TAO SUN

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PROFESSIONAL SUMMARY

- Results-driven AI and software engineering professional with a PhD in Computer Science and extensive experience in neuromorphic systems and deep learning.
- Adept at developing advanced algorithms for real-world applications, including uncertainty estimation and speech enhancement.
- Strong foundation in AI frameworks such as PyTorch and TensorFlow.
- Skilled in the design and development of scalable, efficient, and maintainable systems.
- Proven ability to collaborate across interdisciplinary teams, communicate complex ideas clearly, and drive innovative solutions.

EDUCATION & CERTIFICATIONS

Doctor of Philosophy in Computer Science / Ohio University, Athens, OH   September 2016 – April 2022

RESEARCH EXPERIENCES

AI RESEARCHER   May 2022 – Now
National Research Institute for Mathematics and Computer Science (CWI), Amsterdam

My research focuses on the following two areas:

Perceptive Acting under Uncertainty: Safety Solutions for Autonomous Systems
In this project funded by the Dutch Research Agenda (NWA), I am developing uncertainty estimation algorithms utilizing spiking neural networks (SNNs). By leading the coordination among multiple teams, we have successfully published a paper and are currently exploring new applications for our findings. This experience has enhanced my ability to manage complex projects and collaborate effectively in interdisciplinary environments.

Speech Enhancement with SNNs
I have created an innovative SNN model for speech enhancement that showcases competitive performance on benchmark datasets. A paper detailing this research has recently been published in *Neuromorphic Computing and Engineering*.

RESEARCH PROJECTS

Low-latency Speech Enhancement with SNNs   May 2023 – July 2024

Speech enhancement, alternatively known as speech denoising, constitutes a power-constrained task with considerable commercial importance. The remarkable energy efficiency and temporal characteristics of SNNs position them as optimal models for addressing speech enhancement tasks. In this work, I introduce a very low-latency SNN framework for speech enhancement.

The framework addresses the current limitations of effective SNN for speech enhancement as for instance developed in the context of the recent Intel DNS challenge. These solutions typically impose substantial latency due to long sampling windows, typically 32 ms. This latency exceeds the requirements of many speech enhancement applications, such as hearing aids, which require latency <5 ms. Inspired by the success of high-performance, low-latency deep learning models, we have developed a novel two-phase time-domain streaming SNN framework that offers the required

low-latency. This is combined with competitive accuracy and power efficiency compared to SNN state-of-the-art for speech enhancement.

The publication:

- T. Sun and S. Bohte, "DPSNN: Spiking Neural Network for Low-Latency Streaming Speech Enhancement," *Neuromorphic Computing and Engineering* (2024) **DOI** 10.1088/2634-4386/ad93f9

Uncertainty Estimation for SNNs   May 2022 – Now

Uncertainty estimation is essential for decision making in high-stakes applications, such as autonomous vehicles, medical diagnosis, and high frequency trading. In this project, I propose an efficient Monte Carlo (MC)-dropout based approach for uncertainty estimation in SNNs. This Bayesian approximation approach exploits the time-step mechanism of SNNs to enable MC-dropout in a computationally efficient manner, without introducing significant overheads during training and inference while demonstrating high accuracy and uncertainty quality.

I successfully applied the proposed approach to classification tasks. Currently, I am extending its application to regressions and have achieved very promising results.

The publication:

- T. Sun, B. Yin, & S. Bohte, "Efficient uncertainty estimation in Spiking Neural Networks via MC-dropout". International Conference of Artificial Neural Networks (ICANN), 2023

Integrating Speech Components into Denoising Neural Networks   January 2020 – August 2021

Integrating human speech components into speech enhancement neural networks has proven to be a simple yet effective strategy to improve denoised speech quality and intelligibility. In this direction, I proposed to rely on self-supervised speech representations to provide guidance for the current denoising neural networks. This approach achieved great success. The output intelligibility of current denoising networks is boosted dramatically.

The publication:
- T. Sun, S. Gong, Z. Wang, C. D. Smith, X. Wang, L. Xu, and J. Liu, "Boosting the intelligibility of speech enhancement networks through self-supervised representations," IEEE International Conference on Machine Learning and Applications (ICMLA), 2021

Dilated FCN: Listening Longer to Hear   November 2018 – May 2019

The capabilities to capture long context and extract multi-scale patterns are crucial to design effective speech enhancement networks. Such capabilities, however, are often in conflict with the goal of maintaining compact networks to ensure good system generalization. This project explored dilation operations and applied them to FCNs to address this issue. Particularly, I proposed the idea that relies on the dilation operations to capture long context for FCN speech enhancement networks.

The publication:
- S. Gong, Z. Wang, T. Sun, Y. Zhang, C. D. Smith, L. Xu, and J. Liu, "Dilated FCN: Listening longer to hear better," IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (WASPAA), IEEE, 2019

Semantic Segmentation with Capsule Networks   January 2018 – December 2018

A capsule-based neural network model to solve the medical semantic segmentation problem was proposed in the project. By taking advantage of the extractable part-whole dependencies available in capsule layers, I derived the probabilities of the class labels for individual capsules through a recursive, layer-by-layer procedure. With the procedure, image-level class labels and object boundaries are jointly sought in an explicit manner, which poses a

significant advantage over the state-of-the-art FCN solutions. Although the paper based on this project was not among the final selections for ICLR 2019, two out of three reviewers recommended its acceptance and provided positive feedback.

The publication:

- T. Sun, Z. Wang, C. Smith, and J. Liu, "Trace-back along capsules and its application on semantic segmentation," arXiv preprint arXiv:1901.02920, 2019

P U B L I C A T I O N S

- T. Sun and S. Bohte, "DPSNN: Spiking Neural Network for Low-Latency Streaming Speech Enhancement," *Neuromorphic Computing and Engineering* (2024) **DOI** 10.1088/2634-4386/ad93f9
- T. Sun, B. Yin, & S. Bohte, "Efficient uncertainty estimation in Spiking Neural Networks via MC-dropout". International Conference of Artificial Neural Networks (ICANN), 2023
- Y. Yue, M. Baltes, N. Abuhajar, T. Sun, T. Bihl, & J. Liu, "Spiking neural networks fine-tuning for brain image segmentation". Frontiers in Neuroscience, 17, 1267639, 2023
- Y. Yue, M. Baltes, N. Abuhajar, T. Sun, C. D. Smith, T. Bihl, & J. Liu, (2023), "Hybrid Spiking Neural Networks Fine-Tuning for Hippocampus Segmentation," IEEE 20th International Symposium on Biomedical Imaging (ISBI), 2023
- T. Sun, S. Gong, Z. Wang, C. D. Smith, X. Wang, L. Xu, and J. Liu, "Boosting the intelligibility of speech enhancement networks through self-supervised representations," IEEE International Conference on Machine Learning and Applications (ICMLA), 2021
- T. Sun, N. Abuhajar, Z. Wang, S. Gong, C. D. Smith, X. Wang, L. Xu, and J. Liu, "Network compression and frame stitching for efficient and robust speech enhancement," IEEE National Aerospace & Electronics Conference (NAECON), 2021
- T. Sun, Z. Wang, C. Smith, and J. Liu, "Trace-back along capsules and its application on semantic segmentation," arXiv preprint arXiv:1901.02920, 2019
- S. Gong, Z. Wang, T. Sun, Y. Zhang, C. D. Smith, L. Xu, and J. Liu, "Dilated FCN: Listening longer to hear better," IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (WASPAA), IEEE, 2019
- T. Sun, D. Zhu, Z. Yang, Z. Liu, and Y. Liu, "Theoretical predictions of photonic properties of nanoporous copolymer films as photonic band gap materials using FDTD," Applied Physics B, 82(1), 89-92, 2006

R E S E A R C H   A C T I V I T I E S

Program Committee member and reviewer:
    Automation in Machine Learning Workshop (KDD 2021)
    Automation in Machine Learning Workshop (KDD 2020)
Reviewers
    IEEE Transactions on Pattern Analysis and Machine Intelligence (IPAMI)
    Frontiers in Neuroscience
    Neural networks
    Neuromorphic Computing and Engineering
    IEEE International Symposium on Circuits and Systems (ISCAS 2024)
    IEEE Access
    PLOS One

I N D U S T R I A L   E X P E R I E N C E

TECHNICAL LEAD   **April 2015 – July 2015**
SAS Institute Inc., Beijing

I led a team developing *SAS BI Dashboard*. My main responsibilities included:
- Working closely with the manager in the US team to understand requirements.
- Planning and documenting technical specifications for features translated from requirements.

- Directing the development team in the design, development and testing applications.

SENIOR SOFTWARE ENGINEER   **September 2013 – March 2015**
SAS Institute Inc., Beijing

FormControl, a highly reusable HTML5 component in SAS, was designed to collect user-input values. Based on a data model, it generates various UI controls and organizes them into hierarchical forms.

Strengths and achievements:
- Object-oriented design of *FormControl* to meet general requirements, especially the potential requirement to extend it to *PropertySheet*, a more sophisticated and reusable SAS HTML5 component.
- Designed and implemented some fundamental features of *FormControl*, including but not limited to responsive web solution, data modeling, and binding.
- Fixed most of obstructive bugs.
- Developed other miscellaneous HTML5 components.

The essential supports I provided were crucial to successful releases of *FormControl*. And I was also promoted to a lead position due to my significant contributions to this product.

SOFTWARE ENGINEER   **September 2011 – September 2013**
SAS Institute Inc., Beijing

Initially, I was responsible for the plugin developments of [SAS Environment Manager](#) (EV). Starting from fall 2012, I was appointed as the coordinator for the project of the [SAS Visual Data Builder](#) (VDB) plugin *File Importer*. Together with other team members, I overcame a series of challenges and ensured high-quality release of VDB. I won the 3C (Collaboration, Communication and Consistency) Award of SAS 2012 due to my great contributions to the project.

Strengths and achievements:
- Rewrote the EV plugin named *Library* and fixed some fatal bugs that deferred the release of EV.
- Set up the prototype of *File Importer* and led the development of it technically.
- Solved a long blocking bug of *Data Spreadsheet*, a component that *File Importer* depended on.

HONORS AND AWARDS

SAS 2012 3C (Collaboration, Communication and Consistency) Award, December 2012

TECHNICAL SKILLS

[Machine Learning and Deep Learning]
- PyTorch, TensorFlow
- NumPy, SciPy
- SpeechBrain toolkit

[Programming]
- Python
- Java (Java EE, Spring)
- Javascript (JQuery, Dojo, OpenUI5)

[Hardware]
- FPGA programming
- CUDA programming

[Software Engineering]
• Object-oriented Analysis and Design (OOAD)
• Project management and agile development (Scrum)