**Revolutions in Neural Networks computing and their Data Science Backgrounds: Introducing SPOCU and DEXPSO.**

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## Talk Abstract

In this talk, I will introduce our adaptive transfer function SPOCU [1], which I developed with collaborators to address the insufficiency of standard transfer functions in properly processing real data flows and the necessity of data science and statistical methodologies. SPOCU is a revolutionary improvement in the speed and innovation of adaptation strategies, filling a gap in existing technology. Activation functions are crucial in deep learning for extracting complex data patterns, and traditional functions like ReLU, Selu, among others, have limitations in adapting to specialized tasks. Standard transfer functions have limitations in complex setups, thus necessitating the development of robust approaches like large-scale self-normalizing neural networks. See, for example, [1], [2], and [3]. To address this, we propose a novel trainable adaptive activation function based on SPOCU construction. Dynamical networks face challenges with big and irregular data. Optimal activation function selection and hyperparameter management are crucial. The SPOCU transfer function offers flexibility and superior performance in machine learning tasks (see [4], [5] or [6]). Experimental results show improvements in cancer diagnosis and pollutant adsorption dynamics. Developing adaptive algorithms for hyperparameter selection is essential, and our milestone result of DExPSO [7] is giving a chance to avoid recurrent premature failures of standard neural networks. In [8], we showed how Cobetia bacteria adaptation to large temperature ranges can be modeled by an SPOCU-based neural network.

During the talk, we will discuss how the SPOCU prototype adaptive function has been created and explore new ideas for optimizing hyperparameters in adaptive transfer functions like SPOCU for real-world data flows, improving methodologies in different application areas.

**Keywords:** SPOCU Prototype, DExPSO, optimization , hyperparameters, transfer functions, dataflows, complexity, networks, ecology.

### Acknowledgements

This work was partially supported by Proyecto Exploracion ANID GRT-AC: Nr. 13220184. I acknowledge the support of Professor Dr. Manoj Sharma.

# References


[1] Kiselak, J.; Lu, Y.; Svihra, P.; Szepe, M. ; Stehlik, M. "SPOCU": scaled polynomial constant unit activation function, *Neural Comput and Applic* **33**, (2020) 3385-3401.

[2] Subramanian, B., Jeyaraj, R., Akhrorjon, R, Ugli, Kim (2024) APALU: A Trainable, Adaptive Activation Function for Deep Learning Networks, arXiv:2402.08244 [cs.LG]

[3] Chen, Z., Zhao, W., Deng, L., Ding, Y., Wen, Q., Li, G., y Xie, Y. (2024). Large-scale self-normalizing neural networks. *Journal of Automation and Intelligence*, 3(2), 101-110.

[4] Bamimore, A., Sobowale, N.B., Osunleke, A.S. et al. Offset-free neural network-based nonlinear model predictive controller design using parameter adaptation. *Neural Comput and Applic* 33, 10235–10257 (2021).

[5] Vives-Boix, V., Ruiz-Fernández, D. (2021) Fundamentals of artificial metaplasticity in radial basis function networks for breast cancer classification. *Neural Comput and Applic* 33, 12869–12880 (2021).

[6] Mesellem, Y., Hadj, A.A.E., Laidi, M. et al. (2021) Computational intelligence techniques for modeling of dynamic adsorption of organic pollutants on activated carbon. *Neural Comput and Applic* 33, 12493–12512 (2021).

[7] Stehlík, M. , Ping-Yang, Ch. Wong, WK, Kiseľák, J. (2024) A Double Exponential Particle Swarm Optimization with non-uniform variates as stochastic tuning and guaranteed convergence to a global optimum with sample applications to finding optimal exact designs in biostatistics, *Applied Soft Computing*, https://doi.org/10.1016/j.asoc.2024.111913

[8] Dinamarca,A, Stehlik, M. et al. (2025) Comprehensive and deep learning classification for analyses of biological complexity of growth and biofilms of Cobetia marina under different temperature growths. *PLOS ONE*, in revision.