Indo/US Collaborative Research Grants

National Science Foundation of US and Technology Innovation Hubs of India

सत्यमेव जयते

Title: Computational Learning through Context Adaptation for Effective and Efficient Agriculture

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Together, the NSF AI Institute on Intelligent Cyber Infrastructure with Computational Learning in the Environment (ICICLE) and the Technology Innovation Hub for IoT and IoE (TIH-IoT) are codeveloping next-generation cyberinfrastructure (CI) to facilitate digital agriculture. This includes AI and machine learning methods that sense crop health and recommend contextualized crop management practices to boost yield, fully autonomous equipment to monitor crop health, detect crop stressors, and apply remedies with little human intervention, Internet of Things (IoT) and sensor systems capable of massive data collection, and secure, trustworthy, and privacy-preserving platforms that connect farmers and allow them to share information and resources safely.

However, for all of the promise of digital agriculture, developing robust solutions that can be deployed cost effectively in diverse contextual environments is challenging. For example, AI models developed for Soybean fields may not transfer well to Onion crops. Sensors deployed safely in one region/state may present severe privacy problems in another region. Farmers are left on their own to defend their privacy and there are no regulations that directly protect farmer's data. Information they share about the environmental and soil conditions of their farms to participate in various government and NGO programs can be used against them in unexpected ways. The risks that they take include adverse pricing and competitive disadvantages as well as price discrimination, interference of potential diseases, insurance costs, and farmers interactions. Local, regional, and national contexts affect the efficacy and efficiency of crop management, so CI must adapt to the context in which it is deployed.

Our research collaboration is yielding robust and adaptable CI through projects that (1) effectively employs state-of-the-art transfer learning practices to develop models of crop growth and disease progression, (2) use differential privacy methods to protect farmers, landowners, and governmental agencies from invasive sensing and AI technologies, and (3) automate crop management with novel algorithms to manage autonomous vehicles.

We are currently focusing on better transfer learning approaches suitable for databases related to agriculture (plant diseases/pest classification, progression). Our initial results for Onion disease classification are promising. We are considering dataset similarity measures to guide us in transfer learning. Another novel contribution is to assess the epsilon-differential level of privacy that farmers may rely upon when sharing information about the attributes of their farm lots. We used existing farm datasets to analyze and identify potential farm attributes with potential privacy risks. One technique for securing the privacy of farmers is offered by adding 'noise' to the publicly available information. The effect of the added noise is a calculable measurement of privacy called epsilon differential privacy. As next steps, differential privacy for shared datasets can be estimated and be used with time-series data to investigate approaches that can protect farmer's privacy and data.

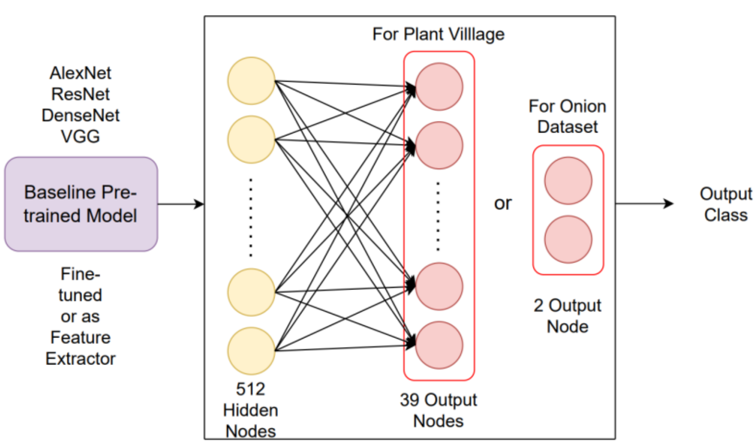

Figure 1 Transfer learning from existing datasets for Onion disease classification.

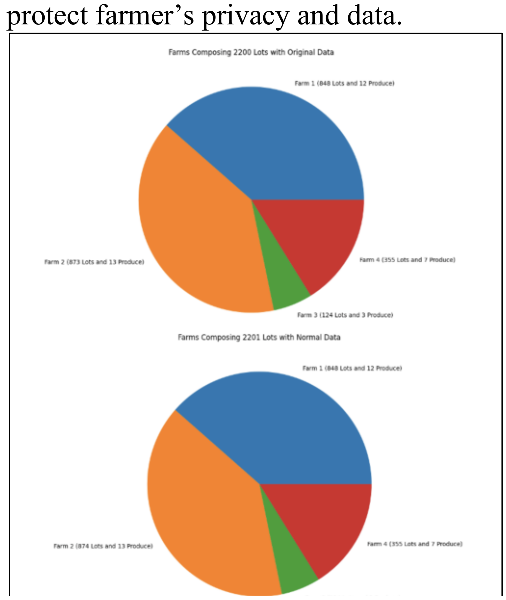

Figure 2 Original and perturbed farm data leads to privacy violation and is not noticeable. We propose algorithms to protect against such privacy violations.