Interval-Related Talks at the NAFIPS International Conference on Fuzzy Systems, Soft Computing, and Explainable AI NAFIPS 2024 (South Padre Island, Texas, USA, May 27–29, 2024)

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In practice, we rarely know the exact values of a physical quantity x. Whether we estimate this value based on the measurement result or based on an expert opinion, the resulting estimate $\widetilde{x}$ is, in general, different from the actual (unknown) value x. In many cases, the only information that we have about the measurement error $\Delta x \stackrel{\text{def}}{=} \widetilde{x} - x$ is the upper bound Δ on its absolute value: $|\Delta x| \le \Delta$. In such cases, the only information that we have about the actual value x is that this value belongs to the interval $[\widetilde{x} - \Delta, \widetilde{x} + \Delta]$. Several papers presented at this conference show how to take this uncertainty into account – and how taking this uncertainty into account leads to a better understanding of real-life phenomena.

Specifically:

- for agriculture applications, the paper [3] shows that taking interval uncertainty into account leads to better predictions of evapotranspiration, the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants;

- for engineering applications, the paper [1] shows that taking interval uncertainty into account leads to better understanding (and thus, better control) of an electric-arc furnace;

- for food industry and medicine, the paper [4] shows that taking interval uncertainty into account leads to a better understanding of the growth of Saccharomyces cerevisiae – bacteria used in producing beer, yeast, and medicine.

The last example takes into account not only the uncertainty with which we know the values, but also the known relations between the values – to be more precise, constraints describing such relations.

Finally, the paper [2] describes how to take interval uncertainty into account in deep neural networks, where the so-called softmax operation

$$p_i = \frac{\exp(k \cdot v_i}{\sum_j \exp(k \cdot v_j)}$$

is used to estimate the probability p_i of an object belonging to the i-th class based on the output v_i of the corresponding part of the network. A similar formula – due to Nobelist McFadden – is used to predict the probability p_i of different human actions based on the values v_i of (expected) utility corresponding to these actions.

References

[1] A. Blazic, I. Skrjanc and V. Logar, "Prediction Interval Fuzzy Model for Bath Temperature Estimation in an Electric Arc Furnace", *Proceedings of the NAFIPS International Conference on Fuzzy Systems, Soft Computing, and Explainable AI*, to appear.

[2] B. Kubica, O. Kosheleva, and V. Kreinovich, "McFadden's Discrete Choice and Softmax under Interval (and Other) Uncertainty: Revisited", *Proceedings of the NAFIPS International Conference on Fuzzy Systems, Soft Computing, and Explainable AI*, to appear.

[3] H. Patel, "Modified Hargreaves Equation Using Interval Type-2 Fuzzy Logic System for Predication of Reference Evapotranspiration: Case Study for Arid Climate Region of Gujarat", *Proceedings of the NAFIPS International Conference on Fuzzy Systems, Soft Computing, and Explainable AI*, to appear.

[4] P. Zanineli, P. Ferrari, V. Wasques, J. Netto, and J. Smetana, "Fitting interval data through interactive arithmetic: Application in Saccharomyces cerevisiae growth", *Proceedings of the NAFIPS International Conference on Fuzzy Systems, Soft Computing, and Explainable AI*, to appear.