Contents

Messages From the Chairs

We have entered the third year of the Brain-Mind Institute (BMI) and the International Conference on Brain-Mind (ICBM).

Several U.S. government-funding agencies have started their funding programs as part of the President Barack Obama's BRAIN Initiative. The European Union's Human Brain Project is going on. After a series of workshops, China seems to be still preparing its own brain project. Understanding how the brain works is one of the last frontiers of the human race. The progress on this subject will lead to not only new technology but also human improved ways to develop human societies.

Therefore, BMI has been an earlier platform that treats every human activity as a part of science, including, but not limited to, biology, neuroscience, psychology, computer science, electrical engineering, mathematics, intelligence, life, laws, policies, societies, politics, and philosophy. BMI plans to further span its service to the scientific community and public by promoting science in human activities.

This year BMI offered BMI 831 Cognitive Science for Brain-Mind Research and BMI 871 Computational Brain-Mind. We would like to thank the Institute of Automation of the Chinese Academy of Sciences (CASIA) for hosting the BMI 831 and BMI 871 classes as well as ICBM 2014. The Brain-Mind Institute and the Brainnetome Center of CASIA co-sponsored and co-organized BMI 2014. As BMI planned to host BMI courses and ICBM at an international location, this year, it is Beijing. BMI 2014 co-locates with the World Congress on Computational Intelligence 2014.

As a multi-disciplinary communication platform, ICBM is an integrated part of the BMI program. ICBM 2014 includes invited talks, talks from submitted papers, and talks from submitted abstracts. As last year, ICBM talks will be video recorded and available publicly through the Internet.

As before, the BMI Program Committee tries to be open-minded in its review of submissions. This open-mindedness is necessary for all subjects of science, not just brain-mind subjects.

Welcome to Beijing!

Tianzi Jiang, General Co-Chair and Program Co-Chair
Juyang Weng, General Chair and Program Chair

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Invited Talks

Brainnetome: A New Avenue to Understand the Brain and its Disorders

Tianzi Jiang *(Brainnetome Center, Institute of Automation)*

Abstract

The Brainnetome (Brain-net-ome) is a new "-ome" in which the brain network is its basic research unit. It includes at least the following essential components: network topological structure (connectome), performance, dynamics, manifestation of functions and malfunctions of brain on different scales, genetic basis of brain networks, and simulating and modeling brain networks on supercomputing facilities. Here we will review progress on some aspects of the Brannetome, including Brainnetome atlas, Brainnetome-wise Association Studies (BWAS) of neurological and psychiatric diseases, such as schizophrenia and Alzheimer's disease, and how the Brainnetome meets genome, and so on. It envisions that the Brainnetome will become an emerging co-frontier of brain imaging, information technology, neurology and psychiatry. Some long-standing issues in neuropsychiatry may be solved by combining the Brainnetome with genome.

Short Biography

Tianzi Jiang is Professor of Brain Imaging and Cognitive Disorders, Institute Automation of Chinese Academy of Sciences (CASIA), and Professor of Queensland Brain Institute, University of Queensland. He is the Director of Brainnetome Center of CASIA and the Chinese Director of the Sino-French Laboratory in Computer Science, Automation and Applied Mathematics (LIAMA), one National Center for International Research. His research interests include neuroimaging, Brainnetome, imaging genetics, and their clinical applications in brain disorders and development. He is the author or co-author of over 200 reviewed journal papers in these fields and the co-editor of six issues of the Lecture Notes in Computer Sciences. He is Associate Editor of IEEE Transactions on Medical Imaging, IEEE Transactions on Autonomous Mental Development, Neuroscience Bulletin and an Academic Editor of PLoS One.

Visual Perceptual Learning and Its Brain Mechanisms: A New Perspective

Cong Yu *(Peking University)*

Abstract

Visual perceptual learning is regarded as a powerful tool to understand brain plasticity at the behavioral level. Learning is known to be specific to the trained retinal location and orientation, which places important constraints on perceptual learning theories, many of which assume that perceptual learning occurs in the early visual areas that are retinotopic and orientation selective.

However, we created new experimental paradigms to demonstrate that location and orientation specificities can be eliminated from perceptual learning. In a "double training" paradigm, location specific learning can transfer completely to a new retinal location following additional training at the new location with an irrelevant task. Similarly, in a training-plus-exposure (TPE) paradigm, orientation/direction-specific learning can transfer completely to an untrained new orientation/direction if an observer is also passively exposed to the new orientation/direction through an irrelevant task.

These results suggest that perceptual learning is more likely a high-level process that occurs beyond the retinotopic and orientation/direction selective visual cortex. What is being actually learned in perceptual learning? I will present evidence that perceptual learning may be a form of concept learning, in that the brain may learn a highly abstract "concept" of orientation/direction. On the other hand, why high-level perceptual learning shows specificity in the first place? I will present evidence that learning specificity may result from high-level learning not being able to functionally connect to the untrained visual inputs that are under-activated due to insufficient stimulation or suppression, as well as unattended, during training. It is the double training and TPE paradigms that bottom-up and top-down reactivate untrained inputs to establish functional connections and enable learning transfer.

Short Biography

Cong Yu received his Ph.D. in experimental psychology from University of Louisville in 1995. After postdoc trainings in basic and clinical vision sciences at University of Houston and UC Berkeley, he joined in the Inst. of Neuroscience, Chinese Academy of Sciences in 2003, the Inst. of Cognitive Neuroscience and Learning, Beijing Normal University in 2006, and the Department of Psychology, Peking University in 2012. He is currently a professor with the Department of Psychology and an Investigator with the Peking-Tsinghua Center for Life Sciences at Peking University.

Scale-Free Music of the Brain

Dezhong Yao *(University of Electronic Science and Technology of China)*

Abstract

To listen to brain activity as a piece of music, we proposed scale-free brainwave music (SFBM) technology, which translated the electroencephalogram (EEG) into musical notes according to the power law of both the EEG and music. In this talk, first shown is the general scale-free phenomena in the world, then a few versions of brain music are presented, they are music from one EEG channel, Quartet from multichannel EEGs, and music from both EEG and fMRI. Finally, potential application for mental health is discussed.

Short Biography

Dezhong Yao, PhD (1991, 2005), Professor (1995-), ChangJiang Scholar Professor (2006-); Dean, School of Life Science and Technology (2001-), University of Electronic Science and Technology of China, Chengdu 610054, China; Director, Key Laboratory for NeuroInformation, Ministry of Education of China (2010-); Head, Domestic Team of the 111 Project on NeuroInformation, Ministry of Education of China (2011-). His main research interests are Brain-X interaction including brain-computer interface, brainwave music interface, and Neuro-Imaging on music, epilepsy, cerebral palsy and plasticity. Since 1990, he has published 100 more peer-reviewed international journal papers, with 1000 more citations. He won the Outstanding Youth Resaerch Fund of NSFC (2005), and the first class Natural Science Reward of the Ministry of Education (2010). Websites: http://www.neuro.uestc.edu.cn/bci/member/yao/yao.asp, and http://scholar.google.com/citations?user=ClUoWqsAAAAJ

The Brain Works like Bridge-Islands with Modulation

Juyang Weng *(Fudan University and Michigan State University)*

Abstract

On one hand neuroscience is rich in data and poor in theory. On the other hand, many computer scientists are busy with engineering inspired methods, not motivated by brain inspired methods. However, in this talk, I argue that it is no longer true that "we do not know how the brain works". The knowledge of computer science is also necessary to understand how the brain works. Supported by a series of experimental studies known as Where What Networks (WWN-1 through WWN-8), I present an overarching but intuitive analogical model called bridge-islands. Each island is either a sensor (e.g., an eye or an ear) or an effector (an arm, or a gland). The brain is a multi-exchange bridge that connects to all the islands in bidirectionally. It is not productive to model the brain statically as a connected set of Brodmann areas, because in the born blind, the visual areas are automatically assigned to audition and touch. Therefore, the bridge-island model describes how various brain areas emerge from pre-natal and post-natal activities based on largely statistics. In other words, the brain wires itself. We also discuss how the self-wired basic circuits become motivated through four additional neural transmitters beyond glutamate and GABA --- serotonin, dopamine, acetylcholine, and norepinephrine.

Short Biography

Juyang (John) Weng is a professor at the Dept. of Computer Science and Engineering, the Cognitive Science Program, and the Neuroscience Program, Michigan State University, East Lansing, Michigan, USA, and a Changjiang visiting professor a Fudan University, Shanghai, China. He received his BS degree from Fudan University in 1982, his MS and PhD degrees from University of Illinois at Urbana-Champaign, 1985 and 1989, respectively, all in Computer Science. From August 2006 to May 2007, he was also a visiting professor at the Department of Brain and Cognitive Science of MIT. His research interests include computational biology, computational neuroscience, computational developmental psychology, biologically inspired systems, computer vision, audition, touch, behaviors, and intelligent robots. He is the author or coauthor of over two hundred fifty research articles, including a book Natural and Artificial Intelligence: Introduction to Computational Brain-Mind. He is an editor-in-chief of International Journal of Humanoid Robotics and an associate editor of the IEEE Trans. on Autonomous Mental Development, and the editor-in-chief of the Brain-Mind Magazine. He is instrumental in the establishment and operation of the Brain-Mind Institute, a nonprofit for cross-disciplinary education and research. He was an associate editor of IEEE Trans. on Pattern Recognition and Machine Intelligence, an associate editor of IEEE Trans. on Image Processing. He is a Fellow of IEEE.

The New Memory Technology to Support Brain-Like Computer

Luping Shi, Jing Pei, and Lei Deng Beata Jarosiewicz *(Tsinghua University)*

Abstract

The memory is the one of the main components of computer system as well as the key component for hand phone and cloud computing. For the last century, scaling has been being the main driving force for all of the current memory technologies in order to increase the density and reduce the cost. There are several kinds of memory to form a data storage hierarchy, such as DRAM,SRAM, Flash, optical disks, and hard disk drive. Although people have put a lot of effort to break scaling limitation, it could be estimated that all of above technologies might reach their scaling limits in about 10 to 15 years. On the other hand CPU also faces the same problem. Thus it is the time to find a new way to develop memory and CPU and to further develop computer. Brain like computer is one of the best approaches to solve the above problem. In this talk, the current statuses of memory and brain-like computer are briefly introduced. The requirement for the new memory technology to support brain-like computer is analyzed. The new memory should be capable of emulating some of brain functions. It should have the unique integrated function of storage and processing. The main problem and the possible approaches will be discussed.

Short Biography

Prof.Luping Shi received his Doctor of Science from University of Cologne, Germany in 1992. In 1993, he worked as a Post-doctoral fellow in Fraunhofer Institute of Applied Optics and Precision Instrument, Jena, Germany. From 1994 to 1996, he worked as a research fellow in Department of Electronic Engineering, City University of Hong Kong. From 1996 to 2013 he worked in data storage institute, Singapore as a senior scientist and division manager and led nonvolatile solid-state memory (NVM) and artificial cognitive memory (ACM) and optical storage researches. He joined Tsinghua university, China, as a national distinguish professor and director of optical memory national engineering research center in Mar 2013. His main research areas include NVM, ACM, optical data storage, integrated opto-electronics, and nanoscience. He has published more than 150 papers in prestigious journals including Science, Nature Photonics, Advanced Materials, Physical Review Letters, filed and granted more than 10 patents and conducted more than 60 keynote speech or invited talks at many important conferences during last 10 years. He is the recipient of the National Technology Award 2004 Singapore. He served as general co-chair of The 9th Asia-Pacific Conference on Near-field Optics2013, IEEE NVMTS 2011- 2014,East-West Summit on Nanophotonics and Metal Materials 2009 and ODS'2009.

Brain-Inspired Multi-Anything Algorithms for Medical Image Analysis and Computer Vision

Bart M. Romeny *(Eindhoven University of Technology, Netherlands and Northeastern University)*

Abstract

Electrophysiological, optical, opto-genetic, fMRI-, diffusion MRI and other brain imaging techniques have revealed an astoundingly well organized visual front-end. However, real understanding and generic modeling of the complex representations in the huge filter banks still offers many challenges. The multi-scale structure has inspired to (now in computer vision widely used) robust differential shift- and rotation invariant operators and keypoint detectors, and to hierarchical segmentation approaches and recognition techniques. The multi-orientation structure, recognized in the cortical pinwheels and their interconnections, has inspired to robust contextual tracking and adaptive enhancement operations.

We will discuss an innovative Lie-group based model for simultaneous analysis in the multi-scale, multi-orientation, multi-velocity, multi-disparity and multi-color domain. Applications will be presented for contextual, crossing preserving enhancement of elongated structures, such as 2D and 3D brain vasculature (e.g. quantitative retinal and extra-orbital vessel analysis exploited in a large-scale program for screening for early diabetes), and complex 3D brain dwMRI tractography, and perceptual grouping. The results are highly promising, and regularly outperform classical approaches, but need substantial processing, which today can be directed to, also brain-inspired, massively parallel GPU processing.

Short Biography

Bart M. ter Haar Romeny received the MSc degree in Applied Physics from Delft University of Technology in 1978, Ph.D. from Utrecht University in 1983 in biophysics. He became principal physicist of the Utrecht University Hospital Radiology Department. He was co-founder and associate professor at the Image Sciences Institute (ISI) of Utrecht University (1989-2001). From 2001, ter Haar Romeny holds the chair of Biomedical Image Analysis at the Department of Biomedical Engineering of Eindhoven University of Technology and Maastricht University in the Netherlands, and since 2011 is appointed distinguished professor at Northeastern University, Shenyang, China. His research interests include quantitative medical image analysis, its physical foundations and clinical applications. His interests are in particular the mathematical modeling of the visual brain and applying this knowledge in operational computer-aided diagnosis systems. He authored an interactive tutorial book on multi-scale computer vision techniques, edited a book on non-linear diffusion theory in computer vision.

He is author of over 200 refereed journal and conference papers, 12 books and book chapters, and holds 2 patents. He supervised many PhD students, of which 4 graduated cum laude. He is senior member of IEEE, and chairman of the Dutch Society for Pattern Recognition and Image Processing.

Information Processing in the Visual Pathway

Zhongzhi Shi *(Institute of Computing Technology)*

Abstract

Intelligence Science is an interdisciplinary subject that dedicates to joint research on basic theory and technology of intelligence by brain science, cognitive science, artificial intelligence and other disciplines. We have proposed a mind model CAM which is a general framework for brain-like machines. This talk will focus on the information processing in the visual pathway. Information processing in the visual pathway can be separated into objective processing and spatial processing. The Conditional Random fields based Feature Binding (CRFB) computational model is applied to visual objective processing. Feature integration theory is widely approved on the principles of the binding problem, which supplies the roadmap for our computational model. We construct the learning procedure to acquire necessary pre-knowledge for the recognition network on reasonable hypothesis–maximum entropy. With the recognition network, we bind the low-level image features with the high-level knowledge. For visual spatial processing, we explore three important kinds of relationship between objects that can be queried: topology, distance, and direction.

Short Biography

Zhongzhi Shi is a professor at the Institute of Computing Technology, Chinese Academy of Sciences, leading the Intelligence Science Laboratory. His research interests include intelligence science, machine learning, multi-agent systems and image processing. Professor Shi has published 14 monographs, 15 books and more than 450 research papers in journals and conferences. He has won a 2nd-Grade National Award at Science and Technology Progress of China in 2002, two 2nd-Grade Awards at Science and Technology Progress of the Chinese

Academy of Sciences in 1998 and 2001, respectively. He is a fellow of CCF and CAAI, senior member of IEEE, member of AAAI and ACM, Chair for the WG 12.2 of IFIP. He serves as Editor-in-Chief for International Journal of Intelligence Science and Series on Intelligence Science. He has served as Vice President for Chinese Association of Artificial Intelligence and General Secretary of China Computer Federation.

Control for the Autonomy of Mobile Robots

Jianda Han *(State Key Laboratory of Robotics, Shenyang Institute of Automation)*

Abstract

With the great development of robotics in recent years, many field robots have been expected to carry out tasks in outdoor surroundings, where the robots may suffer from complex terrains, dynamic obstacles/dangerous, bad weather conditions, and so on. Thus, one of the challenging topics is: how a field robot can survive the environment while handling the assigned tasks in an optimal/intelligent approach. The autonomy, which enables robots working on those complicated circumstances with reduced human intervention, has been becoming one of the main goals of mobile robotics. In this talk, I will introduce a feasible control scheme that has been implemented on and experimentally tested on ground mobile and flying robots. The scheme includes four aspects: 1) modeling and understanding the behavior environment; 2) behavior optimization; 3) autonomous learning; and 4) cooperation and coordination of multiple robots. By this scheme, we have realized the autonomous flight of the 100kg-level flying robots and the long-distance autonomous navigation of polar robots. Some of the experimental tests and the applications will be also demonstrated in this talk.

Short Biography

Han Jianda received his PhD degree in Electrical Engineering from the Harbin Institute of Technology in 1998. Currently he is a professor and deputy director of the State Key Laboratory of Robotics, Shenyang Institute of Automation, Chinese Academy of Sciences. His research interests include nonlinear estimation and robust control, control for the autonomy of robots, and robotic system integrations and applications such as medical and assistant robots, ground mobile robots, as well as flying robots. His team developed the first polar robot of China, which was tested in Antarctica in 2008 and 2011; and also the 100kg flying robot, which has realized its applications such as rescue, precision agriculture, power cable construction, etc. Dr. Han currently also serves as a member of the 5-person Expert Panel of the Intelligent Robot Division, the National High Technology Research and Development (863) Program of China.

Brainnetome Studies of Alzheimer's Disease with Neuroimaging

Yong Liu *(Brainnetome Center, Institute of Automation)*

Abstract

The human brain has been described as a large, sparse, complex network. Some of previous neuroimaging studies have provided consistent evidence of dysfunctional connectivity among the brain regions in the AD; however, little is known about whether or not this altered functional connectivity causes disruption of the efficient of information transfer of brain functional networks in the AD. We will introduce the altered functional connectivity pattern of the AD from region of interest analysis, to local network analysis and to whole brain network analysis. And there has been a considerable amount of work recently on the characterization of brain structure and function in the context of networks. This includes identifying correlated changes, defining various network properties (such as long-distance connectivity, rich club behavior, or more general information theoretic measures) and evaluating changes in these properties in the AD groups. Detection and estimation of these alterations could be helpful for understanding the functional alteration of the AD.

Short Biography

Dr. Yong Liu is an associate professor in Brainnetome Center, National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of Sciences. He received his PhD degree from CASIA in 2008 and obtained his MSc degree from Beijing University of Technology in 2005. Since June 2008, he joined CASIA as an assistant/associate research professor. He is a visiting scholar from April 2011 to March 2012 in Brain Mapping Unit in

University of Cambridge, where he worked with Professor Ed Bullmore. His main interests are the analysis of brain networks using multi-modal approaches as well as the application in cognitive disorders, especially in Alzheimer disease and mild cognitive impairment. To date, he has authored about 52 peer-reviewed journal articles and has an h-index of 19. He is a member of Youth Innovation Promotion Association of CAS (2013). He has published in several international peer-reviewed journals including Brain, Cerebral Cortex, NeuroImage and Human Brain Mapping. He is a member of academic editor of PloS One and the Organization for Human Brain Mapping.

Paper

Full paper

Neuromorphic Motivational Systems for Sequential Tasks in Dynamic Environment Dongshu Wang, Yihai Duan and Juyang Weng

Comparison between WWN and Some Prior Networks Zejia Zheng and Juyang Weng

Abstract

Salient Region Detection by Combining Background Contrast and Connectivity Jiamei Shuai, Zhiguo Ma, Laiyun Qing, and Jun Miao

An Experimental Study on Simulating Human Eye Searching Paths Using an Eye-Movement Control Model Based on Neural Coding of Visual Context   **Lijuan Duan, Zhiguo Ma, Jili Gu, Jun Miao**