Artificial Intelligence in Agriculture: Reinforcement Learning for Irrigation

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Abstract

With the world populations increasing with such a rapid rate, food crisis is one of the major concerns to the current world. And the major source to food is agriculture. Making agriculture precise, efficient and sustainable would be one of the most significant steps in the prevention of this upcoming crisis. To promote profitable precise and sustainable agriculture with the help of artificial intelligence, we propose a project to create a decision support system for farmers. The system predicts profitable crops in the near future, and integrates with irrigation system to provide optimum water and fertilizer use. Using current literature, we identified viable parameters, artificial intelligence models, and limitations for such a system. Based on these insights, we built a prototype for our system that uses most valuable parameters and successful models to provide optimal information. Research design and evaluation system was also proposed to test and improve such a system.

Keywords— Agriculture, Reinforcement Learning, AI, Drip Irrigation

1 Introduction

1.1 Domain

The project revolves around the idea of Sustainable, Precise and Profitable agriculture.

1.2 Context

In agriculture, a farmer takes multiple key decisions every year, and during every crop cycle. Some of these decisions are as follows: choosing the right crops; choosing the right amount of fertilizers; deciding the amount of water needed

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for irrigation; and choosing relevant farming techniques.

However, these decisions are not always optimal. In many developing nations, like India, there is: distorted cropping pattern that ignores protein and vitamin rich crops; excess use of costly fertilizers; low agricultural yield; and wastage of freshwater on water hungry crops such as sugarcane in arid regions. This leads to increased cost of farming, indebtedness, poor nutrition in food, groundwater depletion, damage to soil health, and in extreme cases, farmer suicide. At a global level, every year, agriculture consumes 70 percent of freshwater resources and contributes about 10 percent of greenhouse gas emissions.

In this context, Artificial Intelligence can help cut down the costs of farming and guide the farmer towards profitable, precise and sustainable agriculture.

1.3 Task

The goal of this project is to create a data-based decision support system for the farmer, that aims to combine profit and sustainability. This system will derive insights from factors such as: soil parameters, groundwater levels, farmer's budget, agricultural land area, weather, commodity prices, government subsidy and so on.

Using these insights, the system will predict and suggest the following: most sustainable and profitable crop for the next season; the amount and type of fertilizer needed to maintain desired soil health for future; and desired amount of water to maintain optimal soil moisture in the field. In terms of information, the system can inform the farmer about likely pests, diseases and weeds to be expected in that region, for the suggested crop. Although the system won't suggest the optimal farming technique, it will certainly make it easier to decide the most suitable one.

This way the farmer will grow the crops in demand, while using her resources sustainably. She can further increase her profits by connecting the system to efficient farming techniques such as drip irrigation system. Thereby saving more money, time and groundwater resources.

In the long run, this approach will significantly reduce freshwater consumption and Green House Gas emissions due to agriculture, and thereby guiding humanity to a more sustainable future

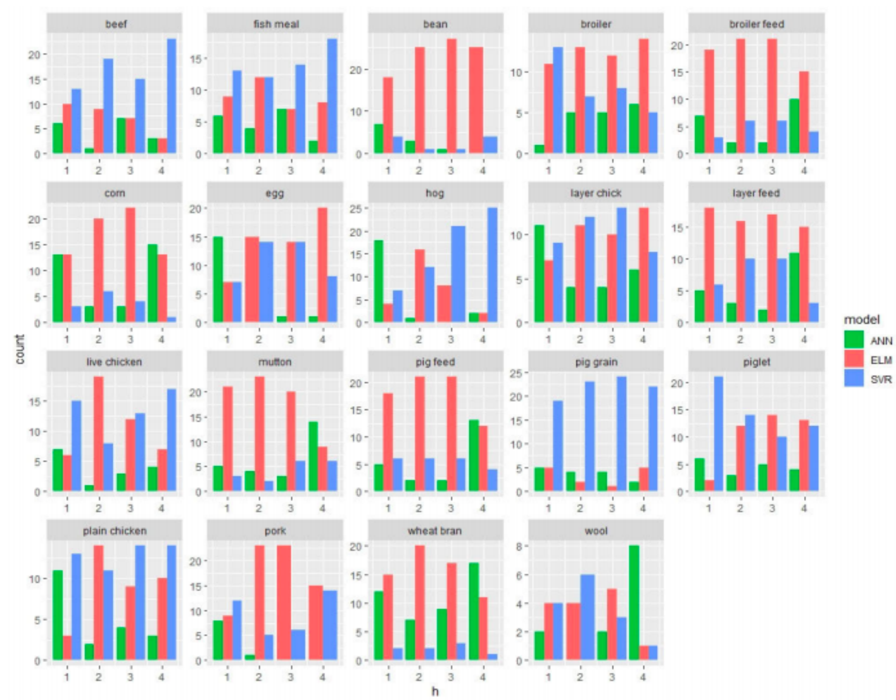

FIGURE 5. Facet plots of the optimal model selected at different horizons for different commodities.

Figure 1: Effectiveness of various models in predicting price for various crops

(causing plants to die) by mistakes as its knowledge will technically be zero at the beginning and moreover, would take a long time to be prepared.

When at action, the sensors will collect readings of the relative humidity, air temperature, sunshine hours (accounting solar radiation as well), precipitation and wind speed which will be sent as input into the system. This is where the AI will use the knowledge it has gained through RL and process the information inputted, evaluate (using reasoning and what it has learned through the simulation in RL) and decide which area of the field needs to watered, when or how much and simultaneously control the drip-irrigation systems to supply water accordingly through the drippers.

The AI system will also keep learning every day from its own actions. But for that, the farmer will have to input the results; like how did the crops turn out to be, were they getting enough water, or more water delivered; into the system so it understands its mistakes, trying to avoid those and will understand which steps were right during which conditions and, try to replicate those in the future. This will be making our AI more experienced and improve its performance as time proceeds. There might be a connection between the app the system so that the farmer can input the results directly there, otherwise he might have to input in the system itself. The use, proper training and installation of this project is expected to lower the usage of unnecessary water and maintain crops quality as well, thus bringing stability in the farmer's production as well as the sustainable use of water in the irrigation process, optimizing the agricultural output as well.

5 Evaluation

5.1 AI controlled irrigation in simulator and on field

Our AI irrigation system will undergo two evaluations, both internal and external. The main idea is to ensure the good quality of the crops by providing proper irrigation. So the dependent variables here, except the final reward, are the amount of water to be supplied and the times of watering; which are dependent on the input taken from the different sensors (humidity, air temperature, sunshine hours, precipitation and wind speed), the independent variables. Pests or technical problems in other stages of the agricultural production could be the possible confounding variable in the external evaluation which might affect the final results by damaging the crops. Experts or farmers with knowledge about crops and irrigation of a specific place needs to be involved in both the evaluating stages.

The internal evaluation will take place in the simulator. The RL itself is an evaluation as the results are evaluated after each trial and the system is updated. Yet, we do a final evaluation by creating a range of probable environments by

Research protocol that we will follow for our evaluation:

Research question - Is it possible to to predict commodity prices and soil health in the future, and suggest farmer best crop and fertiliser in his situation.

Hypothesis - Machine learning and Neural network led systems lead to better results in profit and farming sustainability as compared to just providing the farmer information.

Experimental and control condition - Half the farmers are given the Ai system, and other half is given information only.

Independent variable - Availability of a system to the farmer.

Dependent variable - Their profits and sustainability of soil

Subject or participants - Middle income farmers who have limited budget and not growing crops in a sustainable way with average profits.

Removing possible confounding variables - Variables that may affect the experiment but do not have any relevance to the experiment. May be the monsoon or the weather suddenly changed or there was a global crisis in the suggested crops. Sudden epidemic like Locust disrupted the crops.

6 Conclusion

With the help artificial intelligence, we hope to provide farmer with an accurate picture of the future. With right information on crop prices, water and fertiliser usage, we expect the farmer to practice profitable and sustainable agriculture. The system only provides numbers to the farmer, but it is up to the farmer what to do with it. Because in the end, humans must make their own choices.

7 References

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