# Li Ju

+46 0762733465 | li-ju666@outlook.com | https://li-ju666.com

## Education

**Uppsala University** — Uppsala, Sweden
*Ph.D. in Scientific Computing* — *09.2021 – 09.2026 (Expected)*

**Uppsala University** — Uppsala, Sweden
*M.Sc. in Computational Science* — *09.2019 – 08.2021*

**University of Science and Technology of China** — Hefei, China
*M.Sc. in Chemometrics (Honour)* — *09.2016 – 06.2019*

**University of Science and Technology of China** — Hefei, China
*B.Sc. in Chemistry* — *09.2012 – 06.2016*

## Work Experience

**Doctoral researcher** — 09.2021 – Present
*Scientific Machine Learning Laboratory* — *Uppsala, Sweden*

- Analysed and developed algorithms for learning from distributed and heterogeneous data in both theoretical and applicative aspects.
- Collaborated on research in hierarchical information management systems, and attacks and defences in distributed machine learning.
- Taught courses Data Engineering and Cloud Computing, and supervised master students on two course projects on vision language models.

**Master thesis student** — 02.2021 – 08.2021
*Integrative Scalable Computing Laboratory* — *Uppsala, Sweden*

- Proposed and implemented a proactive autoscaler for Kubernetes, reducing the average response time for heterogeneous edge computing systems by up to 15%.

**Junior data scientist (Part-time)** — 06.2020 – 03.2021
*Scaleout Systems AB* — *Uppsala, Sweden*

- Contributed to the PyTorch support for FEDn, an open source framework for industry-grade federated learning, and developed a few example applications.

## Skills & Tools

**Languages:** Python, C/C++, Haskell, Erlang, Lisp (Racket).

**Modelling:** Distributed machine learning, probabilistic machine learning, Bayesian inference, self-supervised learning, vision language models, uncertainty quantification.

**Frameworks:** PyTorch, JAX, pthread, OpenMP, MPI, CUDA.

**Tools:** Docker, Apptainer, Kubernetes, OpenStack, LaTeX, SQL.

## Main Project Experience

**Accelerating fair federated learning**

- Theoretically analysed the suboptimal convergence of the first-order optimisation methods on existing fairness-aware federated learning formulation, particularly under heterogeneous data distributions.
- Reformulated fairness-aware federated learning as a dynamic multi-objective optimization problem, ensuring theoretically improved convergence while maintaining fairness constraints.
- Proposed AdaFedAdam, introducing adaptive hyperparameter tuning and normalized updates to accelerate convergence and reduce fairness bias, and provided theoretical guarantees for the better convergence.

- Empirically validated our method on standard benchmarks for its Pareto optimality and robustness in different scenarios.

**Analysis of logit adjustment in federated learning**

- Investigated logit adjustment, a method used in heterogeneous federated learning to address label skew problems practically, without theoretical justification for its effectiveness nor consistency.
- Developed a novel theoretical framework to analyse logit adjustment in federated learning, moving beyond traditional optimisation-based perspectives.
- Examined how logit adjustment alters local objectives and impacts consistency with the Bayes optimal classifier, and identified a trade-off between improved convergence and suboptimal asymptotic predictive performance when applying logit adjustment.
- Provided practical guidelines to balance the application of logit adjustment in federated learning, depending on system constraints and desired model optimality from the theoretical analysis.

**Uncertainty quantification of vision language models**

- Addressed the limitations of existing post-hoc uncertainty quantification methods for pre-trained vision-language models.
- Proposed and validated a hypothesis regarding the asymmetry in the structure of uncertainty between vision and language modalities through rigorous experimentation.
- Developed a novel framework to model uncertainty in spherical space, systematically evaluating it using dropout and Bayesian neural network implementations.
- Demonstrated the advantages of vision-language models with quantified uncertainty across various downstream tasks, including zero-shot classification and image retrieval.

## Selected Publications

- Ju, L., Zhang, T., Toor, S., & Hellander, A. (2024). Accelerating fair federated learning: Adaptive federated adam. IEEE Transactions on Machine Learning in Communications and Networking.
- Ju, L., Hellander, A., & Spjuth, O. (2024). Federated learning for predicting compound mechanism of action based on image-data from cell painting. Artificial Intelligence in the Life Sciences.
- Ju, L., Singh, P., & Toor, S. (2021). Proactive autoscaling for edge computing systems with kubernetes. Proceedings of the 14th IEEE/ACM International Conference on Utility and Cloud Computing Companion.
- Ju, L., Lyu, A., Hao, H., Shen, W., & Cui, H. (2019). Deep learning-assisted three-dimensional fluorescence difference spectroscopy for identification and semiquantification of illicit drugs in biofluids. Analytical chemistry.

## Remark

- Achieved 2nd place in the Huawei Sweden Hackathon 2024, competing against 30+ teams from across Europe, in solving the localisation problem using channel charting in wireless communication.
- Serving as the president of the Society for Industrial and Applied Mathematics (SIAM) Uppsala University Chapter since 2024.