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REVIEW ARTICLE

FIRM AUTOMATION: A REINFORCEMENT LEARNING APPROACH

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ARTICLE DETAILS

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ABSTRACT

In most automation, we use ANN or RNN based algorithms. This results well but the prior information is what actions were previously taken by a human, this cannot be the only measure of learning a process we know humans learn everything with experience. And the most appropriate algorithm to learn like a human is Reinforcement Learning.

KEYWORDS

Computerized Farm, Reinforcement Learning, Computation Creativity, Art Learning, AI in Agriculture.

1. INTRODUCTION

Agriculture is the base of our economy but in innovation and use of modern technology has not progressed much. Cost is a major factor in it. But now the reach of low cost data plans and reach of high speed connectivity with smartphones can make huge progress in this sector (Balaji, S., and Ganapathy, K., 2019).

We can build low cost data collection and controlling devices and deploy them in the fields to take control of every action from controlling the pumps to spraying fertilizers and pesticides and we can provide notifications about the best possible course of action in real-time (Ashish, T., and Balaraman, R., 2019).

And the huge collection of data has other applications like better weather prediction, advance alert on food shortage (In case of droughts), etc.

2. BACKGROUND

The technologies and terms we need to understand are:

2.1 Client-Server

All data is collected from the fields and used to predict and control devices.

2.2 RNN (Recurrent Neural Network)

This algorithm uses not only the current data to predict but also use some previous actions to predict.

Mostly used in weather prediction.

2.3 Reinforcement Learning

This is a kind of algorithm which learns from feedback from the environment (Garychl., 2018).

2.4 CNN (Convolutional Neural Network)

is a type of neural network used on images to regress or classified.

2.5 2D Convolutional Network (layer)

Used for data augmentation. This layer imitates a human vision. It is very efficient compared to a dense layer, not operating the whole image at a time it operates on a local region; it scans a part of the whole image at a time. It reduces the parameter size drastically (known as Kernel size)

Ex: Conv2D(Filters, KernelSize, ActivationAlgorithm, InputShape)

2.6 2D MaxPooling (layer)

It is a vector to scalar transformation that operates on each local region of an image, like convolutions do, however, unlike convolutions, they do not have filters and do not compute dot products with the local region, instead they compute the average of the pixels in the region (Average Pooling) or picks the pixel with the highest intensity and discards the rest (Max Pooling). It reduces the image pixel count.

2.7 Flatten (layer)

It transforms the 2D Network to a 1D Network.

2.8 Dense (layer)

It's simply an ANN layer where all nodes of the previous layer are connected to the next layer.

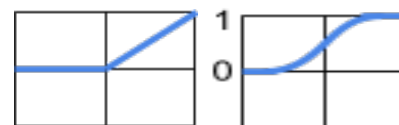
2.9 Embedding (layer)

It is a RNN layer used to include current data in the prediction process.

2.10 GRU (layer)

It is a RNN layer which includes previous states in the prediction process.

2.11 Activation Function



Relu

Sigmoid

Quick Response Code



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Website:
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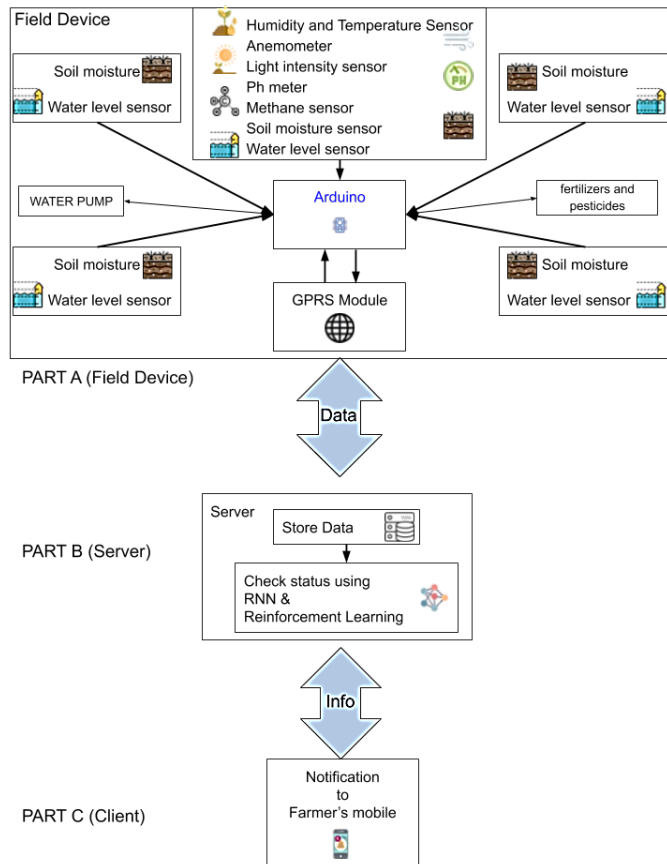
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There are some special functions that can help produce categorical results by adding them at the end of a Neuron.

2.12 Transfer Learning

When a previously trained network is retrained by adding new layers to fine-tune or make a network flexible.

3. WORKFLOW DIAGRAM



4. DATABANK

Data is collected from the field using many sensors attached with a monitoring device in the field

Part-A in the diagram has 7 sensors

- 5, 0.5 meter soil moisture sensors.
- 5, 1.5 meter water level sensor.
- 1 humidity and temperature sensor.
- 1 anemometer
- 1 light intensity sensor to detect clouds.
- 1 ph sensor
- 1 methane sensor

All of this data with some others provided by the users using their APP

- Soil type.
- Damage to growing crops (Picture to get suggestions)
- Location (GPS)

Is sent to the server. To further process.

5. PREDICTION

This is the most important step of all, done on the Part-B of the diagram. It has 4 type of Networks mentioned below:

5.1 Weather Prediction

This is done based on 4 data collected from the field namely -

1. Humidity
2. Temperature
3. wind speed (anemometer)
4. light intensity (cloud density)

Two algorithms are mixed together a RNN with a reinforcement learning layer on the top.

5.2 Crop Health

This can be done using CNN algorithm on the data sent by users (Picture of growing crop) using their smartphones.

It will produce categorical data of any fungus or other infection report (Different crops has different Networks)

For example we made a model that can take 240/240 images and can check 5 different types of diseases of plants. We made different networks for different types of plants (Crop) In the model last layer with output shape dense and 5 neurons with sigmoid activation function to produce categorical output about a disease.

Layer (type)	Output Shape	Param
conv2d_12 (Conv2D)	(None, 238, 238, 32)	320
Max_pooling2d_8	(None, 119, 119, 32)	0
conv2d_13 (Conv2D)	(None, 117, 117, 64)	18496
max_pooling2d_9	(None, 58, 58, 64)	0
conv2d_14 (Conv2D)	(None, 56, 56, 64)	36928
flatten_4 (Flatten)	(None, 200704)	0
dense_8 (Dense)	(None, 64)	12845120
dense_9 (Dense)	(None, 5)	325

Total params: 12,901,189

Trainable params: 12,901,189

Non-trainable params: 0

Next we can use Reinforcement Learning throughout when it is deployed and it can correct itself and learn to produce more accurate results. So it provides flexibility. On the other hand if we add one extra dense layer (Transfer learning) it can make more progress but takes more time to make acceptable results (Shivaram, K., et al., 2007). So we have to choose which procedure we want to follow depending on the requirement, but if we have lots of data available we must go for the latter option.

5.3 Device Control Network

The field devices like Water Pump, Water Sprinkler, Fertilizer and Pesticide Sprayer, etc. are controlled by a Reinforcement Learning algorithm. This can make decisions like a human would do in any situation. The attributes taken as input: (Different crops has different Networks)

- Water pump
 - a) Water level
 - b) Temperature
 - c) Day count for next rain predicted
 - d) Humidity
 - e) Wind Speed

Example model for controlling Water Pump

Layer (type)	Output Shape	Param
Dense	(None, 10)	60
Dense	(None, 12)	132
Dense	(None, 8)	104
Dense	(None, 1)	9

Total params: 305

Trainable params: 305

Non-trainable params: 0

Now as previous Reinforcement Learning with a new layer (transfer learning) can help increasing the accuracy significantly (Dimitri, B., 2019).

- Fertilizer
 - a) Water level
 - b) Day count for next rain predicted
 - c) Soil moisture
 - d) Soil Color
 - e) Water permeability
- Pesticide
 - a) Wind speed
 - b) Day count for next rain predicted
 - c) Crop health
 - d) Crop age
 - e) Soil Type

5.4 Harvest Time Prediction

This is done in using the following inputs (Different crops have different Networks):

- Crop age
- Day count for next rain predicted
- Day count for next high wind speed
- Crop health
- Market Demand

This data is sent to the user's smartphone as notification.

6. EXTRA DEVICE

Extra helping devices can be used to get better results like: drones can be used to monitor working of every device, monitor crop health, spray fertilizer, pesticide. better with more experience. But the disadvantage is it needs more time to learn than other algorithms, like a human needs more time and they need expert help in the process.

And the system also needs a centralized data server, if everyone tries to implement it and make their own data collection and prediction it cannot work in proper manner.

7. CONCLUSION

The whole system can help increase production with minimum possible cost. And the system will work

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