TOWARDS INTEGRATION OF PROBABILISTIC AND INTERVAL ERRORS IN ENGINEERING CALCULATIONS

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In many engineering applications, we have to combine probabilistic and interval errors. For example, in environmental analysis, we observe a pollution level $x(t)$ in a lake at different moments of time t, and we would like to estimate standard statistical characteristics such as mean, variance, autocorrelation, correlation with other measurements.

In environmental measurements, we often know the values with interval uncertainty. For example, if we did not detect any pollution, the pollution value can be anywhere between 0 and the detection limit DL. Another example: to study the effect of a pollutant on the fish, we check on the fish daily; if a fish was alive on Day 5 but dead on Day 6, then the lifetime of this fish is $\in [5, 6]$.

We must modify the existing statistical algorithms to process such interval data. In general, the resulting problems are NP-hard [1,2]. In this talk, we survey cases when feasible algorithms exist: e.g., when measurements are very accurate, or when all the measurements are done with one (or few) instruments.

Other applications:
• In non-destructive testing, we look for outliers as indications of possible faults. To detect an outlier, we must know the mean and standard deviation of the normal values – and these values can often only be measured with interval uncertainty.
• In bioinformatics and bioengineering applications, we must solve systems of linear equations in which coefficients come from experts and are only known with interval uncertainty.
• In biomedical systems, statistical analysis of the data often leads to improvements in medical recommendations; however, to maintain privacy, we do not want to use the exact values of the patient's parameters, we only keep *ranges*; we must perform statistical analysis based on such interval data.

References

[1] Kreinovich, V. "Probabilities, Intervals, What Next? Optimization Problems Related to Extension of Interval Computations to Situations with Partial Information about Probabilities", *J. Global Optim.* (to appear).
[2] Kreinovich, V., and Longpré, L.: "Computational complexity and feasibility of data processing and interval computations, with extension to cases when we have partial information about probabilities", In: Brattka, V., Schröder, M., Weihrauch, K., and Zhong, N. *Proc. Conf. on Computability and Complexity in Analysis CCA'2003*, Cincinnati, Ohio, USA, August 28–30, 2003, pp. 19–54.