SYMPOSIUM HONORING

Kunihiko Fukushima

Recipient of the 2021 Bower Award and
Prize for Achievement in Science

DREXEL UNIVERSITY College of Engineering

Penn Engineering

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Abstracts and Bios of Speakers

Laureate: Dr. Kunihiko Fukushima

Fuzzy Logic Systems Institute

Former: Osaka University and NHK Science and Technology Research Laboratories

Title: Deep CNN Neocognitron and its Advances

Abstract: Recently, deep convolutional neural networks (deep CNN) have become verypopular in the field of visual pattern recognition. The neocognitron, which was first proposed by Fukushima (1979), is a network classified to this category. It is a hierarchicalmulti-layered network. Its architecture was suggested by neurophysiological findings on the visual systems of mammals. It acquires the ability to recognize visual patterns robustly through learning. Although the neocognitron has a long history, improvements and extensions of the network are still continuing. This talk discusses the recent neocognitron, focusing on differences from the conventional deep CNN.

Bio: Kunihiko Fukushima received his B.Eng. in electronics (1958) and Ph.D. (1966) from Kyoto University, Japan. From 1958 to 1989, he was with NHK (Japan Broadcasting Corporation), and worked at Research Laboratories. From around 1965, he started building neural network models of the visual systems of mammalian brain. He then extended themodel by adding several hypotheses and proposed the architecture of CNN (convolutional neural network), which was named "neocognitron". The neocognitron can recognize visual patterns robustly without being affected by deformation. In 1989, he became a professorat Osaka University, Japan. He then was a professor at the University of Electro- Communications (1999-2001), at Tokyo University of Technology (2001-2006), and a visitingprofessor at Kansai University (2006-2010). He is now a Senior Research Scientist at FuzzyLogic Systems Institute (part-time position). He is the recipient of the Franklin Institute's2021 Bower Award and Prize for Achievement in Science

Dr. Bernard Widrow
Professor Emeritus, Stanford University

Title: ADALINE, MADALINE, and Neocognitron

Abstract:

I will discuss the historical context of the development of artificial neural network learning machines leading to their present ubiquitous world wide adoption.

Bio: Bernard Widrow is Professor Emeritus of Electrical Engineering; on the Stanford EE faculty for 50 years, from 1959-2009. He taught classes in adaptive signal processing and neural networks and was principal research supervisor of 89 Ph.D. students who have since played major roles in academia and industry. In 1959, with his first Ph.D. student Marcian Hoff, he invented the LMS algorithm, a steepest descent stochastic gradient algorithm with applications to adaptive filtering and neural networks. Every modem in the world uses LMS for channel equalization and echo cancelling. Adaptive antennas, noise cancelling headphones, and many early neural-network pattern-recognizers use it.

Prof. Widrow received the Sc.D. degree from MIT in 1956. He was elected Fellow of the IEEE in 1976. He received the IEEE Alexander Graham Bell Medal in 1986, the IEEE Neural Networks Pioneer Award in 1991. He was inducted into the National Academy of Engineering in 1995 and received the Benjamin Franklin Medal for Electrical Engineering from the Franklin Institute in 2001. He continues to do research on nature's adaptive algorithms in body and brain.

Dr. Jürgen Schmidhuber

Scientific Director of the Swiss AI Lab IDSIACo-Founder
& Chief Scientist, NNAISENSE Professor of Artificial Intelligence,
Univ. of Lugano, Switzerland

Title: Appraisal of Kunihiko Fukushima's Work

Abstract:
I will talk about some of the enormous contributions of Dr. Kunihiko Fukushima in thecontext of Artificial Neural Networks and Deep Learning.

Bio: The Artificial Intelligence (AI) techniques of Jürgen Schmidhuber's team are permeating the modern world. He has received many scientific awards and is often called the father of modern AI by the media. Since age 15, his main goal has been to build a self-improving AI smarter than himself, then retire. His lab's deep learning artificial neural networks such as "Long Short-Term Memory" (LSTM) have revolutionized machine learning. By 2015-17, they were on over 3 billion smartphones, and used billions of times per day, e.g., for Facebook's automatic translation (30 billion translations per week), Google's and Microsoft's speech recognition, Google Translate, Apple's Siri & QuickType, Amazon's Alexa, etc. He also pioneered unsupervised adversarial networks, artificial curiosity and meta-learning machines that learn to learn. He is chief scientist of the company NNAISENSE, which aims at building the first practical general-purpose AI. He is also advising various governments on AI strategies.

Dr. Donald Wunsch

Applied Computational Intelligence LaboratoryMissouri Institute of Science and Technology

Title: Multidisciplinary Innovation, Biological Inspiration, Engineering, and Kunihiko Fukushima: Lessons Learned

Abstract:

Prof. Fukushima had and has the level of multidisciplinary curiosity that often fuels significant discoveries. At the frontiers of knowledge, curiosity is necessary but not sufficient. Another ingredient is the willingness to proceed without complete information. It is also valuable to be grounded in the context of particular, challenging applications with real data, ensuring that results are not merely interesting but meaningful. These lessons are especially relevant in the context of current great challenges in neural networks, such as lifelong learning, explainable AI, and human-computer partnerships.

Bio: Donald C. Wunsch is the Mary K. Finley Missouri Distinguished Professor at Missouri University of Science and Technology, and Director of the Applied Computational Intelligence Laboratory. Earlier employers were: Texas Tech University Boeing, Rockwell International, and International Laser Systems. His education includes Ph.D., Electrical Engineering - University of Washington, Executive MBA - Washington University in St. Louis, M.S., Applied Mathematics - University of Washington, B.S., Applied Mathematics - University of New Mexico. Key research contributions are in Unsupervised and Reinforcement Learning and their applications. He is an IEEE Fellow and previous International Neural Networks Society (INNS) President, INNS Fellow, NSF CAREER Awardee, and recipient of the 2015 INNS Gabor Award, and 2019 Ada Lovelace Award. He has produced 22 Ph.D.s in Computer Engineering, Electrical Engineering, Systems Engineering and Computer Science. He is currently on an Interagency Personnel Assignment as a Program Director for Energy, Power, Control and Networks of the National Science Foundation (NSF).

Dr. Terrance Sejnowski

Computational Neurobiology Laboratory,
Salk Institute and Division of Biological Sciences, University ofCalifornia

Title: The Unreasonable Effectiveness of Deep Learning in Artificial Intelligence

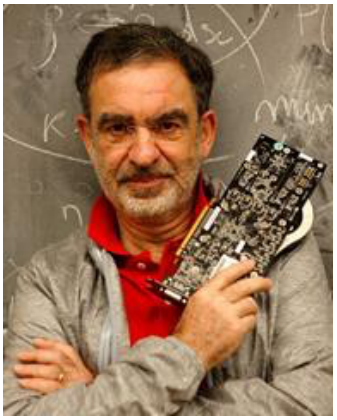
Abstract:

Deep learning networks have been trained to recognize speech, caption photographs and translate text between languages at high levels of performance. Although applications of deep learning networks to real world problems have become ubiquitous, our understanding of why they are so effective is lacking. These empirical results should not be possible according to sample complexity in statistics and non-convex optimization theory. However, paradoxes in the training and effectiveness of deep learning networks are being investigated and insights are being found in the geometry of high-dimensional spaces. A mathematical theory of deep learning would illuminate how they function, allow us to assess the strengths and weaknesses of different network architectures and lead to major improvements. Deep learning has provided natural ways for humans to communicate with digital devices and is foundational for building artificial general intelligence. Deep learning was inspired by the architecture of the cerebral cortex and insights into autonomy and general intelligence may be found in other brain regions that are essential for planning and survival, but major breakthroughs will be needed to achieve these goals

Bio: Dr. Terrence Sejnowski received his Ph.D. in physics from Princeton University and was a postdoctoral fellow at Harvard Medical School before joining the faculty at Johns Hopkins, where he was a Professor of Biophysics. He holds the Francis Crick Chair at The Salk Institute for Biological Studies and is also a Distinguished Professor at the University of California, San Diego, where he is co-director of the Institute for Neural Computation. He is the President of the Neural Information Processing Systems (NIPS) Foundation and the founding editor-in-chief of Neural Computation. Sejnowski is a pioneer in neural networks and computational neuroscience. He co-invented the Boltzmann Machine with Geoffrey Hinton and developed Independent Component Analysis (ICA), a machine learning algorithm for blind source separation of mixed signals. He has published over 500 scientific papers and 12 books, including The Computational Brain and, more recently, The Deep Learning Revolution, both with the MIT Press. He is a member of the National Academy of Sciences, the National Academy of Engineering, the National Academy of Medicine, and the National Academy of Inventors.

Dr. Tomaso Poggio

Center for Brains, Minds, and Machines
Massachusetts Institute of Technology



Title: A brave new world: overfitting is good, when deep

Abstract:
Once upon the time, models needed more data than parameters in order to provide a meaningful fitting. Deep networks seem to avoid this basic constraint. In fact, more weights than data is the standard situation for deep learning networks which typically exactly fit thedata and still show good generalization, that is good predictive performance on new data.We discuss this puzzle and how to reconcile it with standard intuitions.

Bio: Tomaso A. Poggio, is a physicist whose research has always been between brains andcomputers. It is now focused on the mathematics of deep learning and on the computational neuroscience of the visual cortext. He is the Eugene McDermott Professorin the Dept. of Brain & Cognitive Sciences at MIT and the director of the NSF Center forBrains, Minds and Machines at MIT. Among other awards he received the 2014 Swartz Prize for Theoretical and Computational Neuroscience and the IEEE 2017 Azriel Rosenfeld Lifetime Achievement Award. A former Corporate Fellow of Thinking Machines Corporation, a former director of PHZ Capital Partners, Inc. and of Mobileye, he was involved in starting, or investing in, several other high-tech companies including Arris Pharmaceutical, nFX, Imagen, Digital Persona, Deep Mind and Orcam.