Electrical Engineering and Computer Science

Ph.D. Dissertation Defense

Smart Big Data in Precision Agricultural Applications: Acquisition, Advanced Analytics, and Plant Physiology-informed Machine Learning

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Abstract

Big data acquisition platforms, such as small unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), and proximate sensors for precision agriculture, especially for heterogeneous crops, such as vineyards and orchards, are gaining interest from both researchers and growers. The data acquisition platforms and analytics can create big data and demand fractional-order thinking due to the "complexity" and, thus, variability inherent in the process. Much hope is placed on machine learning (ML). How can an ML model learn from big data efficiently (optimally) and make the big data "smart" is important in agricultural research. The key to the learning process is the plant physiology and optimization method. Therefore, in this dissertation, the author investigated the foundations of the plant physiology-informed machine learning (PPIML) and the principle of tail matching (POTM) framework. He elucidated their role in modeling, analyzing, designing, and managing complex systems based on the big data in precision agriculture. The complex system has both deterministic and stochastic dynamic processes with external driving processes characterized and modeled using fractional calculus-based models, which will better inform the complexity-informed machine learning (CIML) algorithms. Data acquisition platforms, such as low-cost UAVs, UGVs, and Edge-AI sensors, were designed and built to demonstrate their reliability and robustness for remote and proximate sensing in agricultural applications. Research results showed that the PPIML, POTM, CIML, and the data acquisition platforms were reliable, robust, and smart tools for precision agricultural research in varying situations, such as water stress detection, early detection of nematodes, yield estimation, and evapotranspiration (ET) estimation. The application of these tools has the potential to assist stakeholders in their crop management decisions in the future.

Schedule

Date: 03/17/2022
Time: 09:00 am - 11:00 am
Location: Zoom
Zoom Link:
https://ucmerced.zoom.us/j/4529169801

More Information

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Biography

Haoyu Niu is a Ph.D. candidate in Electrical Engineering and Computer Science at the University of California, Merced. He is interested in Precision Agriculture, Big Data, Deep Learning, sUAS Remote Sensing/Application.

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