Seminar Hora Informaticae — Institute of Computer Science, Prague

Tuesday, November 22, 2022, 14.00 – 15.30 (2 - 3:30 PM) CET,

Meeting room 318, Address: Pod Vodárenskou věží 2, Prague 8

ZOOM:

https://cesnet.zoom.us/j/95478234977?pwd=dXoyekFHbDJ0MkNrTjVVS3F2STZqUT09

Meeting ID: 954 7823 4977 , Passcode: 712564

Věra Kůrková - Some implications of high-dimensional geometry for classification by neural networks

Computational difficulties of multidimensional tasks, called the ``curse of dimensionality'', have long been known. On the other hand, almost deterministic behavior of some randomized models and algorithms depending on large numbers of variables can be attributed to the ``blessing of dimensionality''. These phenomena can be explained by rather counter-intuitive properties of geometry of high-dimensional spaces. They imply concentration of values of sufficiently smooth functions of many variables around their mean values and possibilities of reduction of dimensionality of data by random projections.

In the lecture, it will be shown how these properties of high-dimensional geometry can be employed to obtain some insights into suitability of various types of neural networks for classification of large data sets. Probabilistic bounds on network complexity will be derived using concentration properties of approximation errors based on Azuma and McDiarmid inequalities. Consequences for choice of network architectures will be analyzed in terms of growth functions and VC dimensions of sets of network input-output functions. General results will be illustrated by examples of deep perceptron networks with various piecewise polynomial activation functions (ReLU, RePU).

References:

V. Kůrková, M. Sanguineti: Correlations of random classifiers on large data sets, Softcomputing 25: 12641-12648, 2021. https://dx.doi.org/ 10.1007/s00500-021-05938-4

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V. Kůrková: Some insights from high-dimensional spheres, Physics of Life Reviews 29: 98–100, 2019. https://dx.doi.org/ 10.1016/j.plrev.2018.09.005

V. Kůrková, M. Sanguineti: Classification by sparse neural networks. IEEE Trans. on Neural Networks and Learning Systems 30 (9): 2746-2754, 2019. https://dx.doi.org/ 10.1109/TNNLS.2018.2888517

Věra Kůrková is a senior scientist from the Department of Machine Learning, Institute of Computer Science of the Czech Academy of Sciences. She received PhD. in mathematics from the Charles University, Prague, and DrSc. (Prof.) in theoretical computer science from the Czech Academy of Sciences. She has been affiliated with the Institute of Computer Science since 1990 (in 2002-2008 she was the Head of the Department of Theoretical Computer Science). In 2010, she received the Bolzano Medal for her contribution to mathematical sciences from the Czech Academy of Sciences.

Her main research interests are mathematical theory of neurocomputing and machine learning. Her work includes analysis of capabilities and limitations of shallow and deep networks, dependence of network complexity on increasing dimensionality of computational tasks, connections between theory of inverse problems and generalization in machine learning, and nonlinear approximation theory.

She has been a member of the Board of the European Neural Network Society since 2008 (in 2017-2019 she was its president) and of the editorial boards of the journals Neural Networks, Neural Processing Letters, and Applied and Computational Harmonic Analysis. She has been involved in organization of conferences ICANN and EANN in various roles (general chair, co-chair, or honorary chair).

HORA INFORMATICAE (meaning: TIME FOR INFORMATICS) is a broad-spectrum scientific seminar devoted to all core areas of computer science and its interdisciplinary interfaces with other sciences and applied domains. Original contributions addressing classical and emerging topics are welcome. Founded by Jiří Wiedermann, the seminar is running since 1994 at the Institute of Computer Science of the Czech Academy of Sciences in Prague.

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