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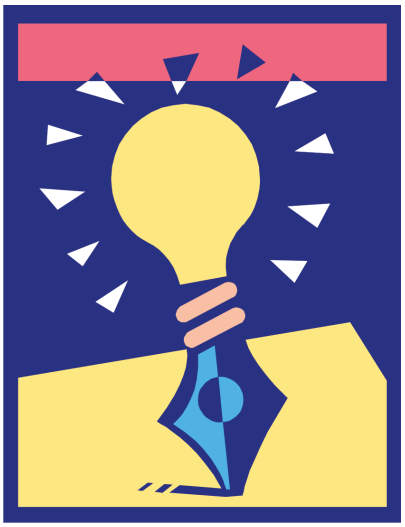
CIS Publication Spotlight

IEEE Transactions on Neural Networks and Learning Systems

Denoising Adversarial Autoencoders, by A. Creswell and A. A. Bharath, *IEEE Transactions on Neural Networks and Learning Systems*, Vol. 30, No. 4, April 2019, pp. 968–984.

Digital Object Identifier: 10.1109/TNNLS.2018.2852738

"Unsupervised learning is of growing interest because it unlocks the potential held in vast amounts of unlabeled data to learn useful representations for inference. Autoencoders, a form of generative model, may be trained by learning to reconstruct unlabeled input data from a latent representation space. More robust representations may be produced by an autoencoder if it learns to recover clean input samples from corrupted ones. Representations may be further improved by introducing regularization during training to shape the distribution of the encoded data in the latent space. We suggest denoising adversarial autoencoders (AAEs), which combine denoising and regularization, shaping the distribution of latent space using adversarial training. We introduce a novel analysis that shows how denoising may be incorporated into the training and sampling of AAEs. Experiments are performed to assess the contributions that denoising makes to the learning of representations for classification and sample synthesis. Our results suggest that autoencoders trained using a denoising criterion achieve higher classification performance and can synthesize samples that are more consistent with the input data than those trained without a corruption process."



(IMAGE SOURCE: WOODCUT CLIP ART—©IMAGE CLUB)

Deep Neural Network Initialization with Decision Trees, by K. D. Humbird, J. L. Peterson, and R. G. Mcclarren, *IEEE Transactions on Neural Networks and Learning Systems*, Vol. 30, No. 5, May 2019, pp. 1286–1295.

Digital Object Identifier: 10.1109/TNNLS.2018.2869694

"In this paper, a novel, automated process for constructing and initializing deep feedforward neural networks based on decision trees is presented. The proposed algorithm maps a collection of decision trees trained on the data into a collection of initialized neural networks with the structures of the networks determined by the structures of the trees. The tree-informed initialization acts as a warm-start to the neural network training process, resulting in efficiently trained, accurate networks. These models, referred to as "deep jointly informed neural networks" (DJINN), demonstrate high predictive performance for a variety of regression and classification data sets and display comparable performance to Bayesian hyperparameter optimization at a lower computational cost. By combining the user-friendly features of decision tree models with the flexibility and scalability of deep neural networks, DJINN is an attractive algorithm for training predictive models on a wide range of complex data sets."

IEEE Transactions on Fuzzy Systems

A Metahierarchical Rule Decision System to Design Robust Fuzzy Classifiers Based on Data Complexity, by J. Cózar, A. Fernández, F. Herrera, and J. A. Gámez, *IEEE Transactions on Fuzzy Systems*, Vol. 27, No. 4, April 2019, pp. 701–715.

Digital Object Identifier: 10.1109/TFUZZ.2018.2866967

"There is a wide variety of studies that propose different classifiers to solve a large amount of problems in distinct classification scenarios. The no free lunch theorem states that if we use a big enough set of varied problems, all classifiers would be equivalent in performance. From another point of view, the performance of the classifiers is dependant of

Digital Object Identifier 10.1109/MCI.2019.2937606
Date of current version: 14 October 2019

the scope and properties of the datasets. In this sense, new proposals on the topic often focus on a given context, aiming at improving the related state-of-the-art approaches. Data complexity metrics have been traditionally used to determine the inner characteristics of datasets. This way, researchers are able to categorize the problems in different scenarios. Then, this taxonomy can be applied to determine inner characteristics of the datasets in order to determine intervals of good and bad behavior for a given classifier. In this paper, the authors will take advantage of the data complexity metrics in order to design a fuzzy metaclassifier. The final goal is to create decision rules based on the inner characteristics of the data to apply a different version of the fuzzy classifier for a given problem. To do so, the authors will make use of the FARC-HD classifier, an evolutionary fuzzy system that has led to different extensions in the specialized literature. Experimental results show the goodness of this novel approach as it is able to outperform all versions of FARC-HD on a wide set of problems, and obtain competitive results (in terms of performance and interpretability) versus two selected state-of-the-art rule-based classification system, C4.5 and FURIA."

A Constrained Representation Theorem for Well-Shaped Interval Type-2 Fuzzy Sets, and the Corresponding Constrained Uncertainty Measures, by D. Wu, H.-T. Zhang, and J. Huang, *IEEE Transactions on Fuzzy Systems*, Vol. 27, No. 6, June 2019, pp. 1237–1251.

Digital Object Identifier: 10.1109/TFUZZ.2018.2874018

"The representation theorem for interval type-2 fuzzy sets (IT2 FSs), proposed by Mendel and John, states that an IT2 FS is a combination of all its embedded type-1 (T1) FSs, which can be nonconvex and/or subnormal. These nonconvex and/or subnormal embedded T1 FSs are included in developing many theoretical results for IT2 FSs, including uncertainty measures, the linguistic weighted averages (LWAs), the ordered LWAs (OLWAs), the linguistic weighted power means (LWPMs), etc. However, convex and normal T1 FSs are used in most fuzzy logic applications, particularly computing with words. In this paper, the authors propose a constrained representation theorem (CRT) for well-shaped IT2 FSs using only its convex and normal embedded T1 FSs, and show that IT2 FSs generated from three word encoding approaches and four computing with words engines (LWAs, OLWAs, LWPMs, and perceptual reasoning) are all well-shaped IT2 FSs. The authors also compute five constrained uncertainty measures (centroid, cardinality, fuzziness, variance, and skewness) for well-shaped IT2 FSs using the CRT. The CRT and the associated constrained uncertainty measures can be useful in computing with words, IT2 fuzzy logic system design using the principles of uncertainty, and measuring the similarity between two well-shaped IT2 FSs.

IEEE Transactions on Evolutionary Computation

Data-Driven Evolutionary Optimization: An Overview and Case Studies, by Y. Jin, H. Wang, T. Chugh, D. Guo, and K. Miettinen, *IEEE Transactions on Evolutionary Computation*, Vol. 23, No. 3, June 2019, pp. 442–458.

Digital Object Identifier: 10.1109/TEVC.2018.2869001

"Most evolutionary optimization algorithms assume that the evaluation of the objective and constraint functions is straightforward. In solving many real-world optimization problems, however, such objective functions may not exist. Instead, computationally expensive numerical simulations or costly physical experiments must be performed for fitness evaluations. In more extreme cases, only historical data are available for performing optimization and no new data can be generated during optimization. Solving evolutionary optimization problems driven by data collected in simulations, physical experiments, production processes, or daily life are termed data-driven evolutionary optimization. In this paper, the authors provide a taxonomy of different data driven evolutionary optimization problems, discuss main challenges in data-driven evolutionary optimization with respect to the nature and amount of data, and the availability of new data during optimization. Real-world application examples are given to illustrate different model management strategies for different categories of data-driven optimization problems."

IEEE Transactions on Games

Building a Planner: A Survey of Planning Systems Used in Commercial Video Games, by X. Neufeld, S. Mostaghim, D. L. Sancho-Pradel, and S. Brand, *IEEE Transactions on Games*, Vol. 11, No. 2, June 2019, pp. 91–108.

Digital Object Identifier: 10.1109/TG.2017.2782846

"In the last decade, many commercial video games have used planners instead of classical behavior trees or finite state machines to define agent behaviors. Planners allow looking ahead in time and can prevent some problems of purely reactive systems. Furthermore, some of them allow coordination of multiple agents. However, implementing a planner for highly dynamic environments such as video games is a difficult task. This paper aims to provide an overview of different elements of planners and the problems that developers might have when dealing with them. We identify the major areas of plan creation and execution, trying to guide developers through the process of implementing a planner and discuss possible solutions for problems that may arise in the following areas: environment, planning domain, goals, agents, actions, plan creation, and plan execution processes. Giving insights into multiple commercial games, we show different possibilities of solving such problems and discuss which solutions are better suited under specific circumstances, and why some academic approaches find a limited application in the context of commercial titles."

IEEE Transactions on Cognitive and Developmental Systems

A Reinforcement Learning Architecture that Transfers Knowledge between Skills when Solving Multiple Tasks, by P. Tommasino, D. Caligiore, M. Mirolli, and G. Baldassarre, *IEEE Transactions on Cognitive and Developmental Systems*, Vol. 11, No. 2, June 2019, pp. 292–317.

Digital Object Identifier: 10.1109/TCDS.2016.2607018

"When humans learn several skills to solve multiple tasks, they exhibit an extraordinary capacity to transfer knowledge between them. The authors present here the last enhanced version of a bio-inspired reinforcement-learning (RL) modular architecture able to perform skill-to-skill knowledge transfer and called transfer expert RL (TERL) model. TERL architecture is based on a RL actor-critic model where both actor and critic have a hierarchical structure, inspired by the mixture-of-experts model, formed by a gating network that selects experts specializing in learning the policies or value functions of different tasks. A key feature of TERL is the capacity of its gating networks to accumulate, in parallel, evidence on the capacity of experts to solve the new tasks so as to increase the responsibility for action of the best ones. A second key feature is the use of two different responsibility signals for the experts' functioning and learning: this allows the training of multiple experts for each task so that some of them can be later recruited to solve new tasks and avoid catastrophic interference. The utility of TERL mechanisms is shown with tests involving two simulated dynamic robot arms engaged in solving reaching tasks, in particular a planar 2-DoF arm, and a 3-D 4-DoF arm."

IEEE Transactions on Emerging Topics in Computational Intelligence

An Evolutionary Constraint-Handling Technique for Parametric Optimization of a Cancer Immunotherapy Model, by W. Xu, J.-X. Xu, D. He, and K. C. Tan, *IEEE Transactions on Emerging Topics in Computational Intelligence*, Vol. 3, No. 2, April 2019, pp. 151–162.

Digital Object Identifier: 10.1109/TETCI.2018.2880516

"Recent studies have shown that evolutionary constraint-handling techniques are capable of solving optimization problems with constraints. However, these techniques are often evaluated based on benchmark test functions instead of real-world problems. This paper presents an application of evolutionary constrained parametric optimization for a breast cancer immunotherapy model formulated based on biological principles and limited clinical results. It proposes a new constraint-handling technique that partitions the population into different sections to enhance the evolutionary search diversity. In addition, the upper bound of each section is reduced dynamically to drive the convergence of individuals toward the feasible solution region. Experimental results show the effectiveness and robustness of the proposed constraint-handling approach in solving parametric optimization problems. Moreover, the evolutionary optimized cancer immunotherapy model can be used for prognostic outcomes in clinical trials and the predictability is considered significant for such a parametric optimization approach."