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Interval Methods in Knowledge Representation

Please send your abstracts (or copies of papers that you want to see reviewed here) to vladik@utep.edu, or by regular mail to Vladik Kreinovich, Department of Computer Science, University of Texas at El Paso, El Paso, TX 79968, USA.

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S. P. Adam, D. A. Karras, G. D. Magoulas, and M. N. Vrahatis, "Reliable estimation of a neural network's domain of validity through interval analysis based inversion", *Proceedings of the International Joint Conference on Neural Networks IJCNN'2015*, Killarney, Ireland, July 12–17, 2015.

The objective of this paper is to present the potential offered by a new approach introduced to estimate the domain of validity of a neural network. This approach is based on Set Inversion via Interval Analysis (SIVIA), a methodology originally established by L. Jaulin and E. Walter in order to cope with nonlinear parameter estimation problems in a bounded error context. SIVIA proved to be effective in tackling several types of problems where nonlinear systems analysis is involved. Our assumption is that, after training, a neural network establishes a nonlinear mapping between the pattern data and the network outputs. Hence, the impact of the input data to the neural network function and the output responses can be addressed as a nonlinear parameter estimation problem that can be tackled by SIVIA. Unlike previous research, which is based upon interval-like considerations for the network's output responses, the proposed approach relies exclusively on Interval Analysis concepts. We present concrete application examples and we show how the proposed method allows delimiting the domain of validity of a trained neural network for different levels of output responses. Experimental results depict the advantage of the proposed method which provides both qualitative and quantitative information of the domain of validity. We discuss advantages, pitfalls and potential improvements offered to neural networks. Finally, the results obtained allow us to extend this research towards evaluation of the network performance in terms of generalization and fitness of the model implemented by the network.

M. N. Vrahatis

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M. A. Sainz, J. Armengol, R. Calm, P. Herrero, L. Jorba, and J. Vehi, *Modal Interval Analysis: New Tools for Numerical Information*, Springer Verlag, 2014.

There are pairs of problem that lead to the same result when we know the exact values of the corresponding quantities, but which lead to different answers in case of uncertainty. For example, if a person originally had a dollars and spent b dollars, then the remaining amount is $c = a - b$. Similarly, if a person originally had a dollars