Artificial Intelligence in Wireless Communication Networks
(December 26-30, 2022)

Overview

The evolution of mobile communication technology has been witnessed all over the world, and the next-generation wireless network, unlike the previous one, will have stronger service capabilities. It has been observed that the communication network's data traffic will increase exponentially due to large-scale mobile users, so the next-generation wireless network needs a higher capacity and faster data transmission rate. One of the most effective solutions is to densely deploy cells to improve spatial multiplexing. Recently, ultra-dense networks (UDNs) have attracted worldwide attention and become a promising architecture that supports massive mobile devices. In the UDN scenario, there is a large number of communication nodes, including low-power small base stations (SBSs) and wireless access points that may be dozens of times more dense than current ones and can achieve great capacity and spectrum efficiency improvement in local hotspots.

The densification of the network makes the coverage of base stations (BSs) smaller, while the distance between the BS and the user is shorter and each BS needs to serve only a small number of users. In such situations the cooperation between advance wireless technologies like non-orthogonal multiple access (NOMA) and UDNs can enhance the network spectrum efficiency and can also support large-scale connection of users. However, radio resource management, especially in terms of subchannel and power allocation, becomes extremely challenging if the NOMA techniques are used.

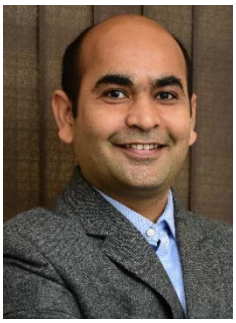
Artificial intelligence (AI), a recently popular subject, enables computers to learn and perform complex tasks. Future intelligent mobile terminals are expected to achieve autonomous learning and decision making through AI to find the optimal resource allocation scheme. At present, machine learning is widely used to solve the problem of AI and is the most important way to realize AI. Complex communication networks will generate large amounts of data, and machine-learning algorithms can extract valuable information from large data sets and make predictions, so they have excellent capabilities for finding new solutions. Considering that the traditional resource allocation scheme takes a lot of time to calculate, we can use historical data generated by classical resource allocation algorithms as training samples and employ the k-nearest-neighbor algorithm, one of the simplest of all machine-learning algorithms, to locate the most similar sample sets from the historical database to find a matched resource allocation scheme. In addition, a deep neural network (DNN) can be used to train existing data to find the relationship between inputs and outputs and learn the characteristics of optimal resource allocation for wireless resource management.

Modules	**Day1: 26 Dec 2022** **Lecture 1**:Introduction to advanced wireless communication networks. **Lecture 2**:The ultra dense networks, introduction to the architecture and system design issues. **Lecture 3**:Advances in physical layer techniques for wireless communication systems, the non-orthogonal multiple access (NOMA) systems, performance evaluation metrics. **Tutorial 1**:Problem solving: Identifying communication system components; **Day 2: 27 Dec 2022** **Lecture 4** : Introduction to artificial intelligence methods and algorithms, communication nework's data, reinforcement learning. **Lecture 5**:Machine Learning and artificial intelligence for the performance improvement of wireless communication networks. **Lecture 6**:Resource allocation in ultra-dense networks, artificial intelligence basedlearning methods for communication networks. **Tutorial 2**:Language/programming skills for artificial intelligence. **Day 3: 28 Dec 2022** **Lecture 7** : Q-learning based resource allocation for UDNs, the event-triggered Q-learning. **Lecture 8**: Q-learning based resource allocation for UDNs, the event-triggered Q-learning. **Lecture 9:**Online Supervised Learning for Traffic Load Prediction, conventional backlog predictions. **Tutorial 3**:Coding tutorial and demo: Implementing simulation algorithms; Demonstrations of open source simulation platforms. **Day 4: 29 Dec 2022** **Lecture 10** :Deep Reinforcement Learning for Real-Time Optimization **Lecture 11**: Uplink Resource Configuration Based on Load Estimation, Tabular-Q Based Uplink Resource Configuration **Lecture 12**:Online Supervised Learning for Traffic Load Prediction, conventional backlog predictions. **Tutorial 4**: Implementing simulation algorithms and evaluating the networks' performance **Day 5: 30 Dec 2022** **Lecture 13** : Cross-layer design issues in UDN's and performance analysis **Lecture 14**:Application of machine learning and artificial intelligence in other areas of wireless communications. **Tutorial 4**: Roundtable discussion on potential application areas.
You Should Attend If…	▪ You are a student (B.Tech./M.Sc./M.Tech./Ph.D.) and aspiring researcher within broad domain of communication engineering. ▪ You are an Executive/engineer or researcher from manufacturing, service and government organizations including R&D laboratories. ▪ You are Faculty and staff from reputed academic institutions and technical institutions.
Fees	The participation fees per person for attending the course is as follows: **Participants from abroad: US $400** **Industry/ Research Organizations: Rs. 10,000/-** **Academic Institutions:** **Students: Rs. 3540/- (For SC/ST and female students course fee is Rs.1770/- only)** **Non-Students: Rs. 4720/-** The above fees include all instructional materials, computer use for tutorials, free internet facility. Limited number of single bedded shared accommodation request can be considered from participants which, if allotted, would be on additional payment basis.

The Faculty

Prof. Arumugam Nallanathan (Fellow, IEEE) has been a Professor of wireless communications and the Head of the Communication Systems Research (CSR) Group, School of Electronic Engineering and Computer Science, Queen Mary University of London, since September 2017. He has published nearly 500 technical papers in scientific journals and international conferences.

His research interests include artificial intelligence for wireless systems, beyond 5G wireless networks, the Internet of Things (IoT), and molecular communications. Prof. Nallanathan is an IEEE Distinguished Lecturer. He was a co-recipient of the Best Paper Awards presented at the IEEE International Conference on Communications 2016 (ICC'2016), the IEEE Global Communications Conference 2017 (GLOBECOM'2017), and the IEEE Vehicular Technology Conference 2018 (VTC'2018). He received the IEEE Communications Society SPCE Outstanding Service Award in 2012 and the IEEE Communications Society RCC Outstanding Service Award in 2014. He served as the Chair for the Signal Processing and Communication Electronics Technical Committee of IEEE Communications Society and the Technical Program Chair and a member of technical program committees for numerous IEEE conferences. He was an Editor of IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS (2006–2011), IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY (2006–2017), and IEEE SIGNAL PROCESSING LETTERS. He is the Editor-atLarge of IEEE TRANSACTIONS ON COMMUNICATIONS and a Senior Editor of IEEE WIRELESS COMMUNICATIONS LETTERS. He has been selected as a Web of Science Highly Cited Researcher in 2016 and AI 2000 Internet of Things Most Influential Scholar in 2020.



Dr. Prabhat Sharma is an Assistant Professor with the Department of Electronics and Communication Engineering, Visvesvaraya National Institute of Technology, Nagpur, India. He has authored over 80 journal and conference papers. He is recipient of the Visvesvaraya Young Faculty Research Fellowship from the Ministry of Electronics and Information Technology, Government of India, and URSI/InRaSS Young Indian Radio Scientist Award 2019.

Dr. Sharma is currently the Chair of IEEE Nagpur Sub-section, and Social media Chair of Technical Committee on Molecular Biological and Multiscale Communications of IEEE Communication Society. His current research interests include Molecular and Biological Communications, and 6G and Beyond Wireless Communications Systems.

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Visvesvaraya National Institute of Technology, Nagpur

Visvesvaraya National Institute of Technology, Nagpur is one of the thirty-one National Institutes of Technology in the country. The Govt. of India conferred on the Institute, the Deemed to be University status (under University Grants Commission Act, 1956 (3 of 1956)) with effect from 26th June 2002. Subsequently, the Central Govt. by Act of Parliament (National Institutes of Technology Act, 2007 (29 of 2007)) declared VNIT Nagpur as an Institute of National Importance along with all former regional engineering colleges. The Act was brought into force from 15th August 2007. Earlier, the Institute was known as Visvesvaraya Regional College of Engineering (VRCE). It was established in the year 1960 under the scheme sponsored by Govt. of India and Govt. of Maharashtra. The college was started in June 1960 by amalgamating the State Govt. Engineering College functioning at Nagpur since July 1956. In the meeting held in October 1962, the Governing Board of the College resolved to name it after the eminent engineer, planner, and statesman of the country Sir M. Visvesvaraya.

Department of Electronics and Communication Engineering

The department of Electronics and Computer Science was created in 1994 from the department of Electrical Engineering. Later, the Department of Electronics and Communication Engineering has been created in May 2014. Department of ECE offers B.Tech. in Electronics and Communication Engineering, M.Tech. in Communication System Engineering, and Ph.D. The department has well qualified and well-motivated faculty members and support staff. There are more than 30 full time Ph.D. students enrolled in the different areas of signal and image processing, medical image analysis, embedded system design, communication system, etc. Department has Centre of Excellence in Combedded Systems and Centre for Artificial Intelligence. The department is actively involved in R&D as well as consultancy projects and has collaborations with several industries, academic institutions and R&D organizations in the country and outside.