

Report on IEEE CIS Summer School on Neuromorphic and Cyborg Intelligence Systems

August 24-28, 2015, Zhejiang University

Introduction

On 24th – 28th, August, 2015, a five-day summer school on neuromorphic and cyborg intelligence systems was held on Zhejiang University, Hangzhou, China. More than fifty attendances worldwide registered and participated in this summer school.

This summer school aims to provide a comprehensive review of current trends of research in the field of neuromorphic systems and cyborg intelligence. The participants are expected to acquire knowledge of various learning framework and computational models for neuromorphic systems and cyborg intelligence and be able to promote research activities in this area.

With the recent development of neuromorphic computing and cyborg intelligence systems, tremendous theoretical results and practical applications have been found within this field. More than fifty attendances worldwide registered and participated in this summer school. In the summer school courses, the experts introduced the frontiers and many of their works to the attendances from many aspects, including the biological brain structure, neuromorphic chips, cyborg intelligence systems and so on. Students not only can have a glimpse of the frontiers of academic work, but also were given the chance of operating real neuromorphic robot cars on their own. Many attendances express their wish of further operations on this field.

Organizers

Program Co-chairs:

- **Gang Pan**
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- **Zonghua Gu**
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- **Yueming Wang**
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Advisory Committee:

- **Zhaohui Wu**
Department of Computer Science, Zhejiang University, China
- **Kay Chen Tan**
Dept. of Electrical and Computer Engineering, National University of Singapore
- **Huajin Tang**
College of Computer Science, Sichuan University, China

Agenda

August 24

9:30 - 10:20	Registration
10:20 - 10:30	Opening Remarks
10:30 - 12:00	<i>Development of a Brain Inspired Computing System</i> Dr. Luping Shi (Tsinghua University, China)
12:00 - 13:30	<i>Lunch</i>
13:30 - 15:00	<i>Neural modeling using the NEF and Nengo</i> Dr. Travis DeWolf (University of Waterloo, Canada)
15:00 - 15:30	<i>Break</i>
15:30 - 17:00	<i>Neural modeling using the NEF and Nengo</i> Dr. Travis DeWolf (University of Waterloo, Canada)

August 25

8:30 - 10:00	<i>Fat Tail Dynamics in the Brain, Part -1 : Network Dynamics</i> Dr. Tomoki Fukai (RIKEN brain science institute, Japan)
10:00 - 10:30	<i>Break</i>
10:30 - 12:00	<i>Fat Tail Dynamics in the Brain, Part -2 : Synaptic Plasticity</i> Dr. Tomoki Fukai (RIKEN brain science institute, Japan)
12:00 - 13:30	<i>Lunch</i>
13:30 - 15:00	<i>Neuromorphic Vision Sensors and Event-based Information Processing for Technical Applications</i> Dr. Jörg Conradt (Technische Universität München, Germany)
15:00 - 15:30	<i>Break</i>
15:30 - 17:00	<i>Learning in Neuromorphic Systems and Cognitive Robots</i> Dr. Huajin Tang (A*STAR, Singapore)

August 26

8:30 - 10:00	<i>Spiking Neural Networks for Machine Learning and Predictive Data Modeling: Methods, Systems, and Applications</i> Dr. Nikola Kasabov & Nathan Scott (Auckland University of Technology, New Zealand)
10:00 - 10:30	<i>Break</i>
10:30 - 12:00	<i>Spiking Neural Networks for Machine Learning and Predictive Data Modeling: Methods, Systems, and Applications</i> Dr. Nikola Kasabov & Nathan Scott

(Auckland University of Technology, New Zealand)

12:00 - 13:30 *Lunch*

13:30 - 15:00 *Project*

Dr. Cristian Axenie (Technische Universität München,
Germany)

15:00 - 15:30 *Break*

15:30 - 17:00 *Project*

Dr. Cristian Axenie (Technische Universität München,
Germany)

August 27

8:30 - 10:00 ***Brain-Inspired Computing: The Extraordinary Voyages in
Known and Unknown Worlds***

Dr. Yiran Chen (University of Pittsburgh, USA)

10:00 - 10:30 *Break*

10:30 - 12:00 ***Brain-Inspired Computing: The Extraordinary Voyages in
Known and Unknown Worlds***

Dr. Yiran Chen (University of Pittsburgh, USA)

12:00 - 13:30 *Lunch*

13:30 - 15:00 *Project*

Dr. Nathan Scott

(Auckland University of Technology, New Zealand)

15:00 - 15:30 *Break*

15:30 - 17:00 *Project*

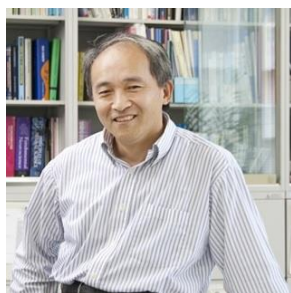
Dr. Nathan Scott

(Auckland University of Technology, New Zealand)

August 28

8:30 - 10:00	<i>Brain-machine Interfaces</i> Dr. Xiaoxiang Zheng (Zhejiang University, China)
10:00 - 10:30	<i>Break</i>
10:30 - 12:00	<i>Brain-machine Interfaces</i> Dr. Xiaoxiang Zheng (Zhejiang University, China)
12:00 - 13:30	<i>Lunch</i>
13:30 - 15:00	<i>Project</i> Dr. Cristian Axenie (Technische Universität München, Germany)
15:00 - 15:30	<i>Break</i>
15:30 - 17:00	<i>Project</i> Dr. Cristian Axenie (Technische Universität München, Germany)

Invited Speakers



Prof. Tomoki Fukai is the team leader of lab for neural circuit theory, RIKEN brain science institute. His research area includes high-level functions of the brain, such as perception, learning and memory, decision making, etc., emerge from computations by neuronal networks. His lab uses theoretical and electrophysiological approaches to better understand the fundamental properties of neural networks.

Prof. Nikola Kasabov is the Director and the Founder of the Knowledge Engineering and Discovery Research Institute (KEDRI), Auckland. He holds a Chair of Knowledge Engineering at the School of Computing and Mathematical Sciences at Auckland University of Technology. He is a Fellow of IEEE, Fellow of the Royal Society of New Zealand, Fellow of the New Zealand Computer Society, the President of the International Neural Network Society (INNS) and a Past-President of the Asia Pacific Neural Network Assembly (APNNA). He is a member of several technical committees of the IEEE Computational Intelligence Society and of the IFIP AI TC12.



Prof. Luping Shi, National 1000 talent distinguish professor, director of center for brain inspired computing research, director of optical memory national engineering research center, Tsinghua university, China, SPIE fellow. He received a Doctor of Science from University of Cologne, Germany in 1992. From 1996 to Mar.2013 he worked in data storage institute, Singapore as a senior scientist and division manager and led nonvolatile solid-state memory (NVM), artificial cognitive memory (ACM) and optical storage researches. His main research areas include Brain inspired computing, NVM,

ACM, optical data storage, and integrated opto-electronics. He has published more than 150 papers in prestigious journals including Science, Nature Photonics, filed and granted more than 10 patents and conducted more than 60 keynote speech or invited talks during last 10 years. He is the recipient of the National Technology Award 2004 Singapore.

Prof. Jörg Conradt is Assistant Professor at the Technische Universität München in the Department of Electrical and Computer Engineering, Center of NeuroEngineering. He holds an MS Degree in Computer Science / Robotics from the University of Southern California, a Diploma in Computer Engineering from TU Berlin and a Ph.D. in Physics / Neuroscience from ETH Zurich. His research group on Neuroscientific System Theory (<http://www.nst.ei.tum.de/en>) investigates key principles by which information processing in brains works, and applies those to real-world interacting technical systems.





Dr. Huajin Tang received the B.Eng. degree from Zhejiang University, Hangzhou, China, M.Eng. degree from Shanghai Jiao Tong University, Shanghai, China, and the Ph.D. degree in electrical and computer engineering from the National University of Singapore, Singapore, in 1998, 2001, and 2005, respectively. He was a R&D Engineer with STMicroelectronics, Singapore, from 2004 to 2006. From 2006 to 2008, he was a Post-Doctoral Fellow with Queensland Brain Institute, University of Queensland, Australia. He has been a Research Scientist and Leader of the Cognitive

Computing with the Institute for Infocomm Research, Singapore. He is now a professor and director of Neuromorphic Computing Research Center, College of Computer Science, Sichuan University.

Dr. Yiran Chen received B.S and M.S. (both with honor) from Tsinghua University and Ph.D. from Purdue University in 2005. After five years in industry, he joined University of Pittsburgh in 2010 as Assistant Professor and then promoted to Associate Professor in 2014. He is now leading Evolutionary Intelligence Lab (www.ei-lab.org) at Electrical and Computer Engineering Department, focusing on the research of nonvolatile memory and storage systems, neuromorphic computing, and mobile systems. Dr. Chen has published one book, a handful of book chapters, and more than 200 journal and conference papers. He has been granted with 89 US and international patents with other 14 pending applications. He is the associate editor of IEEE TCAD, ACM JETC, ACM SIGDA E-news and served on the technical and organization committees of around 40 international conferences. He received three best paper awards from ISQED'08, ISLPED'10 and GLSVLS'13 and other 8 nominations from DAC, DATE, ASPDAC, etc. He also received NSF CAREER award in 2013, ACM SIGDA outstanding new faculty award in 2014, and was the invitee of 2013 U.S. Frontiers of Engineering Symposium of National Academy of Engineering (NAE).



Dr. Travis's research focuses on studying the brain's motor control system. Using modern control theoretic methods, such as operational space control, nonlinear adaptive control, and dynamic movement primitives, he has worked to develop biologically plausible spiking neural networks that model the brain, capable of generating the same diversity of behavioural phenomena and robust adaptation / learning seen in primates. He received his undergraduate degree in computer science at Acadia University, with a thesis discussing the algebraic

properties of template-guided DNA recombination. His masters degree was in computer science at the University of Waterloo, and focused on the development of the Neural Optimal Control

Hierarchy (NOCH); a biologically plausible framework for large-scale models of the motor control system. His Ph.D. was in systems design engineering at the University of Waterloo, where he presented the Recurrent Error-driven Adaptive Control Hierarchy (REACH) model; a large-scale, fully spiking neural model of the motor cortices and cerebellum able to account for data from 20 studies from a behavioural level down to the level of single spiking neurons.



Dr. Xiaoxiang Zheng obtained her B.A. degree from Department of Radio Radio Technology, Zhejiang University (1968), and her Ph.D from the Department of Basic Medical Sciences, University of Tsukuba, Japan (1993). In 1993 he joined department of Biomedical Engineering, Zhejiang University as a professor. From 1999 to 2005, he became dean of college of Biomedical Engineering and Instrument Science, Zhejiang University. She was Director of Laboratory of Biomedical Engineering of Ministry of Education Key and director of Zhejiang Key

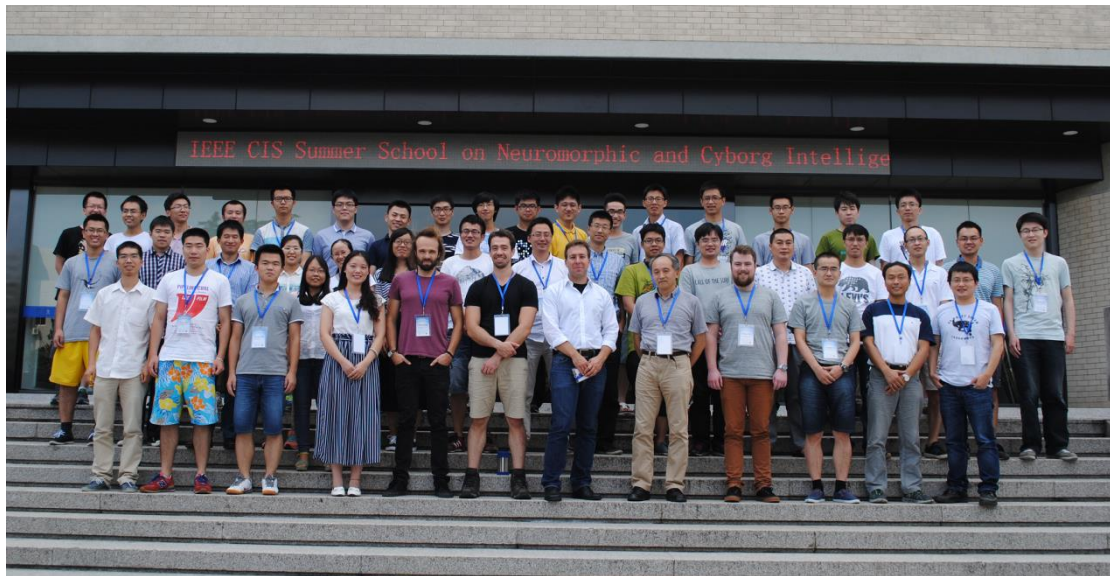
Laboratory for vascular and neurological evaluation and development of traditional Chinese medicine. For thirty years, she has been engaged in research in biology, medicine and engineering interdisciplinary. As leader of Zhejiang University biomedical engineering disciplines, she built a molecular, cellular, and other multi-level overall cardiovascular and nervous system physiology quantitative research technology platform. From October 2006 she was executive vice president of Qiushi Academy for Advanced Studies (QAAS), Zhejiang University. In the past nine years, She took a leadership of a neural engineering team in QAAS and achieved leapfrog development in the brain-computer interface research, in which she has successfully carried out both animal experiments (monkeys) and clinical research, including developing the an animal robot system, a P300 activity based Chinese typewriter, neural control of robot grasp action by monkey and other brain-computer interface systems. Her current research interests include neural engineering, biomedical technology and methods of quantification of cell physiology.

Dr. Nathan Scott has completed his Doctoral Study in Computer Science (AB Defence) at KEDRI, studying design and implementation of SNN and neuromorphic systems under the supervision of Prof. Kasabov. He holds Bachelor of Computer and Information Sciences (First Class Honours), Bachelor of Computer and Information Sciences (Software Development) and Bachelor of Business degrees from Auckland University of Technology. Nathan is an AUT Vice Chancellor's Scholar, recipient of Top Graduate awards, the Dean's highest achievement award and of other study awards. He is a member of the IEEE CIS and SigProc Societies, and a member of the IEEE CIS Neural Networks Task Force on Education. He has given a number of invited talks internationally, including tutorials at WCCI and IJCNN conferences, and chaired a number of conference Special Sessions on SNN. He currently teaches undergraduate courses in computer graphics and embedded computing. More information can be obtained from:



<http://www.kedri.aut.ac.nz>

Pictures



Group photo for IEEE CIS summer school on neuromorphic and cyborg intelligence system



Attendees



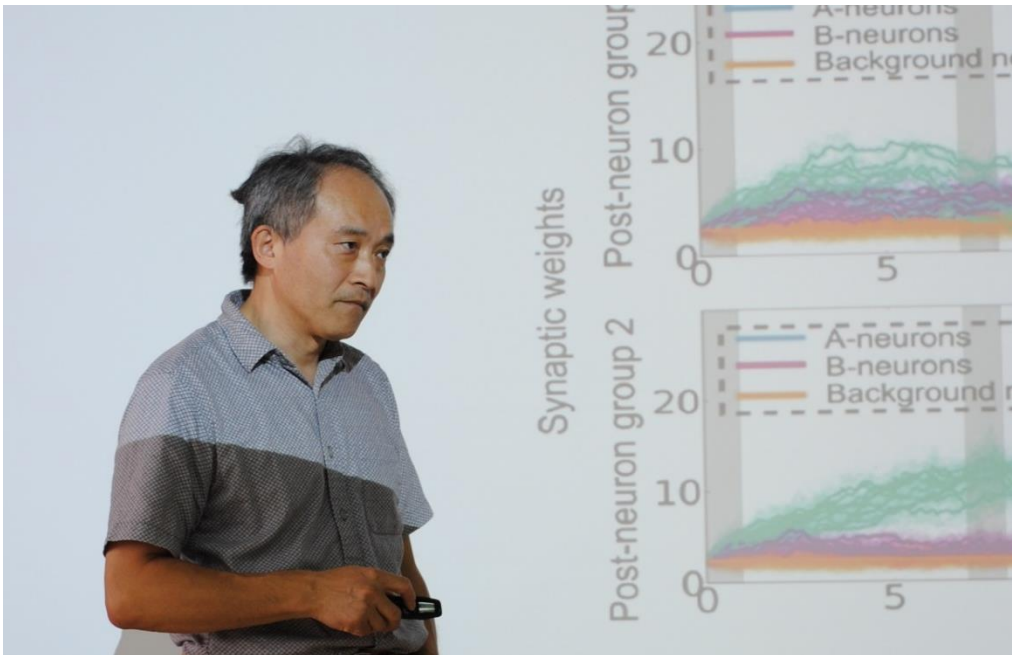
Attendees



Dr. Luping Shi on "Development of a Brain Inspired Computing System"



Dr. Travis Dewolf on “Neural modeling using the NEF and Nengo”



Dr. Tomoki Fukai on “Fat Tail Dynamics in the Brain”



Dr. Jörg Conradt on “Neuromorphic Vision Sensors and Event-based Information Processing for Technical Applications”



Dr. Cristian Axenie on project introduction



Dr. Huajing Tang on “Learning in Neuromorphic Systems and Cognitive Robots”



Dr. Nathan Scott on “Spiking Neural Networks for Machine Learning and Predictive Data Modeling: Methods, Systems, and Applications”



Dr. Yiran Chen on “Brain-Inspired Computing: The Extraordinary Voyages in Known and Unknown Worlds”



Dr. Xiaoxiang Zheng on “Brain-machine Interfaces”