

# THE MIND-BRAIN AND BIG DATA

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The course focuses on mathematical models of the fundamental principles of the mind-brain and practical applications in several fields. Big data algorithms are discussed for cybersecurity, gene-phenotype associations, medical applications to disease diagnostics, financial predictions, data mining in distributed data bases. Mathematical models of mind-brain are discussed for mechanisms of concepts, emotions, instincts, behavior, language, cognition, intuitions, conscious and unconscious, abilities for symbols, functions of the beautiful and musical emotions in cognition and evolution. This research won National and International Awards.

A mathematical and cognitive breakthrough, dynamic logic is described. It models cognitive processes “from vague and unconscious to crisp and conscious,” from vague representations, plans, thoughts to crisp ones. It resulted in more than 100 times improvements in several engineering applications; recent brain imaging experiments at Harvard Medical School, and several labs around the world proved it to be a valid model for the brain-mind processes. New cognitive and mathematical principles are discussed, language-cognition interaction, function of music in cognition, and evolution of cultures. How does language interact with cognition? Do we think using language or is language just a label for completed thoughts? Why the music ability has evolved from animal cries to Bach and Lady Gaga? The tutorial briefly reviews past mathematical difficulties of computational intelligence and new mathematical techniques of dynamic logic and neural networks implementing it, which overcome past limitations.

The tutorial discusses cognitive functions of emotions. Why human cognition needs emotions of beautiful, music, sublime. Dynamic logic is related to knowledge instinct and language instinct; why are they different? How languages affect evolution of cultures. Language networks are scale-free and small-world, what does this tell us about cultural values? What are the biases of English, Spanish, French, German, Arabic, Chinese; what is the role of language in cultural differences?

Relations between cognition, language, and music, are discussed. Mathematical models of the mind and cultures bear on contemporary world, and may be used to improve mutual understanding among peoples around the globe and reduce tensions among cultures.

Tutorial contents and related publications can be accessed at the website <http://www.leonid-perlovsky.com/>

**Background knowledge expected of the participants:** interested undergraduate; mathematics at the Calculus 3 level is helpful, but not essential; the conceptual contents of the course requires no mathematics.

**Objectives:** course attendees will learn emerging ideas in computational intelligence, breakthrough mathematical and cognitive developments applicable to emerging and classical areas.

Time allocations for the major course topics:

0.3 h intro-background  
0.3 h classical applications  
1.0 h emerging areas

Qualifications of the instructor:

Dr. Leonid Perlovsky is Visiting Scholar at Harvard University and CEO LPIT. As Principal Research Physicist and Technical Advisor at the Air Force Research Laboratory he led research projects on modeling the mind and cognitive algorithms for integration of sensor data with knowledge, multi-sensor systems, recognition, fusion, neural networks, languages, music cognition, and cultures. As Chief Scientist at Nichols Research, a \$0.5B high-tech organization, he led the corporate research in intelligent systems and neural networks. He served as professor at Novosibirsk University and New York University; as a principal in commercial startups developing tools for biotechnology, text understanding, and financial predictions. His company predicted the market crash following 9/11 a week before the event. He is invited as a keynote plenary speaker and tutorial lecturer worldwide, including most prestigious venues, like Nobel Forum, published more than 480 papers, 12 book chapters, and 4 books, including “Neural Networks and Intellect,” Oxford University Press, 2001 (currently in the 3<sup>rd</sup> printing) and “Cognitive Emotional Algorithms” Springer 2011. Dr. Perlovsky participates in organizing conferences on CI, Chairs IEEE Boston CI Chapter; serves on the Editorial Board for ten journals, including Editor-in-Chief for “Physics of Life Reviews”, IF=7.2, T-R rank #4 in the world, on the INNS Board of Governors, where he chairs the INNS Award Committee. He received National and International awards including the Gabor Award, the top engineering award from the INNS; and the John McLucas Award, the highest US Air Force Award for basic research.