Recognizing Principles of AI Ethics through a Role-Play Case Study on Agriculture

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Abstract

The continual growth of artificial intelligence (AI) in agriculture has surfaced concerns about AI ethics, responsibility, trust, and transparency among professionals in the industry and communities impacted by the technologies. Machine learning (ML), improved sensors in an Internet-of-Things (IoT) world, and advanced networking capabilities have vastly expanded the information processing capabilities of farmers and co-ops, allowing for action based on real-time information on yields, pest control, and farming cycles, to name a few benefits. However, these systems can also highlight the problematic nature of technology outgrowing regulation. These technologies introduce the same surveillance and data ownership concerns that continue to be raised with technology in other industries. There is also the question of what role human labor has in the future of agriculture. While previous research has outlined several fundamental topics for the ethical implementation of technology in agriculture, navigating conversations about AI in agriculture with members outside the industry is an ongoing discussion. To explore how these conversations can be raised with college students, we use a collaborative approach to augment students' thinking about AI ethics in the context of agriculture and farming. This paper uses a content analysis procedure to explore undergraduate engineering and computing students' recognition of AI ethics principles in agriculture. We describe an exercise using a role-play scenario (RPS) activity and a case study of a fictitious AI-enabled farm to help students make these connections and identify ethical considerations. We collected data from seventy-three (73) students through a written assignment after participating in the RPS activity. Through our analysis, we noted that participants could identify and connect several ethical principles with the contents of the case study. Additionally, all our participants identified transparency, a central theme of the case study, as key to building trust between AI-enabled agriculture and the community. Enabling privacy was another heavily discussed topic across the groups while ensuring that communication was conducted sustainably. Role-plays can effectively engage college students in interdisciplinary conversations, especially for emerging issues such as AI ethics.

Introduction

Technologies reliant on artificial intelligence (AI) have continued revolutionizing how industries function worldwide. Within agriculture, using machines for farming autonomously without human labor is one significant shift that has taken place [1]. In the US, in particular, this is partly due to the overall shrinking agricultural workforce, resulting from a lack of interest in the profession coupled with a political and cultural climate restricting immigration for agriculture-related work [2]. According to some reports, there are over 200 "AI in agriculture" start-ups [3] in addition to research and development in established companies and academia. Automation, autonomous vehicles, data-driven understanding, and algorithmic work on increasing yield and quality are among the applications that are becoming common. Overall,

agriculture is now becoming increasingly digitized and computerized and will rely in the future on a technology workforce to build, train, and deploy solutions. Given this, how do we prepare students to think about the use of technology in this domain holistically?

This paper aims to explore an interdisciplinary application of role-play scenarios (RPS) and case studies to allow engineering and computing students to learn about ethical dilemmas in agricultural systems. This exercise helps bridge the discussion on artificial intelligence, algorithms, and other technical fields with generalized, non-technical topics that affect the everyday member of society. We use content analysis to understand and explore our participants' recognition of AI ethics principles in an agriculture context. Our overall research question was:

- What ethical principles can students recognize in AI and agriculture RPS case studies?

Literature Review

Agriculture is one of the oldest organized activities in which humans have engaged and is also a sector prone to massive changes due to technology. Agriculture has traditionally been a labor-intensive occupation, often requiring humans to work in disagreeable conditions, and it is no surprise that it was a target of industrialization. The industrial era was a significant shift where energy drawn from animals or humans gave way to steam or coal-based energy sources. Farmland often provides a testing ground for technologies that can be implemented without the hustle and bustle of people [3, p. 282]. The use of heavy machines changed both the efficiency of production and the scale at which agriculture could be undertaken.

Agriculture is also a domain where digital applications have found significant use. Robots and drones are often used to collect field-level data for preventing diseases and to design new seeds and crops by considering not just weather and atmospheric data but also soil and vegetation data. Using machine/deep learning techniques, such as artificial neural networks (ANN), expert systems, fuzzy logic, and neuro-fuzzy logic, to solve complex disease-avoidance, pest control, and water management problems [2]. AI-empowered agricultural systems can address the limitations of human beings by working around the clock with precision and doing work that is hazardous to people [4]. For instance, advances in precision agriculture result in AI-based solutions for soil, pest and weed, disease, crop, and water-use management [5], and advances in automation result in more efficient farms.

The industrialization of agriculture created turmoil and left generations without work, forcing agrarian society to move towards working in factories. Even non-technological advances have had significant downsides, such as improvements in pesticides and fertilizers, making it possible for us to feed most of the world. Pollution of soil and water is one negative effect; the lack of a water table due to the need for high amounts of water when fertilizers are used is another downside. Similarly, it is slowly becoming evident and being documented what the long-term downsides of AI in agriculture might be. With the potential for the use of computing in agriculture and the development and deployment of algorithm-driven AI-based technologies, many areas of concern have also arisen [5].

Mark identified several ethical concerns concerning the general use of information technology and AI through a case study research approach, particularly in agriculture [6]. One of the concerns commonly expressed in research is that AI will replace human jobs. In addition, users are concerned about the accuracy and availability of data, privacy, and the security of data and misuse and hacking. Farmers expressed concern over data ownership, especially if they moved to another supplier or company. For many farmers digital divide was another issue they worried about; not all farmers are tech-savvy and able to use technology, especially AI-based systems, effectively. Mark et al. also reviewed a range of empirical papers to identify concerns with the use of AI in agriculture. They found that sustainability was the most discussed topic, followed by non-maleficence, trust, and beneficence [7]. Overall, they found that within AI ethics, discussions on topics related to the environment, sustainability, and the natural world, are limited, and agriculture is a domain that brings these into focus. The review also found that transparency, dignity, and solidarity within the agricultural AI literature are rarely discussed and receive less attention than privacy or justice.

Finally, a recent workshop on AI's ethical and responsible use in agriculture highlighted that AI increases the potential for unintended and unanticipated negative outcomes for farmers and consumers [8]. The report cautioned that although AI-based technology development will most likely improve over time, the complexity of AI systems will increase, leading to new concerns. It emphasized the need for a multi-pronged approach to technology development that included farmers, businesses, researchers, and experts trained to work across disciplinary and organizational boundaries. Finally, it stated that strong regulations would be needed to protect consumers and farmers. Especially for farmers, the advent of AI leads to reduced power and control over their equipment and data, and a better balance must be struck between their needs and business demands.

For the purpose of teaching students about ethics, agriculture is both a relevant and interesting domain. For students, it is easy to identify with food and the role of agriculture in producing food. In recent years concerns about healthy eating have also made this a relevant topic for many students. From a pedagogical perspective, it allows one to bring in different viewpoints and perspectives and raise various ethical concerns about using AI. It also allows one to introduce topics such as sustainability that are rarely discussed in AI ethics. Yet, climate change and food production are intractably linked and co-dependent. Finally, the use of AI in agriculture is a highly interdisciplinary topic that provides students with learning [9].

Teaching about ethics can be a complex topic, especially when students need to gain prior training in the field beyond optional electives. Jobin et al. conducted a review and content analysis of 84 national and international documents on AI ethics and the “soft-law or non-legal norms issued by organizations” through the PRISMA framework [10]. The authors highlighted eleven (11) principles that emerged from texts exploring ethics in technological implementations [11]. These principles are 1) *Transparency*, 2) *Justice & Fairness*, 3) *Non-maleficence*, 4) *Responsibility*, 5) *Privacy*, 6) *Beneficence*, 7) *Freedom & Authority*, 8) *Trust*, 9) *Sustainability*, 10) *Dignity*, and 11) *Solidarity*. Outlining ethical principles in this way can be a valuable instrument to talk to students without a specific background in the terminology to recognize

everyday ways in which ethics affects people. It can also be a powerful tool to bridge interdisciplinary discussions.

Methods

This paper explores using RPS and case studies to facilitate discussion on technology ethics in everyday, interdisciplinary topics. In this section, we will describe the course implementation, data collection, data analysis, and the Future Farm Collective (FFC) case study.

Course Implementation

This study and the RPS cases were implemented in an undergraduate course on the implications of technology in a global, connected world in a college of engineering and computing at a large US public university. The course was a requirement for all students in the program. The course learning outcomes included recognizing the role of technology in the global society, the changing nature of work, and gaining recognition of ethical decision-making processes. Additionally, the course specifically addressed the implications of data across domains and how fairness, accountability, transparency, and ethics affect everyday systems people interact with. Due to the fast-paced nature of technology, the course was presented using resources that could be updated easily, such as peer-reviewed articles, videos, and other online resources. This flexibility allowed students to have conversations within the context of the course on timely topics such as generative AI and large-language models, which were increasingly discussed around the time of data collection.

The course consisted of four modules: 1) Societal Impacts of Technology, 2) Privacy and Surveillance, 3) Data & Algorithms, and 4) Ethics, and role-plays were integrated across all four modules. Although ethical theory, frameworks, and codes are taught as a separate module toward the end of the course, ethical thinking and ideas are integrated throughout the course. Ethics is discussed in a way where students can appreciate the interconnectedness of ethical discussions to all the aspects of the course. Students are encouraged to bring questions and discussions to the class sessions.

Each week, students read and watched a collection of reading and video resources, after which they completed the assignments. Students were provided with the case study (Appendix A) and additional reading resources beyond those required to supplement student knowledge to prepare for the role-play activity. Students were given the reading resources, including frameworks for recognizing ethical dilemmas, to bring all students up to a baseline level of understanding before participating in the activity. This was done in recognition that although collectively learning technical skills in the program, their knowledge of agriculture-domain-specific information may be limited. They were also given examples of exemplary RPS activities that could help reduce anxiety toward interacting with their peers in this way.

After engaging with the materials, students participated in the RPS activity. For this course iteration, synchronous online breakout rooms through the campus-mandated learning management system allowed students to collaborate. The authors moved between the rooms to

ensure any questions, concerns, or technical issues were resolved quickly. At the end of the RPS, students debriefed in a collaborative setting and responded to post-activity questions. The role-play activity participation and assignments significantly affect the student's final grades for the course. The Institutional Review Board approved the study. Data were used only from participants who consented. All data were anonymized.

Data Collection

Data were collected during the fall 2022 semester. The post-discussion responses used in this paper were collected within a day of completing the RPS activity. Questions about overall learning from the case were collected in the final week of the semester. The role-play activity was designed to be engaging and relevant to the broader topic of the week [see Appendix A]. After each role-play, the participants were asked to answer questions about their experience and understanding of the technology-related concepts discussed. This data was collected through the learning management system and stored anonymously.

We included two sets of student responses in the dataset. The first addressed recognizing ethical principles, and we used Jobin et al. ethical principles as a framework for describing technology ethics concerns [11]. This framework was introduced to students before they participated in the RPS. The second student response referred to the student's rationale for whether there is a place for AI in agriculture, and this was inductively coded.

Data Analysis Procedure

We used a content analysis approach to analyze the student response data collected. Content analysis is a popular method of textual analysis that provides the researcher with both direction and flexibility to work through a text corpus. Many variations of quantitative and qualitative content analysis have emerged in different fields. Hsieh and Shannon describe three commonly used approaches: conventional, directed, and summative [12]. In the conventional approach, codes are defined during the data analysis, and few existing or preconceived themes or frameworks are applied to allow new ideas to emerge. In the directed approach, codes are defined before and during the analysis, and existing frameworks can be used as a starting point, but new codes can be derived from the data. Finally, with a summative approach, keywords are identified before and during analysis, and the keywords, whether used quantitatively or qualitatively, are the focus of the analysis [12].

In this analysis, we used a directed content analysis approach. Directed content analysis is a deductive approach that moves from general observations to more specific conclusions or categories. Due to the data collection type, the authors first analyzed data with a qualitative lens and then a quantitative lens. This was done to explore the nuances of the student responses, what they understood, and how they explained why from their viewpoint. Each author read through the student responses individually and then collectively. An initial code list was generated to inform concept identification in the student responses. This codebook included codes, definitions, and examples. As the reviewers read the responses, they highlighted occurrences and passages in the data corresponding to a code. After the initial coding round, we evaluated the fit

and adjusted their shared recognition of the codes based on the data. With the revised codebook, one author coded the whole dataset, and the number of instances for each code was listed for each part of the data.

The Case Study: "Evaluating AI Ethics for Agriculture at Future Farm Collective (FFC)"

The case study is based on a fictitious organization, Future Farm Collective (FFC), curating technology for agricultural processes. FFC is a Midwest-based group of researchers, growers, technology experts, and businesses that mission is to create the future farm, feed a growing world population, develop new opportunities for the community, and align organizations to evolving themes. Using artificial intelligence (AI)-based systems, FFC is making advances across various agricultural practices to create a fully autonomous farm. The whole case, role descriptions, questions, and guiding instructions can be found in Appendix A.

Results and Discussion

The results of the content analysis are presented below. Through the assignments, students were provided with guiding questions to focus their responses. In each section below, we highlight the question, the analysis results, and our discussion.

Identification of Ethical Principles in the Case Study

The first question asked students to identify all the ethical principles addressed in the case study. The ethical principles highlighted by Jobin et al. were used to focus discussion and provide students with descriptors for each before participating [11]. Due to how the case was designed, the FFC case includes all 11 principles.

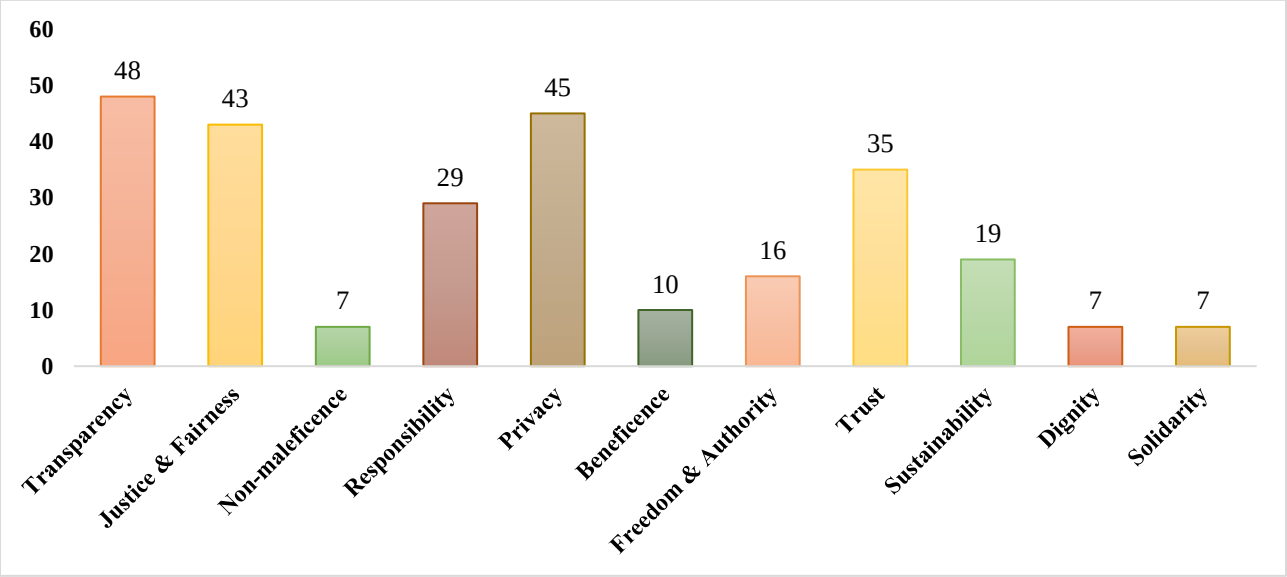

Figure 1: Number of student responses referencing each ethical principle. Each principle (category) could have a maximum potential count of 73.

Transparency, *justice & fairness*, and *privacy* were the most often recognized principles across the responses. One potential reason for these descriptors being common across the participant's responses may have been the ease of explanation for these concepts; students have likely come across these terms already and can more easily recognize them in a case study. The meaning of these terms is inferable from the context and are more often included in media (social media, news, and other digital media) discussions on the use of technology. Therefore, participants may have encountered these principles before and may have some comfort and familiarity with them. The frequency of recognition is considerable, as these three categories were identified in around 60% of our participants.

The least recognized principles were non-maleficence and beneficence, which are concepts many of our students have not encountered before. These terms are also less commonly described in everyday vocabulary and are not simple concepts to explain. Additionally, for some students, going from knowing the definition to recognizing them in a case study may require multiple semesters of instruction and work. These concepts may require additional talking through, examples, and applications for their meaning and application to become more apart in this case.

Other principles like *dignity* and *solidarity* are more commonly known but were not recognized as frequently. Again, this may result in difficulty recognizing dignity and solidarity in the FFC case. What do dignity and solidarity mean in applying AI to agriculture? The case is written with the roles of community members who are for, against, and neutral towards adopting AI in agricultural processes. Depending on the assigned role, students may take a macro view and feel solidarity in working towards the collective good for people rather than their smaller community. In that case, solidarity would be in adopting the technology to improve production yields. Others may believe solidarity falls in trusting a common spirit of autonomy. Recognition of solidarity could also have depended on the role-play activity's group dynamics.

The concept of *dignity* is interesting because farmer autonomy and community values were well-discussed and recognized through the participant's responses. While dignity seems to align with these descriptions, the data does not indicate this. One possible explanation is that participants described trust as a community value more than dignity. Once again, it seems as though students' familiarity with these concepts outside of the classroom affects how they apply them, even if given a specific framework from which to view them.

Should the Committee allow the use of AI in Agriculture? - the rationale behind the decision.

One of the guiding questions in the RPS activity was whether there is a role for AI-based technologies in agriculture – and if so, what. Suppose the students thought there was a suitable role for AI in agriculture based on their role. How should the organization proceed with the implementation of technologies in an ethical manner? After participating in the RPS and hearing from a varied group of stakeholders, all seventy-three (73) participants argued that overall, there is a role for AI in agricultural practices. Using the ethical principles outlined by Jobin et al. as an inspiration [11], we inductively coded categories that demonstrated the participant responses. Regarding the focus on ethical implementation, there were five categories of response: 1) overall

financial and productivity gain, 2) farmer autonomy and community values, 3) transparency between organization and community, 4) effects of automation and job loss, and 5) governmental regulations & protections. The codes and examples of each can be found in Appendix B.

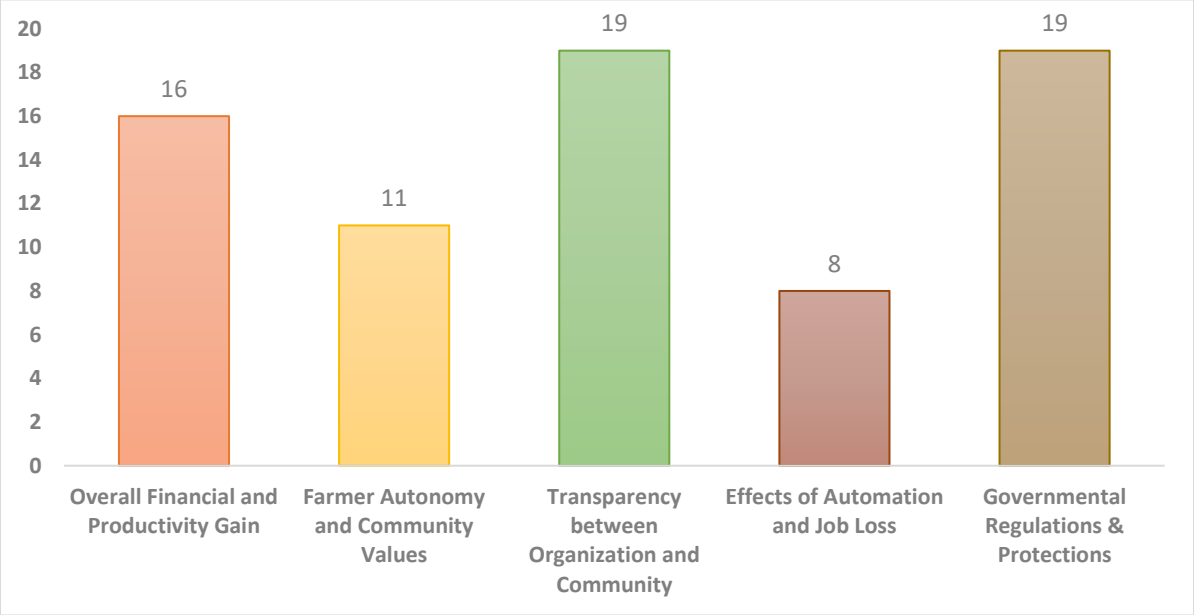

Figure 2: Count of students' rationale of AI's role in agriculture. Each response was coded based on the primary rationale (n = 73).

Transparency between the organization and community and government regulations and protections were the two most frequently occurring categories through the analysis. Perhaps these two categories were the more common in the data because they were explicitly outlined in the case. Transparency concerns were depicted as the central reason why the Committee was formed and the meetings were happening. FFC was interested in the community buying in to ensure their solutions were more widely accepted in the surrounding area. But also, the sentiment toward using AI through media and word of mouth was already pushing people against accepting the technology. Governmental regulations and protections were cited to ensure that companies like FFC would not just be all talk when it came to supporting the community. These regulations also highlighted a system of power in which the community could directly influence and have power.

Next, overall financial and productivity gain was the second-highest cited category. Participants who used this rationale said that from an ethical standpoint, the benefits of using AI and similar technologies to improve farming practices were the right course of action to benefit the community. The increases in yield, identification of pests, and overall improvements in the quality of work for farmers would then be translated into increased food production that benefited the entire community. Some of these participants also viewed the inclusion of AI technology in agriculture as inevitable. So, the right course of action was to ensure the group benefits from this unavoidable situation.

Some participants highlighted farmer autonomy and the values of the community as the focus of implementing AI technology in agriculture. These participants described the increasing importance of choice regarding technology implementation. In this case, there were examples where farmers could not fix their equipment. In addition, students brought in additional examples of cross-pollination from patented seeds as another way of viewing how autonomy can be affected. Participants also talked about the value of not being constantly surveilled as a community. Using drones and other technology equipment makes it easier to access real-time information about the vast land they may be cultivating. However, it also opens the discussion for surveillance. Finally, there was talk of a competitive farming advantage that farmers may give up in sharing their data with whatever third-party organization is coordinating technological activities. Farmers may have their systems, techniques, and tips, which could be more visible and more easily adopted by their competitors.

Finally, participants described the effects on jobs through loss and automation. Another media-focused talking point, these participants specifically focused on the effect of automating manual tasks with drones, self-driving machinery, or remotely operated equipment.

Learning about Ethics through the RPS

As a debriefing question was answered immediately after completing the RPS, participants were asked what they learned about ethics through the RPS and case study. For this portion, we chose specific quotes to highlight the range of reflections that our participants highlighted. The quotes highlighted here were edited for grammar and spelling with care to not change the quote's meaning. To provide some quantitative measures along the quotes, we use the following descriptors: “most” for over 85% of the participants, “many” for over 65%, “half” for around 50%, some for around 30%, and “few” for around 15%.

Firstly, many students outlined the complexity of agricultural systems and the ability of technology to disrupt the entire system.

> *“The Agriculture/Autonomous Farm role play activity taught me about the importance of ensuring the agricultural industry, which has largely been powered by the manual labor of farmers themselves, can prevent itself from being swept away by the emergence of new technology. With the rising use of automation in farming, a wealth gap between farmers, which is already extremely prominent, could widen itself even further as smaller, independent farmers are left behind with confusing, new technology. Ensuring inclusivity would be essential, and thus, a collective of farmers should join and have a say on what goes on their farms”* – Student 1

Through taking part in the activity and doing their own research in preparing to represent their assigned roles, participants were made aware of the ability of technology to aid but also complicate the ways of other systems. This is one of the primary reasons for using role-plays; they encourage reflection and learning in the new subject matter.

Following this idea of connecting AI and technology to interdisciplinary topics, some of our participants found and connected different ethical theories in a practical way.

> *"The agriculture case showed me that sometimes 'ethical' doesn't always mean 'fair.' I say this as AI and autonomous farming techniques pose great benefits to the entirety of humanity, even if that means that some smaller players will eventually fail to use them. I could say that 'ethical' is very case-based and sometimes a utilitarian theory is what works while in other times, it's completely the opposite of what people need."* – Student 2

This quote and other similar quotes identified the intricacies of applying ethics to different scenarios. Different values are at play with a group of diverse people and emerge through decisions in unique ways. Again, this is why role-play activities are useful; crafting roles that will bring different perspectives to the conversation highlights other ways of thinking and making sense of a similar situation. Some participants continued highlighting the community aspects at play when dealing with values and ethics.

> *"Ethics is performed not only by one person but by every single person who is in a group. If one person disagrees on a topic, being able to understand their point of view and letting yours be known is what leads to better understanding and better outcomes. Also, not letting one person take all control. Otherwise, they can take advantage of this and begin to disregard the other part that they are working with."* – Student 3

Autonomy for decision-making came up several times in analyzing the data, but this was a significant theme throughout the case and how participants resonated with this concept.

Finally, over half of our participants brought up the ability of technology to introduce and augment unintended and unwanted consequences.

> *"While AI offers diverse solutions and possibilities, it poses discrimination to those who may not be able to afford it like small farmers and minorities, which makes it easy for bigger companies to take advantage of the technology and advance in the market."* – Student 4

Reflections on the RPS case study and thinking forward

We have found role-play case studies to be an interactive and exciting way for students to explore nuanced topics on applied ethics. The role-plays allow students to work through the information provided through the topic resources and try to take the perspective of a role that may be consistent with or contrary to their opinion. They then talk with their peers, who are also doing this process, to negotiate a final decision – in this case, whether and how AI technology can support agricultural endeavors.

Through a brief survey given at the end of the course, students overwhelmingly highlighted the course's impact in introducing technology ethics to them and how the conversation affects them. The students noted that although they were aware of "problems," they had not considered these as ethical dilemmas until being exposed to them through the case and role-play.

> *"I found that this class taught me about a lot more kinds of ethical issues I had never thought about or experienced before. Many of the things I learned I would call problems already, but I didn't think of them as ethical issues, such as accessibility and inclusiveness. My definition of ethical issues expanded. Additionally, I never really thought about the fact that many new technological advancements would cause these types of ethical issues. I was aware of the Boeing case, or automation and AI putting people out of work, but I was surprised to see that there were layers of ethical issues beyond that."* – Student 5

Students also highlighted the connection between values, morals, and philosophy in an applied nature.

> *"This course brought to my attention a lot of different issues within the realm of technology and AI. I learned about so many problems I wasn't aware of before in so many different spheres of life and tech. This course taught me the importance of privacy as a human right and inclusivity and equality for all. I learned about the difference between ethics, as the philosophy behind and study of morality, and morals which are our society's ideas on what is good and bad. I learned about the importance of ethics and professionalism in the workplace. This course also taught me about different ideas of ethics from different philosophers and what they believed ethics to be. And finally, I was taught about human behavior within our tech-based world and the way in which morality and immorality manifest as well as ways we can encourage the former and deter the latter."* – Student 6

For instructors, there are some considerations to consider in implementing role-play case studies across different domains. First, the tone with which the case unfolds should be overall neutral, but implications should be real. The agriculture case was written with the idea that technology has affected agriculture in primarily positive ways. However, this is an assumption within the case and could be changed depending on the argument being made. For example, the "Future Farm Collective" was written to be an organization that is interested in buy-in from the community. The company itself could have been written as an organization that focused on the impact of money to buy its way into the community instead. This could perhaps have changed the scenario and the way students overwhelmingly responded. In other examples of this implementation, such as the Boeing Max case, students were more willing to shift the focus of malpractice and error toward the organization in charge and hold them accountable rather than what we see in this case [13], [14].

Second, each instructor will need to make and justify a process of individualization based on the students in the course. This course consisted of first- and second-year engineering and computing undergraduate students. The level of guidance they may need during the first few attempts at role-play may be more significant than if they were graduate or returning students. This can be further exacerbated if the course is conducted in a hybrid or online format.

Conclusion

In this paper, we present role-play scenarios as an activity to bridge student learning on real-world practices and challenges surrounding AI in non-technical spaces. The role-play activity was well responded to by the participants and provided them with a safe space to explore the ubiquitous nature of AI systems in an agricultural setting. Additionally, it allowed students to analyze topics from different perspectives and collaboratively work towards defining whether the technology should be used in the industry, how it could be introduced, and the limitations of both. The role-play activities also allowed students to reflect on their beliefs and discuss how their values would form in the scenarios described. Overall, participants found the role-playing aspect helpful in understanding the materials in the course.

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Appendix A – Full Case Study

Scenario/Case: Evaluating AI Ethics for Agriculture at Future Farm Collective (FFC)

Future Farm Collective (FFC) is a group of researchers, growers, technology experts, and businesses based in the Midwest. FFC is driven by the mission to "create the farm of the future, feed a growing world population, develop new opportunities for the community, and align organizations to evolving themes that will accelerate change." To work towards this mission, FFC has converged on a singular goal: to create the prototype for the first fully autonomous farm. The design and development of this autonomous farm will require the application of many novel technologies, including artificial intelligence (AI)-based systems. Unlike other technology and AI-based start-ups, FFC is not trying to improve a single technology or practice but instead make gains across many. By making advances across a range of agricultural practices, FFC hopes to create enough fidelity in the systems that, when it puts them all together, the overall effect will be substantial.

With support from the local and state governments, FFC has been able to acquire significant agricultural land to experiment with different technologies and crop varieties to find the best way to farm autonomously. Established in 2015, FFC took some time to ramp up, as autonomous farming is a complex undertaking that requires not just the use of automation technology, including devices, platforms, and services, but also associated scientific development for improving crop health and productivity. Consequently, projects currently underway at the FFC Test Site include soil health monitoring, uncrewed aerial systems, uncrewed ground systems, autonomous vehicle deployment, sensing and identification of plants, and precision spraying.

Since its inception, the progress of FFC has been closely monitored by the local farming community. News related to FFC in local newspapers, on television programs, or on social media has been read by locals with interest. This is not the first time that farmers in the area have seen an organization with a similar technology-driven agenda establish itself locally with the goal of improving agriculture practices, especially farming. Although farmers understand they have benefitted tremendously from technology over the years, they have recently become extremely circumspect of new digital technologies such as precision farming.

These concerns have largely been precipitated by a regular feature in a local daily on the impact of automating technologies and techniques on farming and farmers' livelihood. A recent editorial in the same paper also raised critical concerns about new AI-based technologies. According to the most recent article, the use of AI will allow companies to monitor and improve their machines automatically through an online connection, and the machines will learn from other machines on the same system to improve themselves and the services they provide, such as the recognition of pests in crops. AI will also assist with other automation tasks, such as maneuvering through a field for spraying pesticides.

The articles have been shared widely among farmers. In addition to the updates they provide, the articles have an additional appeal – interviews with local farming practitioners. In one of the articles, a local farmer who is well-respected in the community said that "with my

tractor, I could always fix something if it stopped working; with the new machines, I have no idea how they work or who controls them and the data." The use of videos in the reporting has made the concerns more poignant for the farmers, and a preponderance of both real and fake videos distributed online, especially through social media, has made the topic much more contentious. Another farmer was very disapproving of drones flying around his field, as he was unsure what images they were capturing and was shocked to see a laser cutter being used for automated weeding.

As part of their outreach function, extension personnel from FFC regularly visit farmers to learn from them and to educate them on their innovations. To scale up experimental work, FFC is stepping up its efforts to engage with farmers through extension efforts such as workshops and demonstrations so that it can introduce innovations in "real" fields. Although FFC can work with farmers in other geographical areas for scaling-up technology, it is important for FFC to have a presence and good relations with the adjoining community. After working with data and algorithms for a while, they realized that all agriculture is localized – even though techniques can work across regions, microclimate, and terrain specifications mean that, to test and develop a robust technology, they have to adapt it within a specific region and even on particular crops. Over the years, extension efforts by FFC members have been successful in getting them access to fields beyond their land and trying out their innovations in working farms. However, their relationship has become slightly contentious in recent months due to the reports in the local newspaper. In the spirit of open dialogue and in order to assuage the misgivings farmers might have about their technology and innovations, FFC has organized a panel discussion at the town hall and invited not just farmers but also community members and businesspersons to attend and ask questions.

This is the second such meeting that FFC has organized. The first time was primarily organized to introduce the FFC and build relationships with the community. Their goals at that time were to gain legitimacy, foster publicity to develop a respectable and trustworthy reputation, and help recruit expertise from neighboring areas. That meeting was a success; participants left excited, and, over the years, FFC members have continued participating in similar events and meetings, having realized that these efforts are necessary to continue building trust and credibility. The event tonight, though, was of a different scale and had much higher stakes. FFC was the primary organizer and to demonstrate that they had no hidden agenda and were open to feedback, FFC invited Sarah Ziegler, the local reporter who had been covering technology and agriculture for a local daily, to be the moderator for the town hall panel. Ziegler was an area resident and well-regarded in the community. Furthermore, her moderating ensured that the event would get media coverage. Inviting her was a no-brainer.

The decision on whom to invite as panelists, though, required more deliberation, and a consensus was harder to reach. Working in conjunction with Ziegler, FFC finally decided to invite the following participants:

1. **Taylor Jennings, CTO of a start-up called Self-Running Farms (SRF).** Taylor Jennings is an experienced engineer with a specialization in AI and Machine Learning. He has used data from the past decade to create an algorithm for dynamic network assignment across servers.

After running a start-up in Silicon Valley, he has moved to the Midwest to start SRF - a cyber-physical applications suite that he believes will convince farmers and others to invest in new technologies. He has compared the effort to that of other technology innovations in interdisciplinary fields, but instead of aiming for the stars, Taylor's effort is to make the lives of people on Earth better.

2. **Sylvia Bruno is an Agriculture Extension Coordinator at Soybean Farmers Group.** Sylvia Bruno has been working in the agricultural extension field for more than two decades, with her current job as an extension coordinator requiring her to bridge the gap between researchers and farmers. The extension job has changed over time, and her background in food science and tech-savvy has helped her to remain employed in the field. She now works with companies to train farmers on sustainable agriculture practices, which is essential for companies to be able to truthfully tell regulators and consumers about the origins of their food.
3. **Andrea Max is the Director of Civic Engagement. Andrea Max is the Director of Civic Engagement at a technology company that is dedicated to helping rural regions across the United States with economic growth and job creation.** She works to promote the company's technological infrastructure, products, and digital skills to help facilitate economic development and digital transformation in these areas. Her company has a vested interest in the success of these communities, as a technologically advanced workforce is essential for their own future.
4. **Kevin O'Brien is a Technology Evangelist for Agricell, a large global conglomerate operating across agriculture-related businesses.** Kevin O'Brien is a Technology Evangelist for Agricell, a global conglomerate focused on agriculture-related businesses. They are currently focusing on precision agriculture and are developing their own data-owning technologies. Kevin is a frequent participant in forums and events in the Midwest to share Agricell's work and discuss issues and solutions facing agriculture today. From his perspective, the FFC meeting is an opportunity to discuss concerns and work with other stakeholders to develop joint responses to the issues facing agriculture today.
5. **Colin McGregor is a concerned farmer. McGregor is wary of the use of AI and other advanced technologies in farming due to his limited profits and lack of legal training.** He is concerned about the privacy policies associated with data collection, the accuracy of AI-generated recommendations, and the potential for large corporate farms to increase their profits due to access to such technologies. He also does not have the time or funds to interpret the data collected by the machines, nor does he understand the decisions or actions made by the machines, and he worries that he will not be able to repair his own machines due to manufacturers' warranties.
6. **Darius Benson is a pecan farmer in Illinois and a representative for non-profit supporting Black farmers and their families.** Benson believes that AI and autonomous vehicles could greatly benefit his crop yields, but he is wary of working with the FFC due to the past discrimination and neglect of Black farmers by the USDA. He is open to collaborating with the FFC if there are tutorial and grant programs specifically designed to benefit minority and fledgling farmers.

To help the participants prepare for the panel, the following format and questions have been shared with the panelists in advance:

A. Do you think there is a role for AI-based technologies in agriculture? Why/why not? [1 minute]
B. From your perspective, do you anticipate ethical concerns arising from the use of AI-based technologies in agriculture? Why/why not? Give examples. [2 minutes]
C. Our local community has seen a net population loss over the past decade. Will more technology lead to job loss and more reliance on transient labor? [2 minutes]
D. Once AI-based technologies take over all farming, would there be any role for farmers? [2 minutes]
E. If a given technology makes it easy to grow a specific crop, and that is what is profitable, will we all start growing that without any regard for what else is needed? [2 minutes]
F. What advice will you give, as a group, to FFC on how to proceed with the implementation of technologies in an ethical manner?

Appendix B – Question 2 Analysis Codebook

Category	Codes	Example
Overall Financial and Productivity Gain	"Work better," "More Efficient," "Financial sense."	"As a group, we basically concluded that there is a role for AI-based technologies in agriculture. Criteria that were considered were productivity, efficiency, and effectiveness."
Farmer Autonomy and Community Values	"Protecting farmers," "Farmer autonomy," "community values."	"The group agreed that there needs to be proper procedures in place to ensure that the farmer still feels in control while implementing more technology and AI into the agricultural business."
Transparency between Organization and Community	"Communication," "Transparency," "informed decisions"	"Our group decided that AI-based farming technologies need to be introduced slowly, and the companies behind them must ensure that farmers perceive any arrangements with them as partnerships, working toward mutual profit. It clear that farmers are feeling exploited by tech companies, and even a small amount of resources allocated to outreach programs for educating farmers on AI-based farming technologies would go a long way toward achieving this perception."
Effects of Automation and Job Loss	"Automation," "job loss."	"We reached to decision where we all realized that technology is important for agriculture, but we also need to keep in mind for the local farmers as they might lose certain job positions, so the best decision we came up with is for to open up more job positions for farmers so that they can collect data from the technology they are using."
Governmental Regulations & Protections	"Government regulations," "local regulations," "data protections," "programs for inclusion and accessibility"	"The decision that our group reached following the discussion was that everyone was open to the implementation of these new AI technologies. However, each person wanted checks and balances to be implemented before completely agreeing and saying yes to these technologies."

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