INTEL NEWS FACT SHEET

Intel and National Science Foundation Announce Future Wireless Systems Research Award Recipients

The Machine Learning for Wireless Networking Systems Program is the Latest in a Series of Jointly Funded Initiatives

June 25, 2020 — Today, Intel and the National Science Foundation (NSF) announced award recipients of joint funding for research into the development of future wireless systems. The Machine Learning for Wireless Networking Systems (MLWiNS) program is the latest in a series of joint efforts between the two partners to support research that accelerates innovation, with the focus of enabling new wireless architectures that meet the density, throughput and latency requirements of future compute applications. In particular, the program will emphasize distributed machine learning computations over wireless edge networks. A full list of the MLWiNS award winners can be found below.

Physical Layer Communication Revisited via Deep Learning

- **Institutions:** University of Illinois Urbana-Champaign and University of Washington
- **Project Leads:** Pramod Viswanath (University of Illinois Urbana-Champaign) and Sewoong Oh (University of Washington)
- **Project Description:** This project will use deep learning applications in the physical layer of communications systems, which will enable researchers to: 1) study the operation of new neural-network based, nonlinear channel codes through jointly trained encoders and decoders, 2) integrate information-theory, which can reduce the number of parameters to be learned and improve the training efficiency of communication systems, to create non-linear codes in feedback channels, and 3) design a family of non-linear neural codes for interference networks.

Deep Neural Networks Meet Physical Layer Communications – Learning with Knowledge of Structure

- **Institutions:** Virginia Polytechnic Institute and State University (Virginia Tech) and Massachusetts Institute of Technology (MIT)
- **Project Leads:** Lingjia Liu (Virginia Tech) and Lizhong Zheng (MIT)
- **Project Description:** This project will explore the use of deep neural networks to address the physical layer problems of a wireless network. The researchers will exploit information theoretic tools in order to develop new algorithms that can better address non-linear distortions and relax simplifying assumptions on the noise and impairments encountered in wireless networks.

Artificial Neural Networks for Interference Limited Wireless Networks

- **Institutions:** Northwestern University, University of Minnesota-Twin Cities and Oregon State University
- **Project Leads:** Dongning Guo (Northwestern University), Mingyi Hong (University of Minnesota-Twin Cities) and Xiao Fu (Oregon State University)
- **Project Description:** This project aims to create a comprehensive cross-layer framework for interference-limited wireless systems by leveraging new deep learning-based algorithms to maximize the performance of a network through power allocation, beamforming, interference sensing, routing, scheduling and cross-layer design.

Dino-RL: A Domain Knowledge Enriched Reinforcement Learning Framework for Wireless Network Optimization

- **Institutions:** The Pennsylvania State University (Penn State) and University of Virginia
- **Project Leads:** Jing Yang (Penn State) and Cong Shen (University of Virginia)
- **Project Description:** This project will explore reinforcement learning for optimizing wireless network operation, focusing on tackling convergence issues, leveraging knowledge-transfer methods to reduce the amount of training data necessary, and bridging the gap between model-based and model-free reinforcement learning through an episodic approach.

Reinforcement Learning-Based Self-Driving Wireless Network Management System for Quality of Experience (QoE) Optimization

- **Institution:** University of California, Santa Barbara
- **Project Leads:** Arpit Gupta, Elizabeth Belding, Yu-Xiang Wang
- **Project Description:** This project will explore a data-driven approach at the network plane level to enhance QoE in wireless networks. The effort is focused on utilizing reinforcement learning to gather data at scale from real-world networks to create new machine learning-based algorithm designs for QoE enhancements, and a platform for algorithm deployment.

Cross-Layer Integrated Radio Frequency-Based Data-Driven Wireless Device Classification Framework for Spectrum Access Awareness

- **Institution:** Oregon State University
- **Project Leads:** Bechir Hamdaoui, Weng Keen Wong, Arun Natarajan and Lizhong Chen
- **Project Description:** This project will leverage machine learning to enable efficient wireless device identification and classification to support spectrum access awareness applications. Specifically, it will focus on investigating cross-layer approaches that integrate transceiver hardware, wireless radio frequency domain knowledge and deep learning to develop robust device classification techniques that scale well with the massive and diverse numbers of emerging wireless devices.

Quality vs. Quantity in Spectrum Sensing with Distributed Sensors

- **Institution:** University of Notre Dame
- **Project Leads:** Bertrand Hochwald, Jonathan Chisum and Siddharth Joshi
- **Project Description:** This project will explore the tradeoff of sensor quality vs. quantity for spectrum measurement and sensing, including analyzing different parts of radio hardware and producing new tools and techniques for spectrum sensing.

Democratizing AI Through Multi-Hop Federated Learning Over-the-Air

- **Institution:** University of North Carolina Charlotte
- **Project Leads:** Pu Wang, Chen Chen, Mohsen Dorodchi and Minwoo Lee
  Project Description: This project will explore methods to speed up multi-hop federated learning over wireless communications, allowing multiple groups of devices to collaboratively train a shared global model while keeping their data local and private. Unlike classical federated learning systems which utilize single-hop wireless communications, the multi-hop system updates need to go through multiple noisy and interference-rich wireless links, which can result in slower updates. Researchers aim to overcome this challenge by developing a novel wireless

multi-hop federated learning system with guaranteed stability, high accuracy and fast convergence speed by systematically addressing the challenges of communication latency, and system and data heterogeneity.

Collaborative Training and Inference at the Wireless Edge for Collective Intelligence

- **Institution:** Georgia Tech Research Corporation
- **Project Lead:** Faramarz Fekri
- **Project Description:** This project aims to analyze and design federated and collaborative machine learning training and inference schemes for edge computing, with the goal of increasing efficiency over wireless networks. Researchers will address challenges with real-time machine learning at the edge, including limited and dynamic wireless channel bandwidth, unevenly distributed data across edge devices and on-device resource constraints.

Ultra-Reliable Collaborative Computing for Autonomous Unmanned Aerial Vehicles

- **Institution:** University of California, Irvine
- **Project Leads:** Marco Levorato and Stephan Mandt
- **Project Description:** This project aims to develop machine learning methodologies to provide reliable distributed computing in drone-infrastructure systems. Researchers will aim to create a layer of intelligence, located in the individual drones, capable of controlling: 1) how information is transferred and analyzed across the available network and server resources, and 2) device flight parameters and navigation. Additionally, researchers will develop systems to compress information-rich data streams generated by the device before they are transmitted for remote analysis.

Wireless On-the-Edge Training of Deep Networks Using Independent Subnets

- **Institution:** Rice University
- **Project Leads:** Christopher Jermaine, Anastasios Kyrillidis and Yingyan Lin
- **Project Description:** This project will aim to train large-scale centralized neural networks by separating them into a set of independent sub-networks that can be trained on different devices at the edge.

A Coding-Centric Approach to Robust, Secure, and Private Distributed Learning Over Wireless

- **Institutions:** University of Southern California (USC) and University of California, Berkeley (UC Berkeley)
- **Project Leads:** Salman Avestimehr (USC) and Kannan Ramchandran (UC Berkeley)
- **Project Description:** This research will focus on a coding-centric approach to enhance federated learning over wireless networks. Specifically, researchers will work to tackle the challenges of dealing with non-independent and identically distributed data, heterogeneous resources at the wireless edge, and minimizing upload bandwidth costs from users while emphasizing issues of privacy and security when learning from distributed data.

Distributed Learning for the Nomadic Edge

- **Institution:** University of Wisconsin-Madison
- **Project Leads:** Suman Banerjee, Kassem Fawaz, Mohit Gupta and Kangwook Lee

- **Project Description:** The nomadic edge will enable a new class of applications for vehicles equipped with many sensors that generate a large volume of multi-modal data. This project will explore the analytics and data exchange considered in layers of abstraction at the nomadic edge, static edge and cloud, addressing challenges in: 1) local real-time learning tasks, and 2) communicating reduced data, features and models to other nodes for collaboration and global coordination.

Resource-Constrained Mobile Data Analytics Assisted by the Wireless Edge

- **Institution:** New York University
- **Project Leads:** Siddharth Garg, Yao Wang and Elza Erkip
- **Project Description:** Through this project, researchers will work on analytics aware data compression methodology to overcome limited mobile resources at the wireless edge and explore deep neural network architectures that can adapt the compression rate and/or computational complexity in the face of varying environmental conditions.

Hyperdimensional Computing for Scalable IoT Intelligence Beyond the Edge:

- **Institution:** University of California, San Diego
- **Project Lead:** Tajana Rosing
- **Project Description:** This project aims to advance new paradigms of data representation through high-dimensional embedding and encoding of data, which could enable lower complexity in computation and increase reliability in communication.

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