KAI CHEN

800 Dongchuan Rd., Shanghai 200240 · kchen513@outlook.com · neoneuron.github.io · ORCID: 0009-0004-3834-9504

(Last updated: 2023/4/30)

EDUCATION

SHANGHAI JIAO TONG UNIVERSITY *Ph.D of Applied Mathematics* 2020/09 ~ Present

- **Relevant Courses**: *Scientific Computing, High performance Computing in ODEs and PDEs, Inverse Problems;*

SHANGHAI JIAO TONG UNIVERSITY *Master of Science of Physics* 2018/09 ~ 2020/06

- **GPA**: 3.57/4.0;
- **Relevant Courses**: *Advanced Statistical Physics, Biological Physics, Advanced Electrodynamics and Analytical Mechanics;*

SHANGHAI JIAO TONG UNIVERSITY *Bachelor of Science of Physics* 2013/09 ~ 2017/06

- **Rank**: 4/71; **GPA**: 3.78/4.0;
- **Scholarships**: National Scholarship; *Liuyuan* Scholarship of Shanghai Jiao Tong University;
- **Relevant Courses**: *Statistical Physics, Computational Physics, Biological Physics, Electrodynamics, Calculus, Linear Algebra, Partial Differential Equation, Complex Variables;*
- **Awards**: Champion in *Shanghai Undergraduate Physicists' Tournament*; Champion in *Shanghai Mathematical Contest in Modeling*; Second Prize in *National Mathematical Contest in Modeling*; Successful Participant in *COMAP's Mathematical Contest in Modeling*; Outstanding Graduates of Shanghai Jiao Tong University;

PUBLICATIONS

Z. K. Tian*, **K. Chen***, S. Li, D. W. McLaughlin, D. Zhou. Quantitative relations among causality measures with applications to pulse-output nonlinear network reconstruction. bioRxiv 2023.04.02.535284. DOI: 10.1101/2023.04.02.535284

PRESENTATIONS

† *Indicates expected*

Oral Presentations:

2023/05 † *Quantitative relations among causality measures with applications to nonlinear network reconstruction,* **SIAM-DS23**, Portland, Oregon, USA.

2022/11 *Quantitative relations among causality measures with applications to nonlinear pulse-output network reconstruction,* **CSIAM2022**, online.

2021/06 *Modeling Attentional Modulated Spike Count Correlation in Macaque V1*, **CCCN2021**, online.

Posters:

2023/08 † *Quantitative relations among causality measures with applications to nonlinear pulse-output network reconstruction,* **ISIAM2023**, Waseda University, Tokyo, Japan.

2023/07 † *Quantitative relations among causality measures with applications to nonlinear pulse-output network reconstruction,* **CNS2023**, Zhuhai, China.

2022/06 *Quantitative relations among causality measures with applications to nonlinear pulse-output network reconstruction,* **CCCN2022**, online.

2022/06 *Modeling Attentional Modulated Spike Count Correlation in Macaque V1*, **CCCN2021**, online.

RESEARCH EXPERIENCE

Project: Computational Mechanism of task-oriented Reservoir Recurrent Neural Networks (RNNs) **SHANGHAI**

Shanghai Jiao Tong University *Supervisor: Prof. Li, Songting; Zhou, Douglas* 2022/12 ~ Present

- Built the pipeline to train RNN and Reservoir RNN to perform cognitive tasks systematically;
- Reverse-engineered well-trained networks to compare and understand mechanism of task performing in RNN and Reservoirs;
- Trained a single Reservoir network to perform multiple tasks, and understood the mechanism of multi-tasking Reservoir network and compared them with uni-tasking neural networks.

Project: Effective Inference of Functional Connectivity from ECoG Data Using TDMI **SHANGHAI**

Shanghai Jiao Tong University *Supervisor: Prof. Li, Songting; Zhou, Douglas* 2021/01 ~ Present

- Developed time-delayed mutual information (TDMI) analysis framework for analyzing neurophysiological data (ECoG).
- Showed that strong TDMI inferred signal highly consistent with anatomical connectivity (structure connectivity) with high positive prediction correct rate (PPV) for ECoG data.
- Demonstrated the merit of our TDMI inference framework by compared our inference performance based on conventional Granger causality (GC) and conditional GC.
- Developed banded inference framework for ECoG data.

Project: Modeling Attentional Modulated Spike Count Correlation(R_{sc}) in Macaque V1 **SHANGHAI**

Shanghai Jiao Tong University *Supervisor: Prof. Li Songting; Zhou, Douglas* 2019/12 ~ Present

- Built neural rate model to simulate the effective dynamics in the delayed color-change detection tasks of macaques.
- Fitted the non-monotonic modulations for R_{sc} w.r.t. task difficulty in our model to the electrophysiology data.
- Obtained a set of optimized parameters for the structure of model system with the help of *mean field theory* analysis.
- Revealed the role of specific top-down inputs towards inhibitory neurons in the attentional modulation.
- Built *spiking neuronal network* (SNN) model to verify prediction got from neural rate model.

Project: Causal Inference of Neuronal Data Based on Time-delayed Mutual Information **SHANGHAI**

Shanghai Jiao Tong University *Supervisor: Prof. Zhou, Douglas* 2017/07 ~ 2018/12

- Developed time-delayed mutual information (TDMI) analysis between Gaussian random variables.
- Revealed the quantitative relation between inferred causality and coupling strength between Gaussian units.
- Designed a pipeline for TDMI estimation between spike train and local field potentials (LFPs) and confirmed its feasibility on causal inference between two types of neuronal signals.

- Determined the relation between interacting strength and the value of mutual information for weakly coupled neurons.
- Revealed the difference behavior of excitatory and inhibitory neurons in TDMI analysis.
- Determined the feasible network dynamical regime for TDMI analysis.

Project: Study of Network Dynamics Based on Integrate-and-Fire Neuron Model **SHANGHAI**
Shanghai Jiao Tong University *Supervisor: Prof. Zhou, Douglas; Cai, David* 2016/02 ~ 2017/06

- Developed programs for point neuronal network simulation, implementing conductance-based LIF model with 4th order global convergence (based on *Runge-Kutta* algorithm).
- Simulated dynamics of 'small-world' networks with up to a thousand neurons. Investigated their oscillations using rasters and power spectrums as functions of different Poisson input conditions.

Project: Coherent Diffraction Imaging (CDI) of Micro-Scale Samples **SHANGHAI**
Shanghai Jiao Tong University *Supervisor: Prof. Xiang, Dao* 2014/09 ~ 2015/06

- Developed CDI retrieval algorithm, and tested it with numerical samples;
- Designed and built optical system of 532nm laser-based CDI. Designed samples and recorded diffraction patterns;
- Optimized the performance of the system, and retrieved the structure of samples with ~2um spatial resolution;

Project: Femtosecond Pump-probe Spectroscopy (FPPS) of Protein Photosynthesis **DAVIS, CA, US**
University of California, Davis *Supervisor: Dr. Cramer, Stephen* 2016/08 ~ 2016/09

- Built and tuned systems of non-colinear optical parametric amplifiers and FPPS for putidaredoxin studies.
- Reconstructed reaction modes based on global analysis simulations with sequential photosynthesis models.

TEACHING EXPERIENCES

2021/09 ~ 2023/01	Linear Algebra (TA)	Shanghai Jiao Tong University
2022/08 ~ 2022/08	CNeuro (TA)	Beijing, China/Basel Switzerland
2022/03 ~ 2022/06	Probability and Statistics (TA)	Shanghai Jiao Tong University
2021/01 ~ 2022/01	Computational Neuroscience Winter School (TA)	Shanghai Jiao Tong University
2021/07 ~ 2021/08	Neuromatch Academy (Leading TA)	Asia time-slot
2019/09 ~ 2021/01	Advanced Topics in computational neuroscience (TA)	Shanghai Jiao Tong University
2020/07 ~ 2020/08	Neuromatch Academy (TA)	Asia time-slot
2018/09 ~ 2019/06	General Physics (TA)	Shanghai Jiao Tong University

SKILLS AND SPECIALISTS

Programming: Python, C/C++, LaTeX, Shell, MATLAB/Octave
Hobbies: Chinese Calligraphy; Chinese Flute; Powerlifting;