PROJECT SUMMARY

Overview:

The primary objective of this project is to create a federated farming analytics framework that allows for collaboration between farms, preserves privacy, satisfies data sharing requirements, and encourages simultaneous collaboration and personalization in the data-driven modeling of agricultural farms. With the advent of smart machines, unmanned vehicles, and static or dynamic sensors, farm management has transformed into a data-enabled process. Data collected at farms enabled artificial intelligence (AI) frameworks to develop models capable of predicting traits such as crop yields and health conditions. Unfortunately, these predictive models are often created in silos based on the data obtained from a single farm, ignoring the data generated in other similar farms. One potential solution to address this limitation is that farms upload their local data to a centralized server, where all data sets are combined to create a model used by all farms. However, this centralized approach creates several challenges, including a lack of participation due to privacy concerns and vulnerability to data leakage and cyber-attacks. This proposed project aims to address these challenges by creating a novel framework for decentralized, federated farming analytics. Under this proposed framework, each farm locally collects data and trains a model (with a common architecture defined by an orchestrator). Next, the created models (e.g., the weights of the model) are uploaded and shared with the orchestrator (e.g., cloud) that aggregates the models. The aggregated model is then broadcasted to the farms, where each farm uses that to create an updated personalized model. This procedure continues when a new data set becomes available.

Intellectual Merit:

The discoveries sought in this project are expected to serve as a foundation for a new knowledge base in connected and smart farm systems. Our proposed project aims to conduct fundamental research to create theoretical foundations for and examine the performance of a privacy-preserving but collaborative farm modeling framework. This federated farm modeling framework allows for collaborative and personalized data-driven modeling without requiring data-sharing among farms. Not only does this approach improve privacy and alleviate the data-sharing challenges in the agricultural farming landscape, but it also enhances the modeling generalizability. This project is expected to be a significant leap toward developing smart connected but federated farms. The proposed research will also significantly advance state of the art in high-dimensional data analysis by introducing federated tensor analysis.

Broader Impacts:

The proposed novel methodology of federated farm analytics will fundamentally transform the farming collaboration environment and enable model generalizability and privacy. PIs will disseminate the outcomes of this research via peer-reviewed journal publications, conference presentations in all those areas, and online public archives such as arXiv (arxiv.org) to maximize the broader impact of this research project. Extension venues (e.g., seminars, webinars, workshops, field days) will be organized at least twice per year to promote findings of this project in their existing programs. The outcomes of this project will result in more efficient and resilient farm management systems. Ultimately, this project will contribute to developing a data-informed cyber-physical farming infrastructure. In connection with this project, several educational and outreach efforts (including new learning tools) are envisioned for integration into undergraduate and graduate courses taught by the investigators at the University of Florida. This project is expected to broaden the participation of underrepresented groups and increase the motivation of K-12 students to pursue a college degree, especially in Science, Technology, Engineering, and Math (STEM) fields.

Keywords: Data analytics and machine learning, Agriculture