SWRM/RM Joint Regional Meeting Biochemistry Abstract Form

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Name: Vladik Kreinovich, Olga Kosheleva, and Julio Urenda

Institution: University of Texas at El Paso

Position: V. Kreinovich is Professor, O. Kosheleva is Associate Professor, J. Urenda is Instructor

Requested Format (highlight one): Oral or Poster

Presentation Title: Why Such a Nonlinear Process as Protein Synthesis Is Well Approximated by Linear Formulas

Abstract (<300 words): Biochemical processes are strongly nonlinear. However, a recent paper [1] has shown that a linear expression provides a surprisingly good approximation to the reaction rate r of protein synthesis. How to explain this?

In biochemistry, many variables are nonlinearly related. There is a small number B of independent variables a, ..., b, others x, ..., y are nonlinear functions of a, ..., b. To get a reasonable description of this nonlinearity, let us take the first two terms in Taylor expansion, i.e., use quadratic approximation. Both r and each x are linear combinations of a, ..., b, and of quadratic terms a*a, a*b, ..., b*b. The number N of quadratic terms is 1 + B + B(B+1)/2. If the overall number of variables V is larger than or equal to N, then, in the generic case, the corresponding vectors span the whole space. In particular, the quadratic expression corresponding to r can be represented as a linear combination of expressions corresponding to x, ..., y. This explains why a linear combination of x, ..., y approximates r so well.

Same idea can be applied if we take, e.g., cubic terms into account -- we just need more variables x, ..., y.

This explains not only the effectiveness of linear systems in biochemistry, similar arguments can explain why linear regressions often work well in describing complex (and clearly nonlinear) phenomena in psychology, economics, and social sciences in general.

1. A. N. Gorban, A. Harel-Bellan, N. Morozova, and A. Zinovyev, "Basic, simple, and extendable kinetic model of protein synthesis", Mathematical Biosciences and Engineering, 2019, Vol. 16, No. 6, pp. 6602-6622.