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CIS Publication Spotlight

IEEE Transactions on Neural Networks and Learning Systems

Change Detection in Graph Streams by Learning Graph Embeddings on Constant-Curvature Manifolds, by D. Grattarola, D. Zambon, L. Livi, and C. Alippi, *IEEE Transactions on Neural Networks and Learning Systems*, Vol. 31, No. 6, June 2020, pp. 1856–1869.

Digital Object Identifier: 10.1109/TNNLS.2019.2927301

"The space of graphs is often characterized by a nontrivial geometry, which complicates learning and inference in practical applications. A common approach is to use embedding techniques to represent graphs as points in a conventional Euclidean space, but non-Euclidean spaces have often been shown to be better suited for embedding graphs. Among these, constant-curvature Riemannian manifolds (CCMs) offer embedding spaces suitable for studying the statistical properties of a graph distribution, as they provide ways to easily compute metric geodesic distances. In this paper, we focus on the problem of detecting changes in stationarity in a stream of attributed graphs. To this end, we introduce a novel change detection framework based on neural networks and CCMs, which takes into account the non-Euclidean nature of graphs. Our contribution in this paper is twofold. First, via a novel approach based on adversarial learning, we compute graph embeddings by training an autoencoder to represent graphs on CCMs. Second, we introduce two novel change detection tests operating on CCMs. We perform experiments on synthetic data, as well as two real-world application scenarios: the detection of epileptic seizures using functional connectivity brain networks and the detection of hostility between two subjects, using human skeletal graphs. Results show that the proposed methods are able to detect even small changes in a graph-generating process, consistently outperforming approaches based on Euclidean embeddings."

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Completely Automated CNN Architecture Design Based on Blocks, by Y. Sun, B. Xue, M. Zhang, and G. G. Yen, *IEEE Transactions on Neural Networks and Learning Systems*, Vol. 31, No. 4, April 2020, pp. 1242–1254.

Digital Object Identifier: 10.1109/TNNLS.2019.2919608

"The performance of convolutional neural networks (CNNs) highly relies on their architectures. In order to design a CNN with promising performance, extensive expertise in both CNNs and the investigated problem domain is required, which is not necessarily available to every interested user. To address this problem, we propose to automatically evolve CNN architectures by using a genetic algorithm (GA) based on ResNet and DenseNet blocks. The proposed algorithm is completely automatic in designing CNN architectures. In particular, neither preprocessing before it starts nor postprocessing in terms of CNNs is needed. Furthermore, the proposed algorithm does not require users with domain knowledge on CNNs, the investigated problem, or even GAs. The proposed algorithm is evaluated on the CIFAR10 and CIFAR100 benchmark data sets against 18 state-of-the-art peer competitors. Experimental results show that the proposed algorithm outperforms the state-of-the-art CNNs hand-crafted and the CNNs designed by automatic peer competitors in terms of the classification performance and achieves a competitive classification accuracy against semiautomatic peer competitors. In addition, the proposed algorithm consumes much less computational resource than most peer competitors in finding the best CNN architectures."

Digital Object Identifier 10.1109/MCI.2020.3019871
Date of current version: 14 October 2020

IEEE Transactions on Fuzzy Systems

Fast and Scalable Approaches to Accelerate the Fuzzy k-Nearest Neighbors Classifier for Big Data, by J. Maillo, S. García, J. Luengo, F. Herrera, and I. Triguero, *IEEE Transactions on Fuzzy Systems*, Vol. 28, No. 5, May 2020, pp. 874–886.

Digital Object Identifier: 10.1109/TFUZZ.2019.2936356

"One of the best-known and most effective methods in supervised classification is the k-nearest neighbors algorithm (kNN). Several approaches have been proposed to improve its accuracy, where fuzzy approaches prove to be among the most successful, highlighting the classical fuzzy k-nearest neighbors (FkNN). However, these traditional algorithms fail to tackle the large amounts of data that are available today. There are multiple alternatives to enable kNN classification in big datasets, spotlighting the approximate version of kNN called hybrid spill tree. Nevertheless, the existing proposals of FkNN for big data problems are not fully scalable, because a high computational load is required to obtain the same behavior as the original FkNN algorithm. This article proposes global approximate hybrid spill tree FkNN and local hybrid spill tree FkNN, two approximate approaches that speed up runtime without losing quality in the classification process. The experimentation compares various FkNN approaches for big data with datasets of up to 11 million instances. The results show an improvement in runtime and accuracy over literature algorithms."

Multitasking Genetic Algorithm (MTGA) for Fuzzy System Optimization, by D. Wu and X. Tan, *IEEE Transactions on Fuzzy Systems*, Vol. 28, No. 6, June 2020, pp. 1050–1061.

Digital Object Identifier: 10.1109/TFUZZ.2020.2968863

"Multitask learning uses auxiliary data or knowledge from relevant tasks to facilitate the learning in a new task. Multitask optimization applies multitask learning an optimization to study how effectively and efficiently tackle the multiple optimization problems, simultaneously. Evolutionary multitasking, or multi-factorial optimization, is an emerging subfield of multitask optimization, which integrates evolutionary computation and multi-task learning. This article proposes a novel and easy-to-implement multitasking genetic algorithm (MTGA), which copes well with significantly different optimization tasks by estimating and using the bias among them. Comparative studies with eight state-of-the-art single-task and multitask approaches in the literature on nine benchmarks demonstrated that, on average, the MTGA outperformed all of them and had lower computational cost than six of them. Based on the MTGA, a *simultaneous optimization strategy* for fuzzy system design is also proposed. Experiments on simultaneous optimization of type-1 and interval type-2 fuzzy logic controllers for couple-tank water level control demonstrated that the MTGA can find better fuzzy logic controllers than other approaches."

IEEE Transactions on Evolutionary Computation

Feature Extraction and Selection for Parsimonious Classifiers With Multiobjective Genetic Programming, by K. Nag and N. R. Pal, *IEEE Transactions on Evolutionary Computation*, Vol. 24, No. 3, June 2020, pp. 454–466.

Digital Object Identifier: 10.1109/TEVC.2019.2927526

"The objectives of this paper are to investigate the capability of genetic programming to select and extract linearly separable features when the evolutionary process is guided to achieve the same and to propose an integrated system for that. It decomposes a c-class problem into c binary classification problems and evolve c sets of binary classifiers employing a steady-state multi-objective genetic programming with three minimizing objectives. Each binary classifier is composed of a binary tree and a linear support vector machine (SVM). The features extracted by the feature nodes and some of the function nodes of the tree are used to train the SVM. The decision made by the SVM is considered as the decision of the corresponding classifier. During crossover and mutation, the SVM-weights are used to determine the usefulness of the corresponding nodes. It also uses a fitness function based on Golub's index to select useful features. To discard less frequently used features, it employs unfitness functions for the feature nodes. The method is compared with 34 classification systems using 18 datasets. The performance of the proposed method is found to be better than 432 out of 570, i.e., 75.79% of comparing cases."

IEEE Transactions on Games

Winning Is Not Everything: Enhancing Game Development With Intelligent Agents, by Y. Zhao, I. Borovikov, F. de Mesentier Silva, A. Beirami, J. Rupert, C. Somers, J. Harder, J. Kolen, J. Pinto, R. Pourabolghasem, J. Pestrak, H. Chaput, M. Sardari, L. Lin, S. Narravula, N. Aghdaie, and K. Zaman, *IEEE Transactions on Games*, Vol. 12, No. 2, June 2020, pp. 199–212

Digital Object Identifier: 10.1109/TG.2020.2990865

"Recently, there have been several high-profile achievements of agents learning to play games against humans and beat them. In this article, we study the problem of training intelligent agents in service of game development. Unlike the agents built to "beat the game," our agents aim to produce human-like behavior to help with game evaluation and balancing. We discuss two fundamental metrics based on which we measure the human-likeness of agents, namely skill and style, which are multi-faceted concepts with practical implications outlined in this article. We report four case studies in which the style and skill requirements inform the choice of algorithms and metrics used to train

agents; ranging from A* search to state-of-the-art deep reinforcement learning (RL). Furthermore, we show that the learning potential of state-of-the-art deep RL models does not seamlessly transfer from the benchmark environments to target ones without heavily tuning their hyperparameters, leading to linear scaling of the engineering efforts, and computational cost with the number of target domains."

IEEE Transactions on Cognitive and Developmental Systems

Concrete Action Representation Model: From Neuroscience to Robotics, by J. Nassour, T. D. Hoa, P. Atoofi, and F. Hamker, *IEEE Transactions on Cognitive and Developmental Systems*, Vol. 12, No. 2, June 2020, pp. 272–284.

Digital Object Identifier: 10.1109/TCDS.2019.2896300

"How can robotics benefit from neuroscience to build a unified framework that computes actions for both locomotion and manipulation tasks? Inspired by the hierarchical neural control of movement from cortex to spinal cord, the authors propose a model that generates a concrete action representation in robotics. The action program is composed of four basic modules: 1) pattern selection; 2) spatial coordination; 3) temporal coordination; and 4) sensory motor adaptation. The first and the fourth are considered for behavior initiation. The model is implemented on a humanoid robot to generate rhythmic and nonrhythmic movements. The robot is able to perform tasks like perturbation recovery, and drawing based on different motor programs generated by the same model. Unifying motor control in robotics through a hierarchical structure increases the capacity to gain an accurate and deep understanding of transfer of motor skills between different tasks."

IEEE Transactions on Emerging Topics in Computational Intelligence

Pedestrian Flow Optimization to Reduce the Risk of Crowd Disasters Through Human-Robot Interaction, by C. Jiang, Z. Ni, Y. Guo, and H. He, *IEEE Transactions on Emerging Topics in Computational Intelligence*, Vol. 4, No. 3, June 2020, pp. 298–311.

Digital Object Identifier: 10.1109/TETCI.2019.2930249

"Pedestrian flow in densely populated or congested areas usually presents irregular or turbulent motion state due to competitive behaviors of individual pedestrians, which reduces flow efficiency and raises the risk of crowd accidents. Effective pedestrian flow regulation strategies are highly valuable for flow optimization. Existing studies seek for optimal design of indoor architectural features and spatial placement of pedestrian facilities for the purpose of flow optimization. However, once placed, the stationary facilities are not adaptive to real-time flow changes. In this paper, we investigate the problem of regulating two merging pedestrian flows in a bottleneck area using a mobile robot moving among the pedestrian flows. The pedestrian flows are regulated through dynamic human-robot interaction (HRI) during their collective motion. We adopt an adaptive dynamic programming (ADP) method to learn the optimal motion parameters of the robot in real time, and the resulting outflow through the bottleneck is maximized with the crowd pressure reduced to avoid potential crowd disasters. The proposed algorithm is a data-driven approach that only uses camera observation of pedestrian flows without explicit models of pedestrian dynamics and HRI. Extensive simulation studies are performed in both MATLAB and a robotic simulator to verify the proposed approach and evaluate the performances."

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