

# AI and ML Research in Infrastructure The University of Texas at Arlington

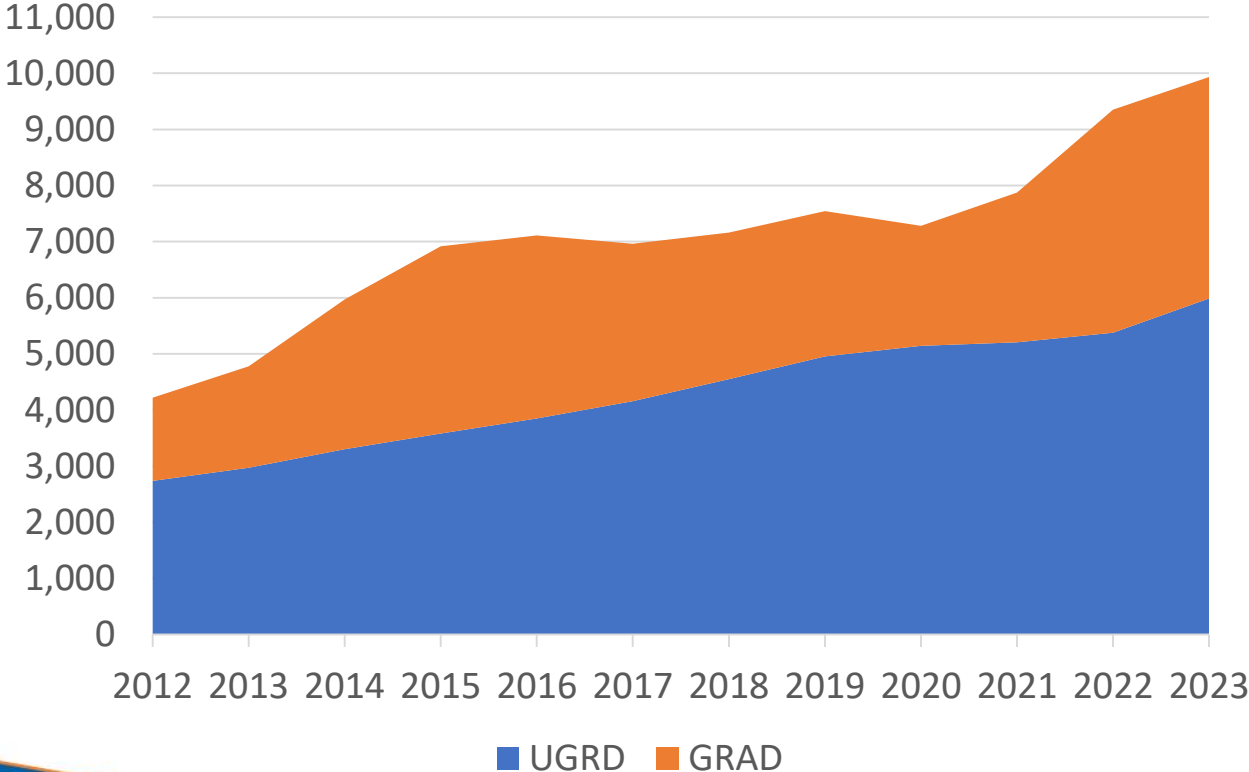
**23rd SAME Infrastructure Forum  
2-9-24**

Peter Crouch, Dean  
Gautam Das, Associate Dean, Research  
College of Engineering

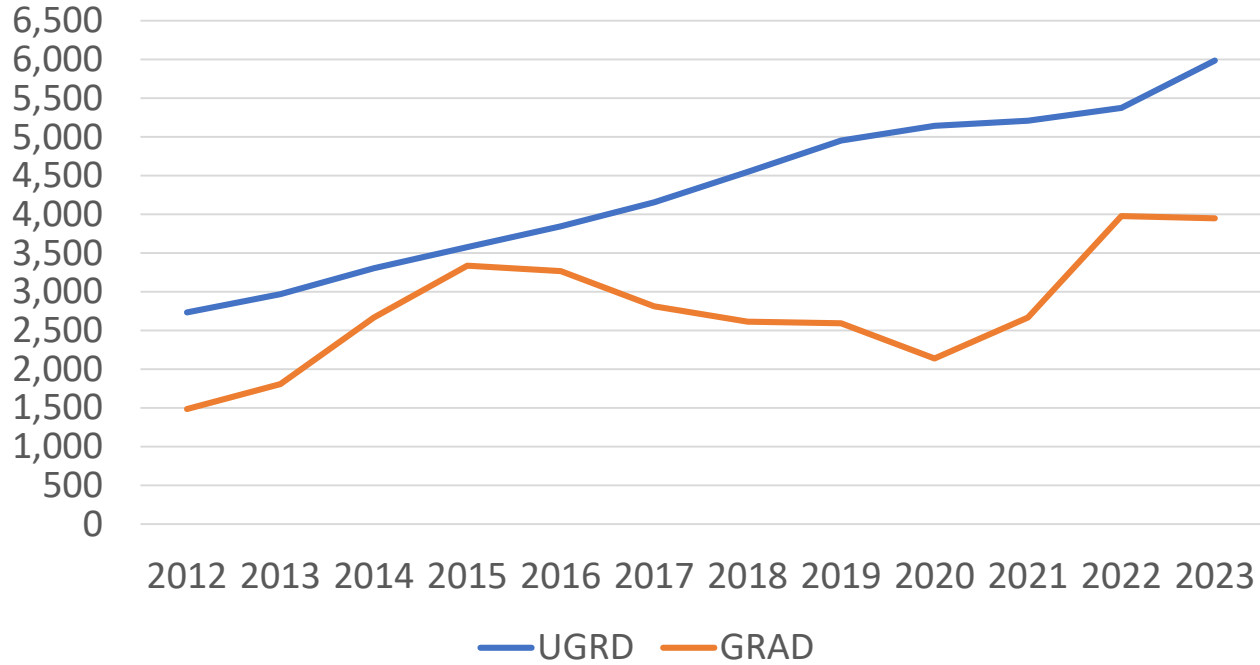
# It's the best of times for the College of Engineering

- Ahead of UTD in the US News Graduate Rankings of engineering colleges, making us the best college of engineering in DFW
- The College almost reached 10,000 student enrollment. Almost 25% of all UTA students on campus!
- Full time faculty increased by 46% in 7 years so in fall '23 it is 237 ( with gross change of 96%)
- Offers programs in 12 BS programs – 13 MS programs – 9 PhD programs - 26 certificate programs
- The College was awarded the Kelcy Warren (alumnus) \$12M gift – to start a new BS program in Resource and Energy Engineering program
- Now Offers two MS programs at UTA Fort Worth Campus – and expanding

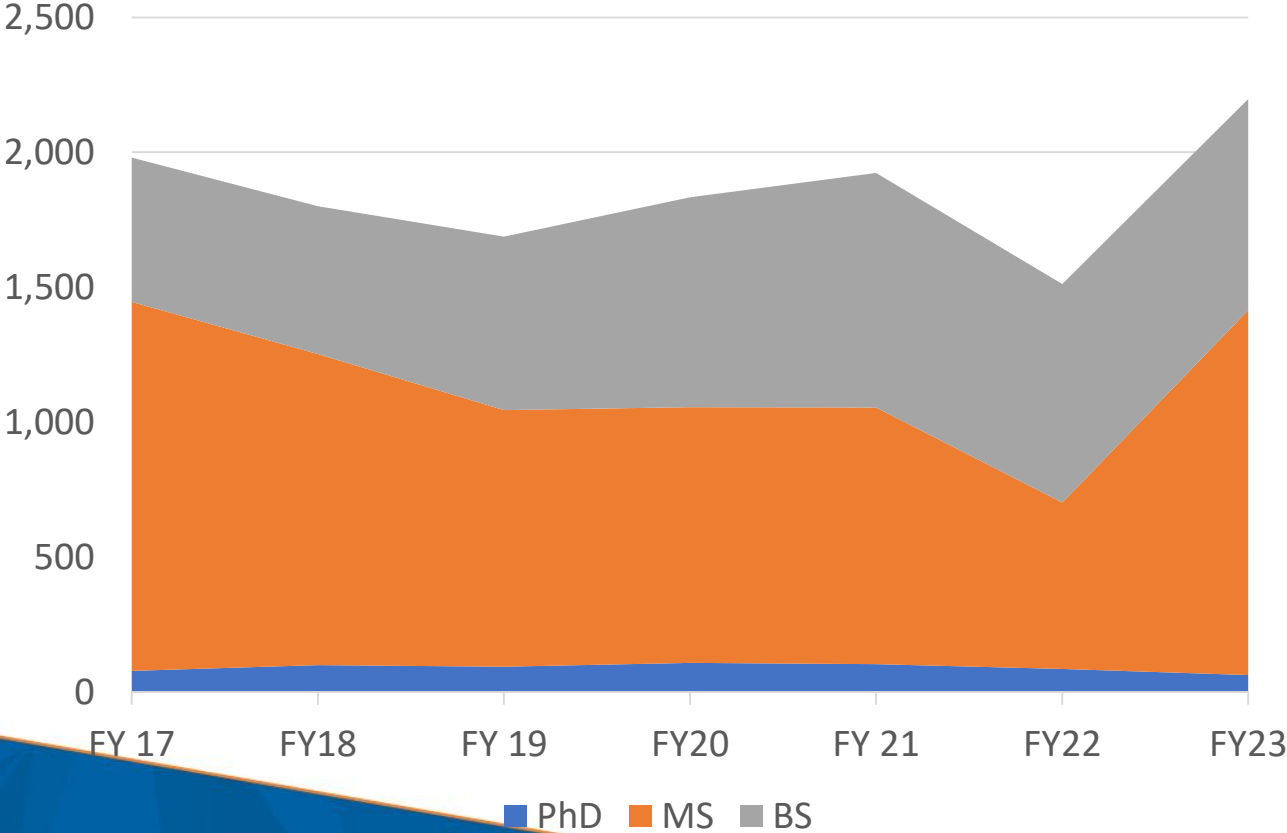
# Enrollment



# Enrollment



# College Graduates



# Engineering Degree Programs

12 BS degrees – 13 MS degrees – 9 PhD degrees

## **Bioengineering:**

B.S., Biomedical Engineering  
M.S., Biomedical Engineering  
Ph.D., Biomedical Engineering

## **Materials Science and Engineering:**

M.S., Materials Science and Engineering  
M.Eng., Materials Science and Engineering  
Ph.D., Materials Science and Engineering

## **Civil Engineering:**

B.S., Architectural Engineering  
B.S., Civil Engineering  
B.S., Construction Management  
M.S., Civil Engineering  
M.Eng., Civil Engineering  
Master of Construction Management  
Ph.D., Civil Engineering

## **Computer Science and Engineering:**

B.S., Computer Engineering  
B.S., Computer Science  
B.S., Software Engineering  
M.S., Computer Engineering  
M.S., Computer Science  
M.S., Software Engineering  
Ph.D., Computer Science  
Ph.D., Computer Engineering  
M.S. Data Sciences

## **Electrical Engineering:**

B.S., Electrical Engineering  
B.S., Resource and Energy Engineering  
M.S., Electrical Engineering  
M.Eng., Electrical Engineering  
Ph.D., Electrical Engineering

## **Mechanical and Aerospace Engineering:**

B.S., Aerospace Engineering  
B.S., Mechanical Engineering  
M.S., Aerospace Engineering  
M.Eng., Aerospace Engineering  
M.S., Mechanical Engineering  
M.Eng., Mechanical Engineering  
Ph.D., Aerospace Engineering  
Ph.D., Mechanical Engineering

## **Industrial, Manufacturing and Systems Engineering:**

B.S., Industrial Engineering  
M.S., Engineering Management  
M.S., Industrial Engineering  
M.Eng., Industrial Engineering  
Ph.D., Industrial Engineering

# Engineering Certificates

## Civil Engineering - Graduate

- SUSTAINABLE ENGINEERING AND RENEWABLE ENERGY

## Computer Science and Engineering - Undergraduate

- CYBER SECURITY
- UNMANNED VEHICLE SYSTEMS
- EMBEDDED SYSTEMS

## Computer Science and Engineering - Graduate

- ARTIFICIAL INTELLIGENCE
- BIG DATA MANAGEMENT AND DATA SCIENCES
- CYBERSECURITY AND PRIVACY
- DEEP LEARNING
- EMBEDDED SYSTEMS
- FIELD PROGRAMMABLE GATE ARRAY (FPGA) AND SYSTEM ON CHIP (SOC) DESIGN

## Electrical Engineering – Undergraduate

- UNMANNED VEHICLE SYSTEMS
- EMBEDDED SYSTEMS

## Electrical Engineering - Graduate

- CYBER-PHYSICAL SYSTEMS
- ELECTRIC PROPULSION
- EMBEDDED SYSTEMS

- PHOTONIC DEVICES AND SYSTEMS
- POWER SYSTEM MANAGEMENT

## Industrial, Manufacturing and Systems Engineering - Graduate

- INDUSTRIAL APPLICATION
- DECISION ANALYTICS
- LOGISTICS
- UNMANNED VEHICLE SYSTEMS

## Industrial, Manufacturing and Systems Engineering - Undergraduate

- UNMANNED VEHICLE SYSTEMS

## Materials Science and Engineering - Undergraduate

- NANOTECHNOLOGY

## Mechanical & Aerospace Engineering - Graduate

- AUTOMOTIVE ENGINEERING
- ELECTRONIC PACKAGING
- MANUFACTURING
- UNMANNED VEHICLE SYSTEMS
- VERTICAL LIFT/ROTORCRAFT

## Mechanical & Aerospace Engineering – Undergraduate

- AUTOMOTIVE ENGINEERING
- UNMANNED VEHICLE SYSTEMS

# College Research Focus

1. Aerodynamics/ Aero-propulsion
2. Automation / Autonomous Systems
3. AI/ML and Big Data Analytics
4. Cyber-Infrastructure
5. Communications and Networks
6. Built Infrastructure
7. Structural and Mechanical Systems Simulation
8. Energy Management and Sustainability
9. Materials
10. Manufacturing
11. Photonics
12. Health Care
13. Smart Transportation
14. Water



**“Artificial intelligence (AI), deep learning, machine learning (ML)—  
whatever you’re doing if you don’t understand it—learn it.**

**Because otherwise you’re going to be a dinosaur within 3  
years.”**

**— Mark Cuban**

And there are many reasons to believe that’s just the beginning of it. Today, AI and Machine Learning, especially Generative AI (ChatGPT), and Big Data are rapidly transforming almost every aspect of our world, including transportation, infrastructure, healthcare, education, agriculture, finance, manufacturing, .....

# Data Driven Discovery: a UTA Strategic Theme and has been for many years

- Our faculty strength in AI and ML has been rapidly increasing
- We have 50+ faculty and researchers across the campus that work on AI and related topics:
- Theoretical underpinnings of AI and ML, and applications to big data, automation, robotics and computer vision, healthcare, nursing, transportation, materials, manufacturing, education, nursing, agriculture, journalism, liberal arts, .....
- This year 12 new faculty joined the CSE department, and most of them are focused on AI (including two well-known senior professors)
- UTA will most likely create a faculty research cluster,, hiring more dedicated faculty
- Student enrollment in computer science programs, especially PhDs in AI and MS in Data Science, has been rapidly increasing
- Numerous research centers and labs leverage AI expertise

# AI and ML in Transportation

- Transportation Planning and Policy: transportation decision making, travel behavior, active modes and transportation equity, transportation logistics and operations research; Faculty: *Civil Engineering* - Stephen Mattingly, Kate Hyun; *Industrial Engineering* – Jay Rosenberger, Victoria Chen; *City and Regional Planning* - Ard Anjomani, Jianling Li, Ivonne Audirac, G. Shen
- Traffic: Traffic signal and monitoring, congestion control, traffic data analytics; Faculty: *Civil Engineering* – Taylor Li, Kate Hyun, Stephen Mattingly, James Williams; *Computer Science and Engineering* – Gautam Das
- Intelligent Transportation Systems: vehicle-to-vehicle and vehicle-infrastructure communication, control and sensing, autonomous vehicles; Faculty: *Civil Engineering* – Taylor Li; *Electrical Engineering* – Frank Lewis, Yan Wan; *UTA Research Institute* – Nick Gans; *Computer Science and Engineering* – William Beksi
- Transportation Infrastructure: durable and resilient transportation infrastructure; Faculty: *Civil Eng* - Surendra Shah, Maria Konsta, Steve Mattingly, *MAE* - Vistasp Karbhari, *CSE* - Gautam Das

# Smart Sustainable Infrastructure

Jinzhu Yu (Civil Engineering)

- research seeks to enable resilient, sustainable, and smart urban systems in uncertain and dynamic settings by developing and applying models and algorithms in network science, operations research, and data science.
- research interests include the resilience of infrastructure systems, disaster management, transportation and supply network analysis, urban informatics, decision-making under uncertainty
- Mohsen Shahandashti (Civil Engineering)
  - Analytics for Resilient Infrastructure Systems:(1) Resilience Optimization of Large-scale Infrastructure Networks, (2) Rapid, Resilient, and Sustainable Geotechnical Asset Management, (3) Economics of Post-Disaster Reconstruction and Recovery, and (4) Risk-based Performance Modeling of Emerging Building Systems.

# Applications of AI: Materials and Manufacturing

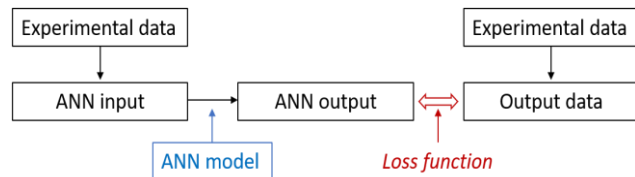
Xin Liu (MAE), Emma Yang (IMSE), Erick Jones (IMSE), ...

## Machine Learning in Multiscale Modeling of Composite Materials

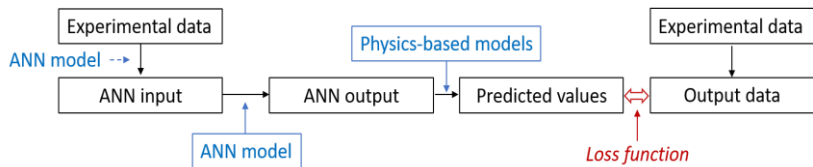
Challenges in modeling material behaviors at small scales

- Material responses are unmeasurable
- The size of training dataset is very small

Based on direct paired data:



Based on indirect data:



# AI in Simulation and Digital Twins

Digital Twin = Digital model of system good enough to exhibit all/most aspects of a physical system

## Digital Twins and Transportation and Urban Planning

- Brian Huff, IMSE Department
- Yuan Zhou, IMSE Departments

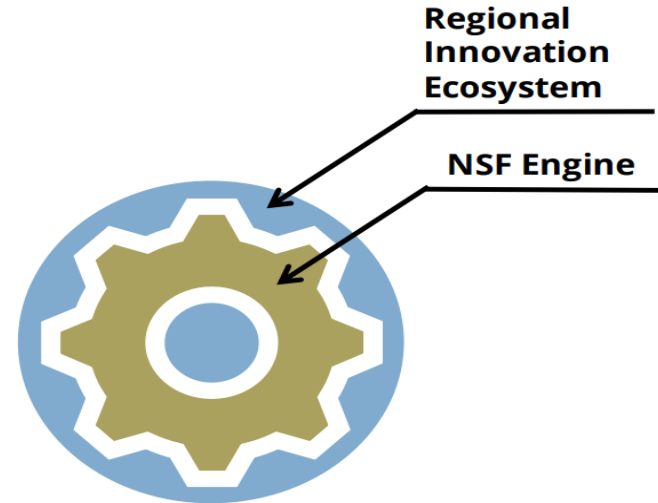
## Digital Twins and Cyber Logistics

- \$1M NSF Engine Type 1 Planning grant awarded to a North Texas Coalition
- Effort Underway to compete in the \$150M Type 2 Grant
- UTA is leading the Cyber Logistics efforts

# NSF Engines

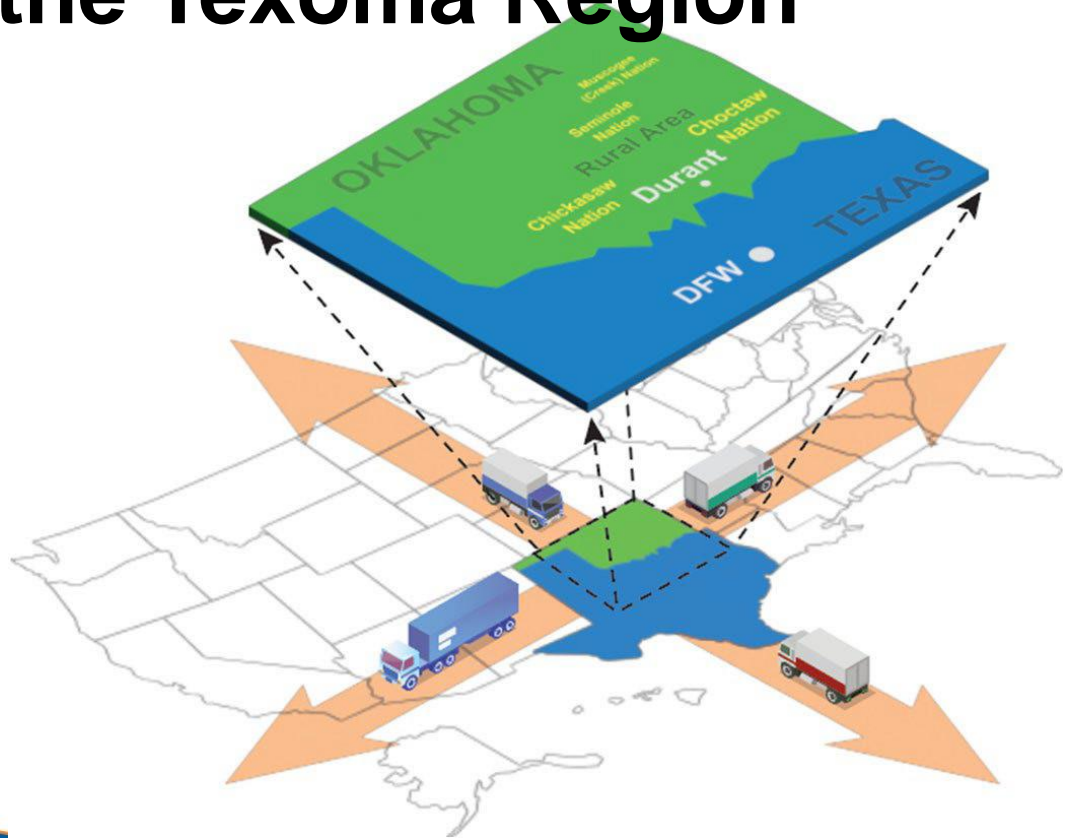
## What exactly is an “Engine”?

- A regionally-centered multi-sector coalition of partners and stakeholders across industry, academia, government, non-profits, civil society and communities of practice, all working together in a topic area of regional relevance, as well as national and societal significance, and led by a full-time CEO to:
  - Drive R&D innovation to achieve regional economic growth
  - Build an inclusive innovation ecosystem that will thrive for decades to come



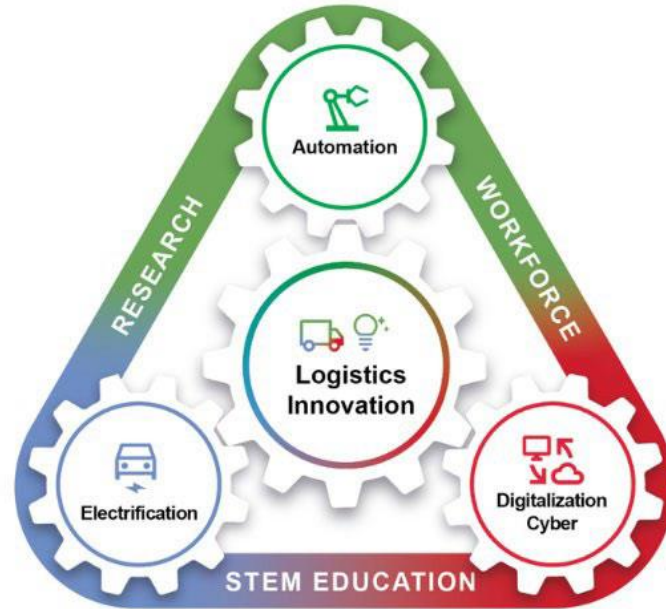
# Our Focus: Logistics Innovation Ecosystem in the Texoma Region

- The “Texoma” Region is the largest inland port and one of the most significant bottlenecks in our nation’s freight system
- It needs transformative change in logistics innovation to ensure long-term resiliency and agility for the global supply chains connecting to companies in the region





# Logistics Innovation



# Data Management

How to better represent, clean, query, and integrate data?

- **Ashraf Abounaga**, Professor
  - Former Chief Scientist at QCRI, former professor at Waterloo
- **Sharma Chakravarthy**, Professor
- **Gautam Das** (University Professor, Fellow of ACM, IEEE):
- **Leonidas Fegaras**, Associate Professor
- **Chengkai Li**, Professor and Associate Chair

# Chengkai Li

## Professor and Associate Chair

### CSE Dept

**2019: led a \$1M NSF Convergence Accelerator Project on Credible Open Knowledge Network(OKN):** A team of 30 experts in computer science, cybersecurity, communication, psychology, and public health from 20 academic, industry, and government organizations including international partners

2021: NSF DCL “Encouraging Research on Open Knowledge Networks”

2022: OKN Roadmap Ideation: Led a team to discuss the creation of a knowledge network for health communication.


**2023: lead PI of \$1.5M NSF grant on NSF OKN grant in collaboration with USDA**



# Gautam Das

## Distinguished University Chair Professor of CSE

## Associate Dean for Research COE

- Director of  DBXLAB
- Fellow of ACM, Fellow of IEEE, Fellow of AAA
- 200+ papers, majority at premier database conferences and journals
- 18,800+ citations and H-index of 61
- Communications of the ACM Research Highlights in 2021, ACM SIGMOD Research Highlights in 2019, IEEE ICDE 10-Year Influential Paper Award in 2012

### Core Research

- Explainability and Fairness in AI
- ML in Database Systems
- Robust Machine Learning

### Applications Research

- Smart Agriculture
- Data Science over Map Data
- Healthcare
- Sleep Apnea

# Big Data and Large Scale Computing Group

How to manage resources in computers, devices and the cloud in order to support AI/ML/big data applications

- Ashraf Abounaga (former Chief Scientist QCRI, former faculty at Waterloo)
- Ishfaq Ahmad (IEEE Fellow, over \$15M in funding, 20,000+ citations, h-index 60)
- Hao Che
- Hong Jiang (Wendell H. Nedderman Endowed Professor, IEEE Fellow)
- Song Jiang
- Jia Rao
- Ming Li
- Mohammad Islam

3 NSF CAREER awardees; SIGMETRICS Test of Time Award; \$7M NSF grants, plus industry grants, in the last few years on systems support for AI/ML/Big Data, from IOT, edge, to cloud, from CPU/GPU to cache, memory and storage systems.

# Cybersecurity, Cyber-Physical Systems, and IOT Group

- Dianqi Han
- Mohammad Atiqul Islam
- Chengkai Li
- Ming Li
- Yonghe Liu
- Shirin Nilizadeh
- Habeeb Olufowabi



## SpeechQoE: A Novel Personalized QoE Assessment Model for Voice Services via Speech Sensing

*ACM Conference on Embedded Networked Sensor Systems (SenSys'22)*

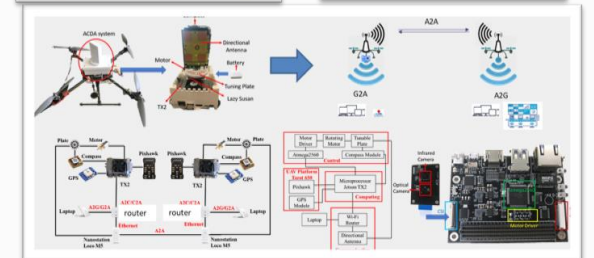
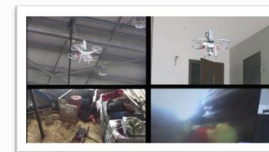
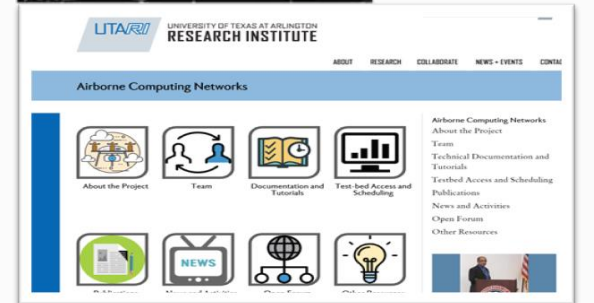
Chaowei Wang, Huadi Zhu, Ming Li

[Computationally Efficient Auto-Weighted Aggregation for Heterogeneous Federated Learning](#) Z. Talukder and M. A. Islam  
*IEEE International Conference on Edge Computing & Communications (IEEE EDGE), 2022.*

[Deep learning-guided jamming for cross-technology wireless networks: Attack and defense](#) D Han, A Li, L Zhang, Y Zhang, J Li, T Li, T Zhu, Y Zhang  
IEEE/ACM Transactions on Networking 29 (5), 1922-1932

# Yan Wan (EE) led projects on AI-aided Cyber-Physical Systems

- AIAA Associate Fellow, BoG members of IEEE Control Systems Society and IEEE Systems Man and Cybernetics Society
- \$8M+ research funding (NSF, ONR, ARO, NIST, FAA IEEE, Toyota, Ford, Dell, Lockheed Martin and MITRE), \$4M+ allocation to Wan
- NSF CAREER Award, RTCA William E. Jackson Award, U.S. Ignite and GENI demonstration awards, IEEE WCNC and ICCA Best Paper Awards, and Tech Titan of the Future – University Level Award
- Award winning in several national challenges, such as SmartAmerica, GlobalCity, GENI, US Ignite and AFRL Swarm and Search AI
- Over 220 publications, 3600+ citations
- Collaborators: UNT, UVA, SDSU, GTech



**And Many More....**

**Questions?**

**Thank YOU**