



UNIVERSITÀ DI PISA
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

Collaborative Edge AI and Applications

Prof. Jian-Nong Cao, PhD; MAE, FHKEng, FIEEE, FCCF, DMacM

Otto Poon Charitable Foundation Professor in Data Science

Chair Professor of Distributed and Mobile Computing

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Short Abstract:

This is an advanced doctoral-level research-oriented course, centered on collaborative edge AI and its applications in AIoT. It systematically covers the various aspects of edge-AI research and applications, including edge computing paradigms, collaborative framework, task scheduling, edge AI model training/inference, and future research directions. This course focuses on academic challenges, state-of-the-art technologies, key research issues, and major application cases, aiming to cultivate students' independent research ability in collaborative edge computing and intelligence.

Course Objectives

- Introduce AIoT ecosystem, core enabling technologies, and application areas.
- Overview edge computing paradigms, edge computing and AI principles, and key research challenges
- Understand collaborative edge computing architecture. Framework and its components
- Study resource virtualization and management mechanisms
- Study the theory and techniques of collaborative edge task scheduling
- Study the collaborative edge AI model training and inference algorithms and techniques
- Investigate collaborate edge AI application scenarios and develop solutions
- Discuss research methods and explore future research topics

Course Contents in brief:

- AIoT and Its Key Enabling Technologies

- Edge Computing and Edge AI
- Collaborative Edge AI
- Collaborative Task Scheduling
- AI Model Training, Inference and Future Research Topics

Total # of hours of lecture: 20

References:

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- [2] Z. Zhou, X. Chen, E. Li, L. Zeng, K. Luo, and J. Zhang, "Edge intelligence: Paving the last mile of artificial intelligence with edge computing," *Proceedings of the IEEE*, vol. 107, no. 8, pp. 1738–1762, 2019.
- [3] M. Zhang, J. Cao, Y. Sahni, Q. Chen, S. Jiang, and L. Yang, "Blockchain-based collaborative edge intelligence for trustworthy and real-time video surveillance," *IEEE Transactions on Industrial Informatics*, vol. 19, no. 2, pp. 1623–1633, 2022.
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- [5] H. Lin, L. Yang, H. Guo, and J. Cao, "Decentralized task offloading in edge computing: An offline-to-online reinforcement learning approach," *IEEE Transactions on Computers*, vol. 73, no. 6, pp. 1603–1615, 2024. doi: 10.1109/TC. 2024.3377912.
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- [7] Yang, L., Lu, Y., Cao, J., Huang, J., & Zhang, M. (2021). E-tree learning: A novel decentralized model learning framework for edge ai. *IEEE Internet of Things Journal*, 8(14), 11290-11304.
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- [9] Duan, J., Yu, S., Tan, H. L., Zhu, H., & Tan, C. (2022). A survey of embodied ai: From simulators to research tasks. *IEEE Transactions on Emerging Topics in Computational Intelligence*, 6(2), 230-244.
- [10] Li, Y., Li, Z., Duan, Y., & Spulber, A. B. (2023). Physical artificial intelligence (PAI): the next-generation artificial intelligence. *Frontiers of Information Technology & Electronic Engineering*, 24(8), 1231-1238.
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CV of the Teacher

Prof. Cao is currently the Otto Poon Charitable Foundation Professor in Data Science and the Chair Professor of Distributed and Mobile Computing in the Department of Computing at The Hong Kong Polytechnic University (PolyU), Hong Kong. He is also the Vice President (Education) of PolyU and the director of the Internet and Mobile Computing Lab (IMCL). He was the founding director and now the director of PolyU's University's Research Facility in Big Data Analytics (UBDA). He served

the department head from 2011 to 2017. Prof. Cao is a member of Academia Europaea, a fellow of IEEE, and an ACM distinguished member. He is also a fellow of China Computer Federation (CCF).

Prof. Cao's research interests include distributed systems and blockchain, wireless sensing and networking, big data and machine learning, and mobile cloud and edge computing. He published 5 co-authored and 9 co-edited books, and over 500 papers in major international journals and conference proceedings. He also obtained 16 patents. Prof. Cao received many awards for his outstanding research achievements, including the PolyU President Award for Excellent Performance/Achievement in Research and Scholarly Activities, Ministry of Education Higher Education Outstanding Scientific Research Output Awards – Natural Science (Second Class), China Computer Federation (CCF) Overseas Outstanding Contribution Award, IEEE TCCLD Research Innovation Award, Hong Kong ICT Awards: Best Innovation & Research - Certificate of Merit and Special Mention, Bronze Medal Award of Brussels Innova, CVIC SE Software Talent Award, Ministry of Education Nominated State Science and Technology Award (First Class), National Science and Technology Progress Award (Second Class), and best paper Awards from IEEE Trans. Industrial Informatics 2018, IEEE DSAA 2017, IEEE SMARTCOMP 2016, IEEE/IFIP EUC 2016, IEEE ISPA 2013, IEEE WCNC 2011, etc. Prof. Cao has delivered over 50 keynote speeches / invited talks.

Prof. Cao has directed and participated in over 130 research and development projects and, as a principal investigator, obtained over HK\$67 million grants from funding agencies such as National Natural Science Foundation of China (NSFC), Ministry of Science and Technology of P. R. China (MOST), Hong Kong Research Grant Council (RGC), Hong Kong Innovation and Technology Commission (ITC), The Society of Hong Kong Scholars, and industries and organizations like Alibaba, IBM, Nokia, HK Jockey Club and Hong Kong Construction Industry Council.

Prof. Cao served the Chair of the Technical Committee on Distributed Computing of IEEE Computer Society 2012-2014, a member of IEEE Fellows Evaluation Committee of the Computer Society and the Reliability Society, a member of IEEE Computer Society Education Awards Selection Committee, a member of IEEE Communications Society Awards Committee, and a member of Steering Committee of IEEE Transactions on Mobile Computing. Prof. Cao has also served as chairs and members of organizing and technical committees of many international conferences, including IEEE INFOCOM, IEEE PERCOM, IEEE IoTDI, IEEE ICPADS, IEEE CLOUDCOM, SRDS and OPODIS, and as associate editor and member of the editorial boards of many international journals, including IEEE TC, IEEE TPDS, IEEE TBD, IEEE IoT Journal, ACM ToSN, ACM TIST, ACM TCPS. Prof. Cao has also actively served Hong Kong local professional communities, including Entrepreneurship Advisor of HK A.I. Lab., member of HK Innovation and Technology Fund Research Projects Assessment Panel, member of Engineering Panel of Hong Kong Research Grant Council, member of Incu-Tech Business Incubation Programme Panel of Hong Kong Science and Technology Parks, and member of HKIE's Accreditation Committee for Computer Science Programmes.

Final Exam: method of final examination

- Class participation & In-class presentation (20%)
- After-class assignments (30%)
- Doctoral-level research innovation proposal (50%)

Room and Schedule

Room: Meeting Room, Dept. of Information Engineering, Largo Lazzarino 1, Pisa

Schedule:

July 6 – 14:00-18:00

July 7 – 09:00-13:00

July 8 – 09:00-13:00

July 9 – 09:00-13:00

July 10 – 09:00-13:00