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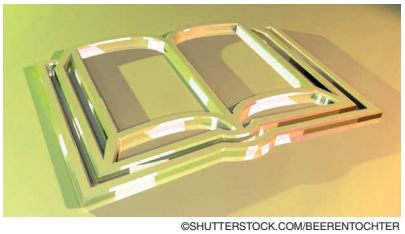
CIS Publication Spotlight

IEEE Transactions on Neural Networks and Learning Systems

Low-Cost Approximation-Based Adaptive Tracking Control of Output-Constrained Nonlinear System, by K. Zhao, Y. Song, W. Meng, C. L. P. Chen, and L. Chen, *IEEE Transactions on Neural Networks and Learning Systems,* Vol. 32, No. 11, November 2021, pp. 4890–4900.

Digital Object Identifier: 10.1109/TNNLS.2020.3026078

"For pure-feedback nonlinear systems under asymmetric output constraint, we present a low-cost neuroadaptive tracking control solution with salient features benefited from two design steps. In the first step, a novel output-dependent universal barrier function (ODUBF) is constructed such that not only the restrictive condition on constraining boundaries/functions is removed but also both constrained and unconstrained cases can be handled uniformly without the need for changing the control structure. In the second step, to reduce the computational burden caused by the neural network (NN)-based approximators, a single parameter estimator is developed so that the number of adaptive law is independent of the system order and the dimension of system parameters, making the control design inexpensive in computation. Furthermore, it is shown that all signals in the closed-loop system are semiglobally uniformly ultimately



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bounded, the tracking error converges to an adjustable neighborhood of the origin, and the violation of output constraint is prevented. The effectiveness of the proposed method can be validated via numerical simulation."

IEEE Transactions on Fuzzy Systems

Concept Drift Detection: Dealing With Missing Values via Fuzzy Distance Estimations, by A. Liu, J. Lu, and G. Zhang, *IEEE Transactions on Fuzzy Systems*, Vol. 29, No. 11, November 2021, pp. 3219–3233.

Digital Object Identifier: 10.1109/TFUZZ.2020.3016040

"In data streams, the data distribution of arriving observations at different time points may change—a phenomenon called concept drift. While detecting concept drift is a relatively mature area of study, solutions to the uncertainty introduced by observations with missing values have only been studied in isolation. No one has yet explored whether or how these solutions might impact drift detection performance. We, however, believe that data imputation methods may actually increase uncertainty in the data rather than reducing it. We also conjecture that imputation can introduce bias into the process of estimating distribution changes during drift detection, which can make it more difficult to train a learning model. Our idea is to focus on estimating the distance between observations rather than estimating the missing values, and to define membership functions that allocate observations to histogram bins according to the estimation errors. Our solution comprises a novel masked distance learning (MDL) algorithm to reduce the cumulative errors caused by iteratively estimating each missing value in an observation and a fuzzy-weighted frequency (FWF) method for identifying discrepancies in the data distribution. The concept drift detection algorithm proposed in this article is a singular and unified algorithm that can handle missing values, but not an imputation algorithm combined with a concept drift detection algorithm. Experiments on both synthetic and real-world datasets demonstrate the advantages of this method and show its robustness in detecting drift in data with missing values. The results show that compared to the best-performing algorithm that handles imputation and drift detection separately, MDL-FWF reduced the average drift detection difference from 10.75% to 5.83%. This is a nearly 46% improvement. These findings reveal that missing values exert a profound impact on concept drift detection, but using fuzzy set theory to model observations can produce more reliable results than imputation."

Digital Object Identifier 10.1109/MCI.2022.3155328
Date of current version: 12 April 2022

Critical Thinking About Explainable AI (XAI) for Rule-Based Fuzzy Systems, by J. M. Mendel and P.P. Bonissone, *IEEE Transactions on Fuzzy Systems*, Vol. 29, No. 12, December 2021, pp. 3579–3593.

Digital Object Identifier: 10.1109/TFUZZ.2021.3079503

"This article is about explainable artificial intelligence (XAI) for rule-based fuzzy systems [that can be expressed generically, as y(x) = f(x)]. It explains why it is not valid to explain the output of Mamdani or Takagi–Sugeno–Kang rule-based fuzzy systems using IF-THEN rules, and why it is valid to explain the output of such rule-based fuzzy systems as an association of the compound antecedents of a small subset of the original larger set of rules, using a phrase such as "these linguistic antecedents are symptomatic of this output." Importantly, it provides a novel multi-step approach to obtain such a small subset of rules for three kinds of fuzzy systems, and illustrates it by means of a very comprehensive example. It also explains why the choice for antecedent membership function shapes may be more critical for XAI than before XAI, why linguistic approximation and similarity are essential for XAI, and, it provides a way to estimate the quality of the explanations."

IEEE Transactions on Evolutionary Computation

Weighted Indicator-Based Evolutionary Algorithm for Multimodal Multiobjective Optimizations, by W. Li, T. Zhang, R. Wang, and H. Ishibuchi, *IEEE Transactions on Evolutionary Computation*, Vol. 25, No. 6, December 2021, pp. 1064–1078.

Digital Object Identifier: 10.1109/TEVC.2021.3078441

"Multimodal multiobjective problems (MMOPs) arise frequently in the real world, in which multiple Pareto-optimal solution (PS) sets correspond to the same point on the Pareto front. Traditional multiobjective evolutionary algorithms (MOEAs) show poor performance in solving MMOPs due to a lack of diversity maintenance in the decision space. Thus, recently, many multimodal MOEAs (MMEAs) have been proposed. However, for most existing MMEAs, the convergence performance in the objective space does not meet expectations. In addition, many of them cannot always obtain all equivalent Pareto solution sets. To address these issues, this study proposes an MMEA based on a weighted indicator, termed MMEA-WI. The algorithm integrates the diversity information of solutions in the decision space into an objective space performance indicator to maintain the diversity in the decision space and introduces a convergence archive to ensure a more effective approximation of the Pareto-optimal front (PF). These strategies can readily be applied to other indicator-based MOEAs. The experimental results show that MMEA-WI outperforms some state-of-the-art MMEAs on the chosen benchmark problems in terms of the inverted generational distance (IGD) and IGD in the decision space (IGDX) metrics."

IEEE Transactions on Games

The Influence of Social Ties on Performance in Team-Based Online Games, Y. Zeng, A. Sapienza, and E. Ferrara, *IEEE Transactions on Games*, Vol. 13, No. 4, December 2021, pp. 358–367.

Digital Object Identifier: 10.1109/TG.2019.2923223

"Social ties are the invisible glue that keeps together human ecosystems. Despite the massive amount of research studying the role of social ties in communities (groups, teams, etc.) and society at large, little attention has been devoted to study their interplay with other human behavioral dynamics. Of particular interest is the influence that social ties have on human performance in collaborative team-based settings. Our research aims to elucidate the influence of social ties on individual and team performance dynamics. We will focus on a popular multiplayer online battle arena (MOBA) collaborative team-based game, Defense of the Ancients 2 (Dota 2), a rich data set with millions of players and matches. Our research reveals that, when playing with their friends, individuals are systematically more active in the game as opposed to taking part in a team of strangers. However, we find that increased activity does not homogeneously lead to an improvement in players' performance. Despite being beneficial to low-skill players, playing with friends negatively affects the performance of high-skill players. Our findings shed light on the mixed influence of social ties on performance and can inform new perspectives on virtual team management and behavioral incentives."

IEEE Transactions on Cognitive and Developmental Systems

Robot Navigation in Unseen Spaces Using an Abstract Map, by B. Talbot, F. Dayoub, P. Corke, and G. Wyeth, *IEEE Transactions on Cognitive and Developmental Systems,* Vol. 13, No. 4, December 2021, pp. 791–805.

Digital Object Identifier: 10.1109/TCDS.2020.2993855

"Human navigation in built environments depends on symbolic spatial information which has unrealized potential to enhance robot navigation capabilities. Information sources, such as labels, signs, maps, planners, spoken directions, and navigational gestures communicate a wealth of spatial information to the navigators of built environments; a wealth of information that robots typically ignore. We present a robot navigation system that uses the same symbolic spatial information employed by humans to purposefully navigate in unseen built environments with a level of performance comparable to humans. The navigation system uses a novel data structure called the abstract map to imagine malleable spatial models for unseen spaces from spatial symbols. Sensorimotor perceptions from a robot are then employed to provide purposeful navigation to symbolic goal locations in the unseen environment. We show how a dynamic system can be used to create malleable spatial models for the abstract map, and provide an open-source

implementation to encourage future work in the area of symbolic navigation. The symbolic navigation performance of humans and a robot is evaluated in a real-world built environment. This article concludes with a qualitative analysis of human navigation strategies, providing further insights into how the symbolic navigation capabilities of robots in unseen built environments can be improved in the future."

IEEE Transactions on Emerging Topics in Computational Intelligence

Deep COLA: A Deep COmpetitive Learning Algorithm for Future Home Energy Management Systems, by G. Mohi-Ud-Din, A. K. Marnerides, Q. Shi, C. Dobbins, and A. MacDermott, *IEEE Transactions on Emerging Topics in Computational Intelligence*, Vol. 5, No. 6, December 2021, pp. 860–870.

Digital Object Identifier: 10.1109/TETCI.2020.3027300

"A smart grid ecosystem requires intelligent Home Energy Management Systems (HEMSs) that allow the adequate monitoring and control of appliance-level energy consumption in a given household. They should be able to: i) profile highly non-stationary and nonlinear measurements and ii) conduct correlations of such measurements with diverse inputs (e.g. environmental factors) in order to improve the end-user experience, as well as to aid the overall demand-response optimization process. However, traditional approaches in HEMS lack the ability to capture diverse variations in appliance-level energy consumption due to unpredictable human behavior and also require high computation to process large datasets. In this article, we go beyond current profiling schemes by proposing Deep COLA; a novel Deep COmpetitive Learning Algorithm that addresses the limitations of existing work in terms of high dimensional data and enables more efficient and accurate clustering of appliance-level energy consumption. The proposed approach reduces human intervention by automatically selecting load profiles and models variations and uncertainty in human behavior during appliance usage. We demonstrate that our proposed scheme is far more computationally efficient and scalable data-wise than three popular conventional clustering approaches namely, K-Means, DBSCAN and SOM, using real household datasets. Moreover, we exhibit that Deep COLA identifies per-household behavioral associations that could aid future HEMSs."

IEEE Transactions on Artificial Intelligence

Playing Against Deep Neural Network-Based Object Detectors: A Novel Bidirectional Adversarial Attack Approach, by X. Li, Y. Jiang, C. Liu, S. Liu, H. Luo, and S. Yin, *IEEE Transactions on Artificial Intelligence*, Vol. 3, No. 1, February 2022, pp. 20–28.

Digital Object Identifier: 10.1109/TAI.2021.3107807

"In the fields of deep learning and computer vision, the security of object detection models has received extensive attention. Revealing the security vulnerabilities resulting from adversarial attacks has become one of the most important research directions. Existing studies show that object detection models can also be threatened by adversarial examples, just like other deep neural networks based models, e.g., those for classification. In this paper, we propose a bidirectional adversarial attack method. Firstly, the added perturbation pushes the prediction results given by the object detectors far away from the ground truth class while getting close to the background class. Secondly, a condense loss function is designed for the region proposal network to reduce the foreground scores. Thirdly, the adversarial examples are generated by a pre-trained autoencoder, and the model is trained using an adversarial approach, which can enhance the similarity between the adversarial examples and the original image and speed up algorithm convergence. The proposed method was verified on the most popular two-stage detection framework (Faster R-CNN), and 55.1% mAP-drop were obtained. In addition, the adversarial examples have superior transferability, migrating which to the common one-stage detection framework (YOLOv3) gets a 39.5% mAP-drop."