

KAIWEN SHENG

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EDUCATION

University College London

MRes in Biosciences: Neuroscience

London, UK

Sept 2021 - Sept 2022

Peking University

BS in Computer Science

Beijing, CN

Sept 2016 - Jun 2020

SELECTED RESEARCH PROJECTS

A computational framework to investigate the functional specificity of cortical neurons

University College London

Advised by Prof. Michael Häusser and Dr. Brendan Bicknell

Dec 2021 - Present

- Derived a general learning rule based on cable theory and Hodgkin-Huxley equations with which detailed models of neurons, comprising 3D reconstructed morphologies and an array of active conductances, can be 'trained' to perform sophisticated computational tasks.
- Designed a battery of tasks with distinct processing requirements, including: nonlinear feature-binding computations, Boolean logic operations, and a regression task designed to test the limits of stimulus selectivity.
- Identified a diverse set of morphological and biophysical features to explain the computational performances of different neuron models.
- Constructed an efficient and flexible software package to support the training of neuronal models and analysis.

Inferring neural properties from neural data across scales

Beijing Academy of Artificial Intelligence

Advised by Prof. Kai Du (PKU) and Prof. Jun Ding (Stanford)

Jan 2020 - Present

- Proposed a general domain adaptive neural inference framework to infer biophysical properties and connectivity.
- Designed self-training and domain adaptation to avoid biased inference results caused by the out-of-distribution problem between synthetic data and experimental data.
- Accurately and efficiently inferred biophysical properties of 550 neurons across 14 brain regions of mice and those of the stomatogastric ganglion microcircuit of the *Cancer Borealis*.
- Achieved near-optimal accuracy in inferring monosynaptic connectivity of networks in the CA1 region of mice.

Geometric analysis of the influence of retina on cortical decision boundaries

Peking University

Advised by Dr. Kai Du

March 2022 - Sept 2022

- Approximated dynamics of retinal gap junction networks by a recurrent neural network based on derivations of conductance-based neuronal models.
- Drafted the manuscript and prepared the figures.

PUBLICATIONS

- **Sheng, K.**, Zhang, S., Beau, M., Qu, P., Yang, L., Liu, X., He, L., Ma, L., & Du, K. (2022). Domain Adaptive Neural Inference for Neurons, Microcircuits and Networks. *bioRxiv*.
- Yue, Y., Zhang, S., **Sheng, K.**, Zhang, S., Zhang, R., & Du, K. (2022). Retina Gap Junctions Support the Robust Perception by Warping Neural Representational Geometries along the Visual Hierarchy. (ready to submit to eLife)
- Shi, R., Wang, W., Li, Z., He, L., **Sheng, K.**, Ma, L., ... & Huang, T. (2022). U-RISC: an annotated ultra-high-resolution electron microscopy dataset challenging existing deep learning algorithms. *Frontiers in Computational Neuroscience*, 21.
- Su, L. *, Wang, W. *, **Sheng, K.**, Liu, X., Du, K., Tian, Y., & Ma, L. (2022). Siamese Network-Based All-Purpose-Tracker, a Model-Free Deep Learning Tool for Animal Behavioral Tracking. *Frontiers in Behavioral Neuroscience*, 48. (* equally contributed)
- **Sheng, K.**, Qu, P., Yang, L., Liu, X., He, L., Ma, L., & Du, K. (2021). A General LSTM-based Deep Learning Method for Estimating Neuronal Models and Inferring Neural Circuitry. *bioRxiv*.
- Shi, R., Wang, W., Li, Z., He, L., **Sheng, K.**, Ma, L., ... & Huang, T. (2020). Human Perception-based Evaluation Criterion for Ultra-high Resolution Cell Membrane Segmentation. *arXiv preprint arXiv:2010.08209*.
- Zheng, S., Liang, Y., Wang, S., Chen, R., & **Sheng, K.** (2020, March). FlexTensor: An Automatic Schedule Exploration and Optimization Framework for Tensor Computation on Heterogeneous System. In *Proceedings of the Twenty-Fifth International Conference on Architectural Support for Programming Languages and Operating Systems* (pp. 859-873).

PRESENTATIONS

Posters

- **Sheng, K.**, Bicknell, B.A., Häusser, M. Computational Specialization of Cortical Dendrites. *Neuroscience 2022*; Dec 2022; San Diego, United States.
- **Sheng, K.**, Bicknell, B.A., Häusser, M. Computational Specialization of Cortical Dendrites. *UCL Neuroscience Symposium 2022*; June 2022; London, United Kingdom.
- Bicknell, B.A., **Sheng, K.**, Häusser, M. Learning to Harness Dendritic Computations. *Dendrites 2020: Dendritic anatomy, molecules and function*; May 2022; Heraklion, Greece.
- **Sheng, K.**, Qu, P., Yang, L., Liu, X., He, L., Ma, L., & Du, K. A General LSTM-based Deep Learning Method for Estimating Neuronal Models and Inferring Neural Circuitry. *Third Chinese Computational and Cognitive Neuroscience Conference*; June 2021; Shenzhen, China.

WORKING EXPERIENCE

Research Assistant Neural Computation Lab	University College London Oct 2022 - Present
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- Established a theoretical framework for investigating principles of single neuron computation.

Research Assistant Neural Analysis Group	International Brain Laboratory Oct 2022 - Present
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- Facilitated the development of the electrophysiology atlas platform.

Leader of Application Research Team Life Simulation Research Center	Beijing Academy of Artificial Intelligence Jun 2021 - Sept 2021
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- Organized research cooperation among researchers and interns.
- Scheduled and summarized weekly discussions on the progress of research projects of the group members.

Software Development Engineer Life Simulation Research Center	Beijing Academy of Artificial Intelligence Jun 2020 - Sept 2021
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- Developed an automatic tool for parameter estimation and optimization for computational neural models.
- Published a preprint paper of the tool on bioRxiv.

TEACHING EXPERIENCE

Teaching Assistant Compiler Practice	Peking University Feb 2020 - Jun 2020
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- Guided students to work through each stage of compiler design, including symbol table construction, type check, intermediate representation generation, register allocation.

Teaching Assistant Algorithm Design and Analysis Seminar	Peking University Feb 2019 - Jun 2019
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- Reviewed and expanded lecture content based on *Introduction to Algorithms*.
- Designed exam papers and provided references on reinforcement learning.

ACADEMIC SERVICE

Reviewer of Bioscience Horizons	Nov 2021 - Present
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LEADERSHIP EXPERIENCE

Badminton Association in Peking University President	Peking University Sept 2019 - Jun 2020
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- Organized badminton competitions at Peking University and scheduled friendly matches among colleges.
- Popularized badminton through social media at Peking University.

Badminton Team of Peking University Captain	Peking University Sept 2019 - Jun 2020
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- Led weekly training and participated in competitions.

AWARDS

Outstanding Graduate of Peking University	Sept 2019
Robin Li Scholarship of Peking University	Sept 2019
Excellent Research of Peking University	Sept 2019
Ke Chuanglong Scholarship of Peking University	Sept 2018
Merited Student of Peking University	Sept 2018 & Sept 2017
May Fourth Scholarship of Peking University	Sept 2017

SKILLS

Languages	Python, C/C++, MATLAB
Framework	NEURON, NEST, PyTorch