Call for Expression of Interest for two (2) PhD Positions

In the framework of the following Greek Research Program **"TROGEMAL: Tropical Geometry and Machine Learning"** funded by the Hellenic Foundation for Research and Innovation (H.F.R.I.), the Intelligent Robotics and Automation Lab (IRAL) (https://robotics.ntua.gr/) and the Computer Vision, Speech Communication & Signal Processing Lab (CVSP) (http://cvsp.cs.ntua.gr/) of the School of Electrical and Computer Engineering of NTUA announce the availability of the following graduate researcher positions leading to a PhD:

2 PhD Positions (funded)

Qualifications: Degree at a level of M.Eng. (π.χ. Δίπλωμα απο 5-ετή Πολυτεχνική Σχολή) or MSc and expertise in least one area from: electrical & computer engineering, computer science, applied mathematics, and machine learning. The acceptance will be based on education, area of expertise, and possible publications and/or research work experience.

Project Information:

- Principal Investigator: Prof. Petros Maragos
- **Duration**: 2022-2024
- **Place**: IRAL & CVSP, School of ECE, NTUA

- **Abstract**: Tropical geometry is a relatively recent field in mathematics and computer science that combines elements of algebraic geometry and polyhedral geometry. The scalar arithmetic of its analytic part pre-existed in the form of max-plus and its dual min-plus semiring arithmetic used in finite automata, convex analysis, nonlinear image processing, nonlinear control, and idempotent mathematics. Tropical geometry has recently emerged in the analysis and extension of several classes of problems and systems in both classical machine learning and deep learning. Three such areas include Neural Networks-NNs (both of the multilayer perceptron type and deep NNs), Piecewise-Linear (PWL) regression for data fitting and surface approximation, and Inference algorithms on probabilistic graphical models. The grand vision of TROGEMAL is to greatly advance the theoretical analysis of machine learning systems and algorithms by using and improving tools from tropical geometry and max-plus algebra, as well as discover new algorithms in key areas, including (classic and deep) neural nets, graphical models and nonlinear regression, and extend all the above by advancing a generalized max-* algebra coupled with learning through novel systems evolving over nonlinear vector spaces. We group the proposed research in four main objectives: 1) Tropical Regression, 2) Tropical Geometry of Neural Networks, 3) Tropical Geometry of Graphical Models and Inference Algorithms and 4) Generalized Tropical Geometry and Learning on Weighted Lattices. Based on the PI's and his team's rich previous experience, TROGEMAL will pursue scientific excellence in researching the above research objectives and aspires to make substantial advances with a strong impact in several theoretical and algorithmic areas at the intersection of machine learning and tropical geometry and algebra. Applications areas include computer vision, NLP, and data science.

- **Related Publication:** P. Maragos, V. Charisopoulos and E. Theodosis, "Tropical Geometry and Machine Learning", Invited Paper, in *Proceedings of the IEEE*, (Special Issue: Machine Learning and Deep Learning), 109(5), pp. 728-755, May 2021. DOI: https://doi.org/10.1109/JPROC.2021.3065238

- **Recent Presentation:** AI Doctoral Academy e-Lecture with video

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