CIFellows 2020-2021

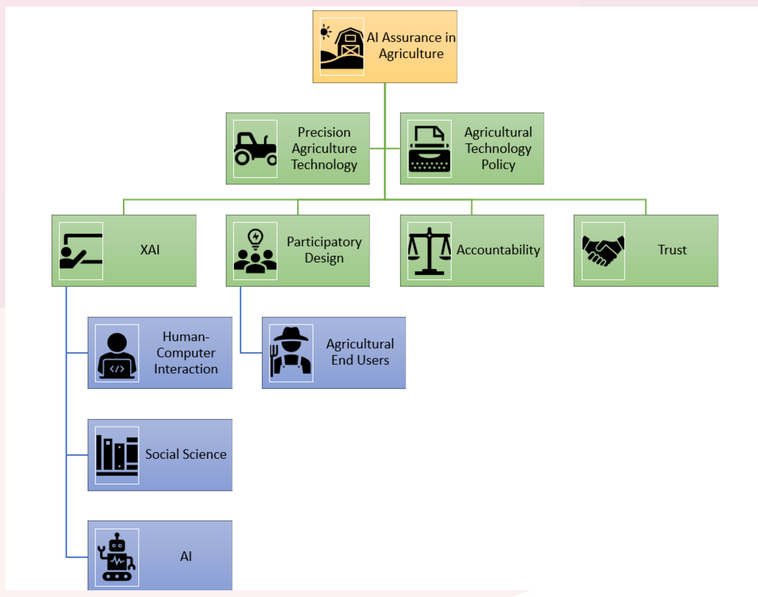
Computing Innovation Fellows

Brianna B. Posadas

Virginia Tech

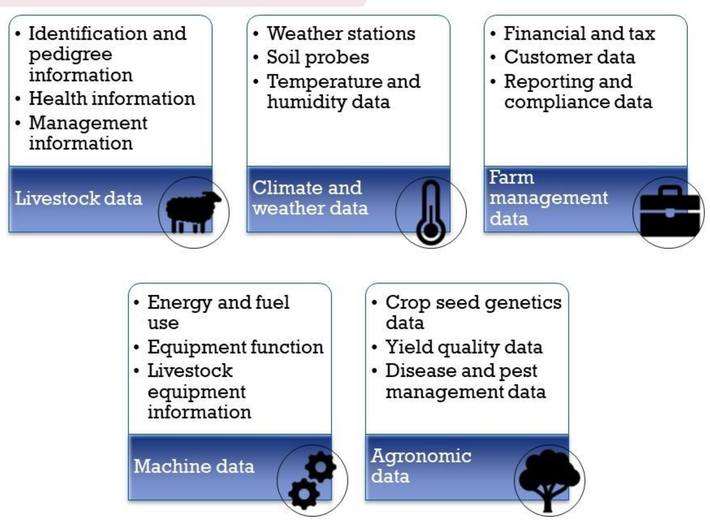
Socially Responsible AI Assurance in Precision Agriculture for Farmers and Policymakers

Overview



- Currently, there are less than 10 studies of AI assurance in agriculture. Of these studies, few test their systems with agricultural experts; none test their systems with agricultural workers.
- This is significant because as agriculture becomes more automated and technologically advanced, the end users who need to understand the "black box" of AI system are overwhelmingly not ML experts.
- Having this "black box" makes it difficult for agricultural workers to trust AI systems and makes it difficult for policymakers to protect the interests of agricultural stakeholders.
- This poster proposes several recommendations for more accessible XAI agricultural systems including utilizing participatory design, designing for different end users, and having programmers be transparent and upfront about data use and privacy.

Background



- As one solution to feeding a growing population with finite resources, some farmers, researchers, and Agricultural Technology Providers (ATPs) have turned to Precision Agriculture (PA).
- PA is the practice of mapping out precise input applications to maximize the yield.
- In order to implement the machine learning algorithms for PA on a larger, industrial scale, Agricultural Technology Providers (ATPs) collect input and output data from farmers to build prescription maps which farmers can program farm equipment to follow.
- To create trusted PA systems, ATPs will need to rely on transparency.
- Addressing the lack of transparency in PA systems will require developing explainable AI (XAI) systems.

Current Methods

Table 1
Summary of AI Assurance in Agriculture Studies

Author	System	Test Conditions	End Users	Models/Algorithms	Results
(Rojo et al., 2021)	*AHMoSe*	choosing ML model to predict grape quality	viticulturalists	knowledge-based fuzzy inference system	viticulutralists using *AHMoSe* were able to select a model with better performance than an AutoML system did
(Gandhi et al., 2021)	N/A	simulating crop yield for cotton, wheat, paddy, barley, and maize using temperature, soil moisture, humidity, nitrogen, phosphorous and soil type	not specified	fuzzy-rule based system	the predicted ideal crop conditions and soil types for maximum yield were comparable to conditions provided by the ministry of agriculture and farmers welfare
(Tsakiridis et al., 2020)	*Vital*	replacing legacy technologies: a set of enviromental sensors in lake Koronia	not specified	fuzzy-rule based system	integration successful
(Tsakiridis et al., 2020)	*Vital*	precision irrigation for young olive tree orchard	agronomists	fuzzy-rule based system	using *Vital* with an expert was not as effective at conserving water as using *Vital* alone
(Tsakiridis et al., 2019)	*DECO$_3$RUM*	LUCAS topsoil database	unspecified experts	Mamdani Fuzzy Rule-based System	*DECO$_3$RUM* statistically outperformed global models
(Tsakiridis et al., 2017)	*DECO$_3$RUM*	to predict soil properties in samples from Central Macedonia, Greece	unspecified experts	Mamdani Fuzzy Rule-based System	*DECO$_3$RUM* statistically outperformed the Partial Least Squares Regression algorithm
(Batarseh & Yang, 2017)	*Intelligent Federal Data Management Tool*, *Intelligent Federal Math Engine*, and *Validation Engine*	suite of engines and tools at the US Department of Agriculture to manage, validate, calculate and stream data	federal analysts and agricultural researchers	knowledge-based system and data mining methods	57% of analysts gave the system positive feedback

- The study of AI Assurance is a newer development for the agricultural field.
- Overall, the studies were tested by the researchers themselves or unspecified experts.
- However, in agriculture, we need to be cognizant that the end-users of these systems are not only the original researchers, but also the grower or agricultural worker.

Recommendations/Further Work

Rubric for XAI systems

- Does the XAI tool clearly identify its target audience and their expectations for the tool?
- Is the presentation of explanations sufficient for the target audience to gain insight and improve upon their model?
- Does the XAI tool provide a variety of types of explanations?

XAI for Agricultural End Users

- Help users understand AI's capabilities
- Be transparent about data and privacy
- Recognize that many recommendations are high stakes
- Leverage existing trusted resources

Farmer-Centered AI Assurance System

- Common hardware and data constraints
- Build for diverse literacies and multiple languages
- Co-design with smallholder farmers and intermediaries

CRA Computing Research Association

CCC Computing Community Consortium Catalyst

NSF