Shengyuan Cai [Link]

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EDUCATION

Imperial College London London, UK

MRes (Master of research) of Neurotechnology Supervisor, Dr. Simon Schultz *Sep. 2023 – Expected Sep.2024*

- Relevant Projects: Muti-scale neural dynamics underlying memory encoding and recall in hippocampal area CA1.
- Relevant Course:
  Mathematical Methods for Neural Science and Engineering, Human Neuromechanical Control and Learning.

Shandong University Shandong, China

B.E in Electrical and Information Engineering, Innovation Key Class *Sep. 2018 – Jun.2022*

- Cumulative GPA: 86.49/100 Technical GPA: 89.01/100
- Relevant Course:
  Mind Introductory on Cognitive Science, Introduction to EECS I (Ref. MIT OCW 6.01), Linear Algebra, Probability Theory and Mathematical Statistics, Machine learning, pattern recognition and deep learning, Digital signal processing, Digital image processing, Digitalelectronic technology, Python and Computational Biology.

Peking University Beijing, China

Summer school: FPGA design flow based on RSIC-V processor (Score:99/100) *Jul. 2020 – Aug.2020*

PUBLICATIONS

Cai, S., Li, H., Wu, Q., Liu, J., Zhang, Y. (2023).

Motor imagery decoding in the presence of distraction using graph sequence neural networks. **IEEE Transactions on Neural Systems and Rehabilitation Engineering 30, 1716-1726**

https://doi.org/10.1109/TNSRE.2022.3183023 [paper]

Han, Y., Chen, K., Wang, Y., Liu, W., Wang, X., Liao, J., Huang, Y., Han, C., Huang, K., Zhang, J., **Cai, S.**, Wang, Z., Wu, Y., Gao, G., Wang, N., Li, J., Song, Y., Li, J., Wang, G., Wang, L., Zhang, Y., Wei, P. (2024).

Multi-animal 3D social pose estimation, identification and behaviour embedding with a few-shot learning framework. **Nature Machine Intelligence 6, 48–61**

https://doi.org/10.1038/s42256-023-00776-5 [paper]

RESEARCH INTEREST

- Representation learning, Computational neurobehavior, Effective connectivity, Neural dynamics

RESEARCH EXPERIENCE IN BRAIN SCIENCE

Muti-scale neural dynamics underlying memory encoding and recall in hippocampal area CA1

Researcher Supervisor, Dr. Mauricio Barahona, Dr. Simon Schultz (Imperial College London) *Sep 2023 – present*

- Modeling dynamic causal model to represent the interaction of CA1 neurons in hippocampus

- Finding higher order motifs of hippocampal network in the presence of dementia

- Training recurrent neural networks (RNNs) to perform path integration alongside firing patterns to exhibit place cell properties

Inferring whole effective connectivity in the infant human brain and the associated developmental trends

Researcher Supervisor, Dr. Quanying Liu (Southern University of Science and Technology) *Feb 2022 – Aug 2023*

- Led the team through the process of scientific hypothesis, comparison experiments, and paper writing
- Modeled neural perturbational inference method for infant human brain
- Found effective connectivity in the non-linear information flow of asynchronous fMRI data, and analyzing brain heterogenous development to detect functional injury in preterms and terms
- Understanding the clinical implications and pathophysiological basis of aberrant network development

Embedding the relationship between neural activity and episodic behavior under the influence of sepsis
Researcher Supervisor, Dr. Pengfei Wei, Dr. Liping Wang (Chinese Academy of Sciences)   *Sep 2021 – Jan 2022*
- Constructed the behavioral map of strain-specific mice for quantitative evaluation learning
- Developed an instance segmentation and dynamic tracking model for animals, and constructed an unsupervised hierarchical clustering algorithm for the refinement of social behavioral mapping of mice
- Analyzed vivo two-photon imaging of calcium influx in the secondary motor cortex, combined it with the theory of mouse behavioral structure, and finally explained the effect of altered neural spine patterns in the primary motor cortex on episodic behavior in the presence of spinal cord injury

Motor imagery decoding in the presence of distraction using graph sequence neural networks
Leader Supervisor, Dr. Qiang Wu, Dr. Ju Liu, Dr. Yu Zhang (Lehigh University)   *Aug 2020 – Aug 2021*
- Led the team through the process of algorithm design, comparison experiments and paper writing
- Analyzed graph of scalp Electroencephalogram (EEG) based on sensors, and mainly realized the functional screening of visual evoked potentials and the visualization of real-time process
- Designed a graph convolutional neural network with the self-attention mechanism for graph feature analysis
- Solved the problem of adaptive feature extraction effectively, thereby enabling the interchannel structures of active brain regions under different distraction themes

Differential study of social dysfunction in mice under transcranial direct current stimulation (TDCS) stimulation
Undergraduate Researcher Supervisor, Dr. Qiang Wu   *Jun 2020 – Sep 2020*
- Designed and implemented a multi-channel TDCS stimulation system
- Pinpointed specific differences from the apparent behavior level to explore the effect of TDCS on the social interaction of mice, and then studied the internal mechanism of the neural loops

WORKING PAPERS

(In revision) Luo, Z.,Peng,K.,Liang,Z., **Cai, S.**, , Xu,C., Li,D., Hu,Y., Zhou,C., Liu, Q. (2023). Mapping effective connectivity by virtually perturbing a surrogate brain. *arXiv*

https://doi.org/10.48550/arXiv.2301.00148 [paper]

(In revision) **Cai, S.**, Luo, Z., Ye, Z., Liu, Q. (2023). Perturbation-based effective connectivity in the infant human brain and the associated developmental trends.

(In revision) Ju, F., Jian, W., Han, Y., Huang, T., Ke, J., Liu, Z., **Cai, S.**, Liu, N., Wang,L., Wei, P. (2022). Long-term two-photon imaging of spinal cord in freely behaving mice. *bioRxiv*

https://doi.org/10.1101/2022.01.09.475306 [paper]

WORK AND COMPETITION EXPERIENCE

Neuromatch [Link]
Supervisor, Dr. Helena Hartmann (University Hospital Essen)   *Jul 2021 – Aug 2021*
- Studied traditional and emerging computational neuroscience tools, on modeling choices, model creation, model evaluation, and understanding of how such models relate to biological questions
- Utilized the (IBL-behavior dataset) for similarity analysis and representing decision factors, including combined generalized linear-hidden Markov models (GLM - HMM) and tensor construction using Pytorch.

Chinese Computational Psychiatry Modeling Competition [Link]
Supervisor, Dr. Mingbo Cai (University of Tokyo)   *Jul 2021 – Aug 2021*
- Designed a diagnostic model based on reinforcement learning to assess anxiety level in clinical situations
- Completed a model to evaluate anxiety levels through decision conversion rates, which basically realized the pathologic evaluation based on questionnaire
- Ranked third place out of ten teams in the seven-day hack challenge with six team members

SCHOLARSHIPS & AWARDS

- Enrolled student of London Geometry and Machine Learning Summer School (July 2024)   [Link]

- Poster for 2024 Society for Neuroscience Abstract (Under Revision)   [Link]

- Poster in the Nature Conference of Transformative Technologies for Neuroengineering, Shenzhen (April 2024)   [Link]

- Poster presentation in the MLSS - Machine Learning Summer School, Poland (July 2023)   [Link]

- Outstanding undergraduate thesis in Shandong University (top 1%) (June 2022)

- Poster presentation in the 3rd International Workshop on Neural Engineering and Rehabilitation (May 2022)   [Link]

- China Ministry of Education College Student Research Project Fund. **(top 0.1%)** (November 2021)

- Excellent Student of Innovation and Entrepreneurship in Shandong University (top 5%) (November 2021)

- Research Scholarship in Shandong University (top 5%) (November 2021)

- Merit student of the winter school in neuroscience (Chinese Institute for Brain Research Beijing). (top 10%) (2021)

- Outstanding College Student of Innovation and Entrepreneurship Award in Qingdao (top 10%) (November 2020)

SKILLS

- Language, Mandarin (native), English (proficient).

- Computer Skills, C/C++, Python, MATLAB, C, Linux, Pytorch, Tensorflow, CUDA, Microprocessors.

- Neuroscience Skills, Nilearn, NetworkX, NEST, Vivo two-photon imaging technique, DIPY, Brainpy