Mathematics helps AI in biomedicine

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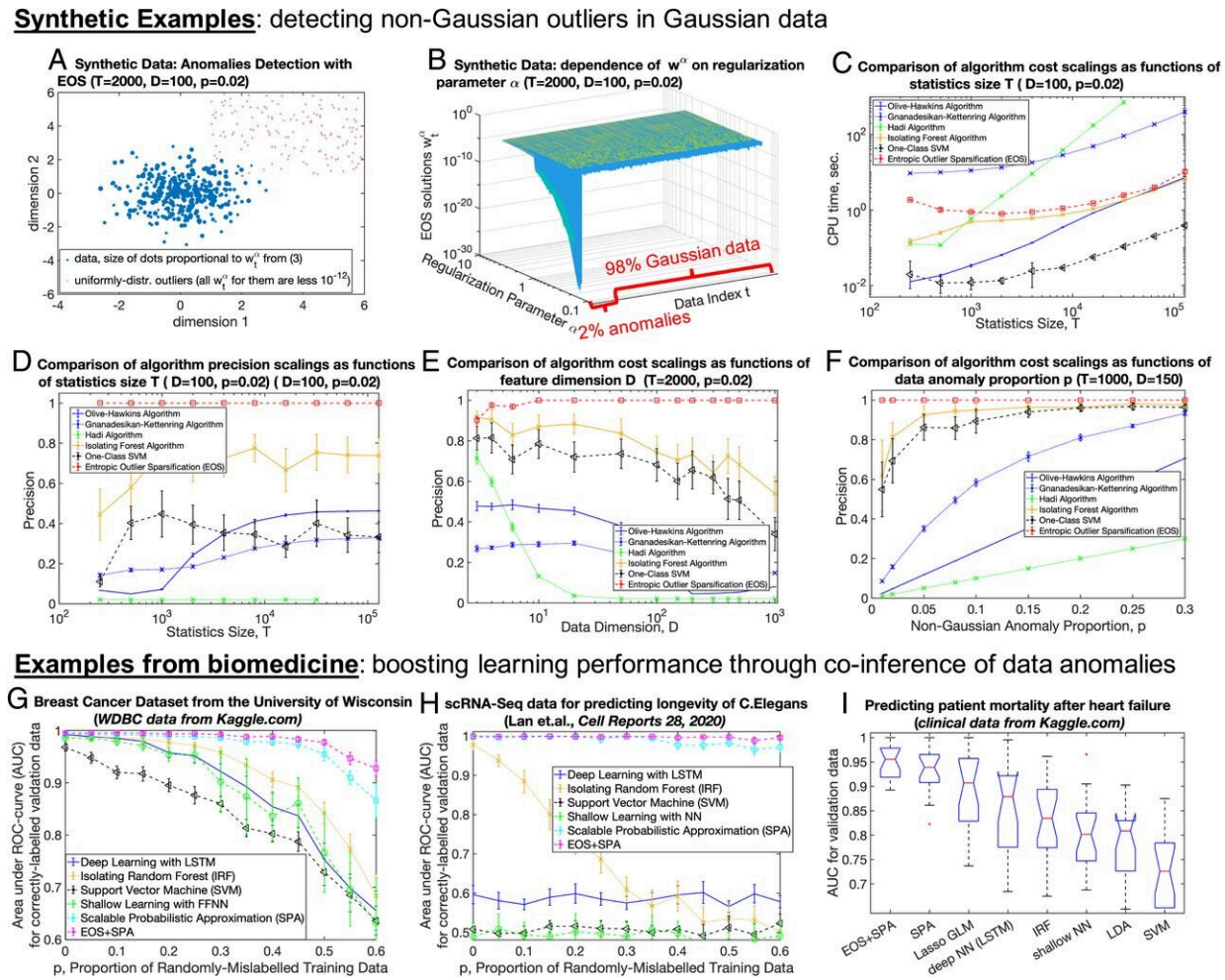

Figure 1. Comparison of EOS algorithm for the solution of optimization problem [2] to common methods of data anomaly detection (A–F) and supervised classifier learning (G–I) on synthetic and real data examples from refs. 12–14. Credit: DOI: 10.1073/pnas.2119659119

"Data is the new oil," it has often been said. Indeed, in the digital age data is the fuel that runs the engines of digital media, advanced informatics (AI, machine learning etc.) and, not least, scientific research. Nevertheless, when facing certain highly complex issues, data-driven approaches may not always be the most effective solutions. At the USI Institute of Computing (Faculty of Informatics), Prof. Illia Horenko has devised a robust unified model learning strategy based on new and very efficient solutions to traditional mathematical and statistical problems, opening to significant developments in fields such as healthcare. His work is published in *PNAS*.

When dealing with the human organism and diseases, the amount of variables and patient characteristics—known and unknown—can easily outnumber the available data to analyze. Moreover, especially in biomedical applications, available data is frequently contaminated with anomalies, outliers, mismeasurements and mislabelings. The idea behind the computational strategy proposed by Prof. Horenko, called Entropic Outlier Sparsification (EOS), is to improve learning from data and the accuracy of predictions when in presence of data anomalies and outliers by exploiting the potential of novel math-driven learning and mathematical methods. A field with huge potential for adopting this sort of strategy is that of biomedicine and healthcare. For instance, large yet unraveled potential of such methods is in improving diagnostics of cardiovascular diseases (CVDs): according to the World Health Organization, CVDs are responsible for approximately one third of the global mortality, yearly accounting for around 18 million deaths globally (and over 21,000 yearly deaths in Switzerland alone).

"For example, EOS can help to achieve a statistically-significant accuracy improvement when predicting patient's mortality from heart failure, compared to the common learning methods currently adopted for this purpose," says Prof. Horenko. "This improvement can potentially mean more timely and correct diagnostics and more adequate clinical

treatment for a significant number of individuals in Switzerland and worldwide."

More information: Illia Horenko, Cheap robust learning of data anomalies with analytically solvable entropic outlier sparsification, *Proceedings of the National Academy of Sciences* (2022). DOI: 10.1073/pnas.2119659119

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