Meet Our Faculty | Prof. Danny Tsang, Internet of Things Thrust

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY (GUANGZHOU) | INFORMATION HUB

Information Hub aims to provide world-class education and conduct cutting-edge research with practical applications in information science and technology that not only advance regional development, but also make a global impact. The Hub primarily comprises four thrusts: Artificial Intelligence (AI), Data Science and Analytics (DSA), Internet of Things (IOT), and Computational Media and Arts (CMA). In Information Hub, you will be inspired by our outstanding faculty who are distinguished scholars, dedicated teachers and passionate life explorers.

Today, let's meet Prof. Danny Tsang from Internet of Things Thrust!

1. Faculty Bio

Photos:

Bio:

Prof. Danny Tsang (M'82-SM'00-F'12) received the Ph.D. degree in electrical engineering from the Moore School of Electrical Engineering at the University of Pennsylvania, U.S.A., in 1989. Upon graduation, he joined the Department of Computer Science at Dalhousie University in Canada. He later joined the Department of Electronic & Computer Engineering at the Hong Kong University of Science and Technology (HKUST) in 1992 and is now a professor in the department. He has also served as the Head of the Internet of Things Thrust Area at HKUST(Guangzhou) since 2020. He was a Guest Editor for IEEE Journal of Selected Areas in Communications' special issue on Advances in P2P Streaming Systems, an Associate Editor for Journal of Optical Networking published by the Optical Society of America, and a Guest Editor for IEEE Systems Journal. He currently serves as Technical Editor for IEEE Communications Magazine. He was nominated to become an IEEE Fellow in 2012 and an HKIE Fellow in 2013. During his leave from HKUST in 2000-2001, Prof. Tsang assumed the role of Principal Architect at Sycamore Networks in the United States. He was responsible for the network architecture design of Ethernet MAN/WAN over SONET/DWDM networks. He invented the 64B/65B encoding (US Patent No.: US 6,952,405 B2) and contributed it to the proposal for Transparent GFP in the T1X1.5 standard that was advanced to become the ITU G.GFP standard. The coding scheme has now been adopted by International

Telecommunication Union (ITU)'s Generic Framing Procedure recommendation GFP-T (ITU-T G.7041/Y.1303)) and Interfaces for the Optical Transport Network (ITU-T G.709/Y.1331). His current research interests include mobile edge computing (MEC), NOMA networks, smart grids, and online algorithm design.

Personal Website：http://c2e.ece.ust.hk/main/

2. Research interests

- Online algorithm design (competitive ratio and regret analysis)
- Digital twin for mobile edge networks
- Intelligent Reflective Surface (IRS)-assisted mobile edge computing (MEC)
- IoT technologies and applications
- Future 6G networks
- Applications of NOMA in future networks
- Distributed machine learning in communication networks
- Federated learning
- Smart grids

3. Research Projects

Project 1 (Learning-based online algorithm design)：

Online resource allocation is ubiquitous in the design of networked systems, ranging from communication networks, cloud computing data centers, to smart energy systems. In this problem, a decision maker must allocate capacity-constrained resources to a set of users that arrive over time without knowing the details of future arrivals. Each resource allocation consumes a certain amount of resources and generates revenues. The objective of the decision maker is to maximize the total revenues of all users. The fundamental challenge of this sequential decision-making problem lies in the uncertainties about the future users. There exist two general paradigms for handling such uncertainties: (i) online competitive algorithms that are designed without any knowledge of the future and aim to guarantee the worst-case performance; and (ii) machine learning (ML) based algorithms that predict the future based on past data and design algorithms using such predictions to achieve good performances in typical cases, where the future will mirror the past. Online algorithms are robust but often overly conservative and perform poorly in typical cases since the worst case may rarely occur. On the contrary, ML-based algorithms often perform well empirically but it cannot provide worst-case guarantee, which becomes crucial when the assumption of "the past can predict the future" does not hold. Thus, in order to achieve best-of-both-worlds, this project aims to combine the design of online algorithms with data-driven online learning approaches to improve their average-case performance while guaranteeing their worst-case performance. In this project, we will investigate the design of data-driven competitive algorithms for online resource allocation.

Project 2 (Digital twin for mobile edge networks)：

Digital twin, which is the virtual representation of the real world, can be implemented along with security-related technologies (e.g., blockchain), communication technologies (e.g.,6G),

computing technologies (e.g., edge computing), and machine learning to empower the emerging intelligent internet of things (IoT) applications, such as smart home, smart factory, virtual reality (VR), extended reality (XR), among others. With the help of the digital twin, the performance of edge intelligent services can be simulated and accurately predicted in real-time, thus can provide optimum energy-efficiency communication and computation resource management strategy. However, digital twins require accurate mapping and real-time synchronization between virtual twin networks and physical networks which poses challenges to the multi-data perception, information processing, privacy-preserving, reliable transmission of massive data, and so on. In this project, we aim to develop digital twin edge intelligent networks that can realize real-time monitoring and management of the physical mobile edge networks. More importantly, it is expected to enable the digital twin networks to optimally allocate both communication and computation resources that can ensure reliable quality of service (QoS) of the system and provide a satisfactory quality of experience (QoE) to the users.

4. Achievements/publications

Prof. Tsang has published more than 120 papers in prevailing journals in the research field of network, including top journals in communication networks, such as IEEE Journal on Selected Areas in Communications (JSAC, IF=13.081), IEEE Transactions on Wireless Communications (TWC, IF=8.346), and IEEE Transactions on Communications (IF=6.166). He has also published more than 160 papers on international academic conferences, including ACM SIGMETRICS, a top conference in computer systems and networks, and IEEE INFOCOM, a top-ranked conference in networks and communications. In addition, he has been granted 9 U.S. invention patents. Prof. Tsang's current Google Scholar Citations is 7759 with an h-index of 50. His work received the Best Paper from Academia Award in IEEE ATM Workshop 1999 and the Best Student Paper Award in ISPA 2004. Some of Prof. Tsang's theoretical achievements have been widely applied in industry. His 64B/65B coding scheme (U.S. invention patent 6952405) was adopted by the International Telecommunication Union (ITU) and incorporated into the GFP-T standard (ITU-T G.7041/Y.1303). Currently, all worldwide SONET optical transmission equipment supporting the GFP-T standard must adopt this coding scheme. For the complete publication list, please refer to Prof. Tsang's group website http://c2e.ece.ust.hk/main/.

5. Admission Requirements

- Major in computer science, communication engineering, information engineering, electronic engineering, electrical engineering, etc.
- Solid in mathematics
- Good at programming
- Good at spoken and written English
- Strongly motivated self-learning and research

6. Contacts

If you'd like to apply for the PhD program in Internet of Things, and join Prof. Danny Tsang's team, you may contact him at [eetsang@ust.hk] with a title of "IoT PhD Application" and submit the application via HKUST Online Application System.

For more information, please visit： http://pg.ust.hk/gz

Welcome to join!