HIROKI SAKAMOTO

Department of Mathematical Informatics, The University of Tokyo
soccer-books0329@g.ecc.u-tokyo.ac.jp
Google Scholar LinkedIn GitHub: hiroki-sakamoto

RESEARCH IINTERESTS

- Model reduction of high-dimensional dynamical systems
- Model compression for deep learning models
- Machine learning and data science for modeling and control of complex systems

EDUCATION

Ph.D. Candidate in Mathematical Informatics, The University of Tokyo, Tokyo — Apr. 2023 – Present (expected Mar. 2026)
Supervisor: Associate Professor Kazuhiro Sato

Exchange Student, Sorbonne University, Paris — Sep. 2023 – Jan. 2024
Supervisor: Professor Emmanuel Trélat

M.S. in Mathematical Informatics, The University of Tokyo, Tokyo — Apr. 2021 – Mar. 2023
Supervisor: Lecturer Kazuhiro Sato

B.S. in Mathematics, Waseda University, Tokyo — Apr. 2017 – Mar. 2021
Supervisor: Professor Hitoshi Arai

RECENT RESEARCH SUMMARY

It is challenging to employ large-scale mathematical models given limited computational resources. The long-established technique of Model Order Reduction (MOR), developed within control theory, is an effective method for reducing the dimensionality of mathematical models. In my research, I develop methods based on MOR for dynamical systems arising in engineering, biology, and financial engineering. In particular, my recent work focuses on the following two areas:

1. **Data-driven h^2 MOR for linear discrete-time systems:**
   We propose a method to construct reduced-order models directly from the measurement data. In comparison with existing methods, our approach effectively builds a reduced-order model that accurately approximates the frequency response of the original system.
2. **Compression of Deep Diagonal State-Space Models based on $\mathcal{H}^2$ MOR:**
   Recently, deep learning models incorporating state-space models have received considerable attention. In this research, we propose a $\mathcal{H}^2$ MOR-based compression method that reduces the number of parameters while maintaining the original deep model's performance.

TECHNICAL SKILLS

- Programming languages: MATLAB, Python.

- Software: PyTorch, TensorFlow.
- Cloud Computing & GPU Acceleration: Built deep learning models on GPU-enabled VM instances on Google Cloud Platform.

RESEARCH ASSISTANT AND INTERNSHIP

RA, Collaborative Project with Industry Aug. 2024 – Mar. 2025
Engaged in research and development of deep-learning models for use in semiconductor manufacturing systems.

RA, Graduate School of Economics, The University of Tokyo Feb. 2022 – Feb. 2024
Development of a Healthcare Forecasting Tool for Japan using the SIR Model. For more details, see the project website.

Internship, Recruit Co., Ltd. Sep. 2022 – Dec. 2022
Improved the point-awarding algorithm for Hot Pepper.

TEACHING EXPERIENCE

TA, Dept. of Mathematical Engineering and Information Physics, The University of Tokyo Oct. 2022 – Feb. 2023
Supported a mathematical optimization class.

TA, Dept. of Mathematical Engineering and Information Physics, The University of Tokyo Apr. 2020 – Mar. 2021
Supported a C language programming exercise class.

Learning Assistant, Center for Data Science, Waseda University Apr. 2020 – Mar. 2021
Supported classes covering fundamentals of statistics, machine learning, and programming.

PUBLICATIONS AND PREPRINTS

[1] H. Sakamoto and K. Sato, **"Compression Method for Deep Diagonal State Space Model Based on $\mathcal{H}^2$ Optimal Reduction,"** to appear in *IEEE Control Systems Letters*, 2025. https://arxiv.org/abs/2507.10078

[2] H. Sakamoto and K. Sato, **"Data-driven h^2 model reduction for linear discrete-time systems,"** conditionally accepted for publication in *IEEE Transactions on Automatic Control*, 2025. https://arxiv.org/abs/2401.05774

[3] M. Obara, K. Sato, H. Sakamoto, T. Okuno, and A. Takeda, **"Stable Linear System Identification with Prior Knowledge by Riemannian Sequential Quadratic Optimization,"** *IEEE Transactions on Automatic Control*, vol. 69, no. 5, pp. 2060–2066, 2023. https://ieeexplore.ieee.org/document/10258405

[4] H. Sakamoto and K. Sato, **"Stable probability of reduced matrix obtained by Gaussian random projection,"** *JSIAM Letters*, vol. 15, pp. 77–80, 2023. https://doi.org/10.14495/jsiaml.15.77

[5] H. Sakamoto and K. Sato, **"Random projection preserves stability with high probability,"** *JSIAM Letters*, vol. 15, pp. 17–20, 2023. https://doi.org/10.14495/jsiaml.15.17

[6] H. Sakamoto and A. Kawamoto, **"Exploring Factors Driving Young People's Migration from Metropolitan to Rural Areas: An Analysis Using a Modified Gravity Model,"** *Tokei (Statistics)*, vol. 73, no. 3, pp. 56–63, 2022. (in Japanese)

Conference Presentations

International Conferences

- **Poster**, *Model compression for deep state space models using optimal-H_2 model reduction*
  Hiroki Sakamoto, Kazuhiro Sato, University of Manchester and University of Tokyo Joint Research Symposium: Global Green Transformation Workshop, University of Manchester, UK, Oct. 2024
- **Poster**, *$\mathcal{H}^2$ Model Order Reduction for Deep State-Space Models*
  Hiroki Sakamoto, Kazuhiro Sato, SICE Festival 2024 with Annual Conference, Kochi University of Technology, Japan, Aug. 2024

Domestic Conferences

- **口頭発表**, $\mathcal{H}^2$ 最適モデル低次元化法による深層状態空間モデルの圧縮
  坂本大樹, 佐藤一宏, The 12th SICE Multi-Symposium on Control Systems, 大阪工業大学, 2025 年 3 月
- **口頭発表**, 離散時間線形システムに対するデータ駆動型 h^2 モデル低次元化
  坂本大樹, 佐藤一宏, The 11th SICE Multi-Symposium on Control Systems, 広島大学, 2024 年 3 月
- **口頭発表**, ランダム射影に基づく一般化シルベスター方程式 AX+YB=C の高速求解法
  Hiroki Sakamoto, Pierre-Henri Tournier, Emmanuel Trélat, シンポジウム「錐線形計画とその周辺」, 成蹊大学, 2024 年 2 月
- **口頭発表**, ガウス埋め込みに基づく確率集中不等式の絶対定数の推定
  坂本大樹, 佐藤一宏, 日本応用数理学会第 19 回研究部会連合発表会, 岡山理科大学, 2023 年 3 月
- **口頭発表**, ランダム射影による大規模なリヤプノフ方程式の高速求解法
  坂本大樹, 佐藤一宏, 日本応用数理学会 2022 年度年会, オンライン, 2022 年 9 月
- **口頭発表**, 重力モデルによる若年層の大都市から地方への移動要因の解明
  川本晃大, 坂本大樹, 経済統計学会 2022 年度全国研究大会, オンライン, 2022 年 9 月

Other Presentations

- **ポスター発表**, 制御理論の知見を活かした深層学習モデルのパラメータ削減
  坂本大樹, 情報学 for all by all, 東京大学, 2025 年 3 月
- **Oral**, *Fast solving of generalized Sylvester matrix equations $AX + YB = C$*
  Hiroki Sakamoto, Pierre-Henri Tournier, Emmanuel Trélat, Workshop (Title TBD), University of Bologna, Italy, Dec. 2023
- **口頭発表**, 感染と経済の統合モデル：Literature Review
  畝矢寛之, 川脇颯太, 坂本大樹, 芳賀沼和哉, 第 1 回コロナ政策研究会, 名古屋, 2022 年 9 月

GRANTS AND FELLOWSHIPS

JSPS Research Fellowship DC2, JSPS	Apr. 2025 – Present
Overseas Study Support Program, JASSO	Sep. 2023 – Jan. 2024
Fellowship for Creation of Intelligent World (IIW), The University of Tokyo	Apr. 2023 – Present
Outstanding Research Assistant, IIW, The University of Tokyo	Oct. 2022 – Mar. 2023
Grant for Independent Research, IIW, The University of Tokyo	Aug. 2022 – Mar. 2023

AWARDS

- **Minister of Internal Affairs and Communications Award**, Statistical Data Analysis Competition 2021 2021
- **IBM Master the Mainframe Contest Excellence Award** 2019