimensional vector before the comparison. Experimental results of relation detection on both SimpleQuestions and

WebQuestions datasets showed that ABWIM achieved state-of-the-art accuracy, demonstrating its effectiveness.

In [A47], Fang *et al.* first enriched the semantic information of apps by extracting descriptive text of each app from the app store and proposing a topic model to transform apps as well as user preferences into latent vectors. Then, a set of nearest neighbors was constructed based on the similarity of latent vectors; it was employed for training the prediction model. Furthermore, their prediction scheme was built on the temporal sequential data and was modeled using the chain-augmented Naive Bayes model. Experimental results with real smartphone application log data have demonstrated that their method achieved higher recall and DCG values compared with several baseline next-app prediction methods.

In [A48], Hao *et al.* reconstructed a GSMN model based on the high-throughput transcriptome sequencing of *Eriocheir sinensis* hepatopancreas. Functional module analysis indicated that the metabolic modules in the network were consistent with the functions of hepatopancreas for lipid metabolism, amino acid metabolism, and other related metabolic processes. The GSMN supplied a novel dataset of the metabolic information in *E. sinensis* to facilitate the further analysis of the metabolic mechanism of *E. sinensis* and other aquatic crustaceans. It also provided a valuable reference for the studies on the regulation mechanism of eyestalk on hepatopancreas in *E. sinensis*.

In [A49], Liu *et al.* proposed an image deblurring algorithm based on a recurrent conditional generative adversarial network (RCGAN), in which the scale-recurrent generator extracted sequenced spatio-temporal features and reconstructed sharp images in a coarse-to-fine scheme. Extensive experiments proved the superiority of RCGAN over state-of-the-art algorithms both qualitatively and quantitatively.

In [A50], Yang *et al.* proposed a new ''binary approach.'' Numerical simulations were carried out on eight real-world datasets, showing that their binary approach performed as well as the traditional one-to-one approach, but used less output nodes and hidden-output weights.

In [A51], Salloum *et al.* proposed a new method for big data analysis. This method used only a few random sample data blocks of a big dataset to obtain approximate results for the entire dataset. The experimental results of three real datasets showed that a subset of RSP data blocks of a dataset was sufficient to obtain estimates and models equivalent to those computed from the entire dataset.

In [A52], Haq *et al.* presented DeepStar, a novel framework for starring character identification based on deep high-level robust features. The promising results obtained using representative Hollywood movies demonstrated the effectiveness of this method in detecting starring characters over state-of-the-art methods.

In [A53], Qi *et al.* chose a hybrid feature selection algorithm, FDHSFFS, and conducted comparative experiments on four UCI datasets with large differences in feature dimension and sample size, using five different cross-validation (CV) methods. The experimental results showed that in the process of feature selection, twofold CV and leave-one-out-CV were more suitable for the model evaluation of low-dimensional and small sample datasets, while tenfold nested CV and tenfold CV were more suitable for the model evaluation of high-dimensional datasets; tenfold nested CV was close to the unbiased estimation, and different optimal models may choose the same approximate optimal feature subset.

In [A54], Nie *et al.* proposed a novel, deep feature ranking scheme. Their main contribution was to rank achieved deep features, which were obtained by the classic deep learning model, and set the sort order number as their feature vector, named as ordinal deep features (ODFs). Comprehensive experiments were carried out to demonstrate the significance of the proposed feature. Meanwhile, comparative experiments were applied over the publicly available dataset; their method achieved promising performance and outperformed the state-of-the-art methods. They also applied the proposed feature in the scenario of image classification and discussed the effectiveness.

In [A55], Zhao *et al.* proposed an image translation network by exploiting attributes with the generated adversarial network, which can significantly contribute to the authenticity of the generated face by supplementing a sketch image with an additional facial attribute feature. Compared with the state-of-the-art methods of image translation, the performance of the proposed network was excellent.

In [A56], Tran *et al.* presented a novel framework DIR-ST2 for delineating an imprecise region by iteratively performing density-based clustering of applications with noise (DBSCAN) along with spatio-temporal-textual information on social media. They proposed an efficient and automated algorithm delineating the imprecise region via hierarchical clustering. Experimental results showed that DIR-ST2 method outperformed the state-of-the-art approach employing a one-class support vector machine in terms of the F1 score from comparison with precisely defined regions regarded as a ground truth and returned a better delineation of imprecise regions.

In [A57], Tang *et al.* introduced and formulated the problem of behavior pattern classification in blockchain networks and proposed a novel deep-learning-based method, termed PeerClassifier, to address the problem. They provided the first formal definition of the problem of peer behavior classification in blockchain networks. Moreover, they conducted extensive experiments to evaluate their proposed approach. Experimental results demonstrated that PeerClassifier was significantly more effective than the existing conventional methods.

In [A58], Wu *et al.* proposed a new paradigm that does not require feature selection so that data can speak for itself without manually picking their features. In addition, they also proposed using the deep network as a methodology to explore previously unknown relationships and capture complexity and non-linearity between target variables and a large number

of input features for big social data. The modeling included model setup and model structures change to achieve relatively high accuracy on prediction results at both model level and case level.

In [A59], Rajapaksha *et al.* explored news producers, news consumers, inter news production patterns, inter news dissemination behaviors, sharing similar news items within Twitter and Facebook (cross-posts), and news readers' reactions to news items. In addition, they investigated the best time period to receive the highest levels of interest from readers toward their news items as this information was useful for other news media to understand. Finally, they proposed a predictive model to increase news media popularity among readers; the results demonstrated that news media should disperse its own content, and that they need to publish before other news media publish the same content on social media in order to be popular and attract readers' attention.

In [A60], Liu *et al.* investigated the problem of a benign or malignant diagnosis of the pulmonary nodule with original thoracic computed tomography images, and presented a novel end-to-end deep learning architecture named dense convolutional binary-tree network (DenseBTNet). Besides introducing center-crop operation into the DenseNet, the DenseBTNet split isolated transition layers of the DenseNet and merged them with dense blocks, then adjusted feature-maps transition mode to compact the model. The DenseBTNet had several compelling advantages: 1) the DenseBTNet not only preserved densely connected mechanisms of the DenseNet to extract features of lung nodules in different levels but also further reinforced this mechanism to a level of dense blocks and enriched multi-scale features and 2) the DenseBTNet owned high parameter-efficiency and was lightweight in the scale of parameters as well. Experimental results showed that the DenseBTNet largely boosted the performance of the DenseNet and achieved higher accuracy on the task of lung nodule classification in comparison with state-of-the-art approaches.

In [A61], Xu *et al.* proposed novel stage-wise convolutional networks followed by an orientation-based region growing method. The stage-wise convolutional networks aimed to learn discriminating features of pulmonary vessels automatically in a stage-by-stage manner, where stage I was the lung segmentation module and stage II was the main vessel segmentation module. In stage I, the lung segmentation module extracted pulmonary regions based on the convolutional neural networks to preprocess computed tomography scans and provided a good initial value for subsequent work. In stage II, the main vessel segmentation module exploited refined fully convolutional networks to hierarchically learn rich representations for pulmonary vessels, which enabled accurate vessel segmentation. In addition, they further proposed an optimization module that refined the results from the previous module based on the orientation of vessels in 3D space. Extensive experiments demonstrated that the proposed method achieved best performance in pulmonary vessel segmentation compared with the state of the art.

In [A62], Shen *et al.* proposed a novel oriented feature selection SVM (OFSSVM) that combined fused lasso and elastic net as regularization for linear support vector machine (SVM), which considered the natural order of genes and used huberized hinge loss as the loss function. Due to the characteristics of the elastic net and fused lasso, the OFSSVM can not only provide automatic feature selection, but also average the adjacent coefficients, resulting in a sparse and smooth solution. The experiments showed that the OFSSVM was an appealing compromise between interpretability and classification accuracy, and was superior to other traditional methods in the sense of comprehensive evaluation.

In [A63], Usama *et al.* proposed a novel medical big data analysis method based on deep learning. This article proposed a new recurrent convolutional neural network (RCNN)-based disease risk assessment multimodel by utilizing structured and unstructured text data from the hospital. In the proposed model, the convolutional layer became a bidirectional recurrent neural network by utilizing the intra-layer recurrent connection within the convolutional layer. Each neuron within the convolutional layer received feedforward and recurrent inputs from the previous unit and neighborhood, respectively. In addition to the step-by-step recurrent operation, the region of context capture increased, thereby facilitating fine-grain feature extraction. Furthermore, they used a data parallelism approach over multimodel data during the training and testing of the proposed model. Results showed that the data parallelism approach led to fast conversion speed. The RCNN-based model worked differently from the traditional convolutional neural network and other typical methods. The proposed model exhibited a prediction accuracy of 96.02%, which was higher than those of typical existing methods.

In [A64], Li and Ye proposed a remote sensing image scene understanding method based on deep learning. This article proposed a novel annotation method for remote sensing image scene datasets called automatic aggregation via hierarchical similarity diffusion (AA-HSD). More specifically, each remote sensing image scene was represented by multiple features. To make full use of these complementary features, this article proposed a new hierarchical similarity diffusion method for robustly measuring the similarity matrix of the scenes in the dataset. Based on this similarity matrix, the scenes were automatically aggregated into clusters. Instead of annotating the dataset scene by scene, as in the traditional manual annotation solution, they annotated the dataset cluster by cluster, which dramatically increased the annotation speed while achieving very high accuracy. Extensive experiments on two public remote sensing image scene datasets demonstrated the validity of the proposed AA-HSD method, which outperformed all competing baselines.

In [A65], Li *et al.* proposed to bridge the gap between the sketch-photo pair by ''translating'' the abstract visual sketch into a photorealistic face with the help of descriptive attributes. Specifically, they proposed an improved multi-modal conditional generative adversarial network (MMC-GAN) to jointly utilize the complementary information

of visual sketches and semantic facial attributes to reduce the uncertainties of the facial image generation. A fusion network was introduced to better leverage the information from different modalities (visual sketch and semantic attributes). In order to improve the details of the generated facial images, they adopted a two-path generator structure in which the global feature and the local feature of human faces were learned in parallel. An identity-preserving constraint was further introduced to enhance the identity consistency between the sketches and facial images. Extensive experiments demonstrated that they can effectively manipulate the face image generation by varying the input facial attributes. The generated photorealistic face image was validated to improve the sketch-photo face recognition and retrieval.

In [A66], Song *et al.* proposed an efficient data-driven approach and developed an android application for 3-D body customization. They first developed a user-friendly interface to semi-automatically segment the human body from photos. Then, the segmented human contours were scaled and translated to the ones under virtual camera configurations. Finally, they learned body parameters which only cost 1.26 s on an Android phone. They invited 12 volunteers for tests, and the mean absolute estimation error for chest/waist/hip size was 2.89/1.93/2.22 cm.

In [A67], Wei *et al.* presented a 3-D surface saliency feature detection method, which can measure the importance geometry region of the point clouds. Different from existing approaches that were based on 3-D filter banks, this method first constructed the curvature co-occurrence histogram (CCH), which encoded not only the global curvature occurrence but also the co-occurrence of local distinctive features. Then, the mesh saliency was extracted from CCH through our mapping function. The effectiveness of the saliency was demonstrated by point clouds' registration and mesh simplification. Experimental results, both visual and by quantification, demonstrated that the detected saliency contained more local geometrical detail information and had more stable global measurements compared with curvature only described features and center-surround saliency.

It has been a great honor for us to be able to edit this Special Section as Guest Editors. Special thanks to Prof. Derek Abbott, Editor-in-Chief of IEEE Access and other relevant staff members of IEEE Access for their strong support and enthusiastic help. We would like to sincerely thank all the authors for submitting their high-quality articles to our Special Section and the reviewers who provided constructive comments for improving the submitted articles. We believe that our Special Section will be of great help to the researchers working in the area of big data learning and discovery.

**ZHONG-KE GAO,** *Lead Editor*
*School of Electrical and Information Engineering*
*Tianjin University*
*Tianjin 300072, China*

**AN-AN LIU,** *Guest Editor*
*School of Electrical and Information Engineering*
*Tianjin University*
*Tianjin 300072, China*

**YANHUI WANG,** *Guest Editor*
*School of Mechanical Engineering*
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*Potsdam Institute for Climate Impact Research*
*14473 Potsdam, Germany*
*Department of Information Technology*
*Lobachevsky University*
*603950 Nizhnij Novgorod, Russia*

## APPENDIX: RELATED ARTICLES

[A1] S. Liu, X. Gao, W. Fang, Q. Sun, S. Feng, X. Liu, and S. Guo, "Modeling the complex network of multidimensional information time series to characterize the volatility pattern evolution," *IEEE Access*, vol. 6, pp. 29088–29097, 2018.

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**ZHONGKE GAO** received the M.Sc. and Ph.D. degrees in control science and engineering from Tianjin University, Tianjin, China, in 2007 and 2010, respectively. He is currently a Full Professor with the School of Electrical and Information Engineering, Tianjin University, where he is also the Director of the Laboratory of Complex Networks and Intelligent Systems. His current research interests include deep learning, multiphase flows, complex networks, multisource information fusion, sensor design, and brain–computer interface.

**AN-AN LIU** received the B.Eng. and Ph.D. degrees from Tianjin University, Tianjin, China. He was a Visiting Scholar with the Robotics Institute, Carnegie Mellon University, and the School of Computing, National University of Singapore. He is currently a Professor with the School of Electrical and Information Engineering, Tianjin University. He is also the Director of the Institute of Television and Image Information, Ministry of Education. His research interests include cross-media analysis, artificial intelligence, and bio-media image analysis.

**YANHUI WANG** received the B.S., M.S., and Ph.D. degrees in mechanical engineering from Tianjin University, Tianjin, China. He is currently a Full Professor at the School of Mechanical Engineering, Tianjin University. He is also the Deputy Director of the Joint Laboratory for Ocean Observing and Detection and the Qingdao National Laboratory for Marine Science and Technology. His research interest includes the design of various underwater vehicles. In 2017, he was elected as the Council Member of the Ocean Observation Branch, Chinese Society for Oceanology and Limnology. He won the Youth Technology Award of Tianjin, in 2019, and the Outstanding Editorial Board Member of the *Chinese Journal of Unmanned Undersea Systems*, in 2017.

**MICHAEL SMALL** received the bachelor's and Ph.D. degrees in pure and applied mathematics from The University of Western Australia (UWA), Crawley, WA, Australia. After postdoctoral experience in Stellenbosch and Edinburgh, he joined as a Faculty with the Department of Electronic and Information Engineering, The Hong Kong Polytechnic University, Hong Kong, from 2001 to 2011. In 2011, he won the Australian Research Council Future Fellowship. In 2012, he was made a Winthrop Professor of applied mathematics with the School of Mathematics and Statistics, UWA. His research interests include complex systems, complex networks, chaos and nonlinear dynamics, nonlinear time series analysis, and computational modeling. He is currently the UWA-CSIRO Chair of Complex Engineering Systems. He is an Editor of *Chaos*. He is on the editorial board of several international journals, including *IEEE Circuits and Systems Magazine*, *IEEE Circuits and Systems Newsletter*, and IEEE TRANSACTIONS on CIRCUITS and SYSTEMS—I: REGULAR PAPERS.

**XIAOJUN CHANG** is currently a Faculty Member with the Faculty of Information Technology, Monash University Clayton Campus, Australia. He is also with the Monash University Centre for Data Science. He has been an ARC Discovery Early Career Researcher Award (DECRA) Fellow, since 2019. Before joining Monash, he was a Postdoctoral Research Associate with the School of Computer Science, Carnegie Mellon University, working with Prof. Alex Hauptmann. He has spent most of his time working on exploring multiple signals (visual, acoustic, and textual) for automatic content analysis in unconstrained or surveillance videos. His system has achieved top performance in various international competitions, such as TRECVID MED, TRECVID SIN, and TRECVID AVS.

**JÜRGEN KURTHS** received the Ph.D. degree from the GDR Academy of Sciences, Berlin, Germany, in 1983. From 1994 to 2008, he was a Full Professor with the University of Potsdam, Potsdam, Germany. Since 2008, he has been a Professor of nonlinear dynamics with the Humboldt University of Berlin, Berlin, and the Chair of the research domain transdisciplinary concepts with the Potsdam Institute for Climate Impact Research, Potsdam. He has authored or coauthored more than 700 papers that are cited more than 53000 times (H-index: 107). His current research interests include synchronization, complex networks, and time-series analysis and their applications. He is a Highly Cited Researcher in engineering and physics. He became a member of the Academia Europaea in 2010 and has been conferred eight honorary doctorates. He was a recipient of the Richardson Award of the European Geophysical Union, in 2013. He is the Editor-in-Chief of *Chaos*.