International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-4, Issue-9)

Research Article **September 2015**

An Approach for Artificial Intelligence Applied to Agriculture

Damodar Padubidri Bhat
Bachelor of Engineering (2014)
Department of Electronics and Communication Engineering
Sri Jayachamarajendra College of Engineering, Mysore, Karnataka, India

Abstract—

Artificial Intelligence (AI) is a field that studies the synthesis and analysis of computational agents that act intelligently. A system fed with quality data is considered to be intelligent. Agriculture is facing great problem mainly in production, transportation and knowledge about demand of particular crops. The study about this field clearly draws insight that, agriculture is lacking the system or solution which would enable it to attain solutions for the chronic problems. This paper speaks about the problems noticed and the probable solution through Artificial Intelligence. Also, highlights the architecture of knowledge based AI system.

Keywords—Artificial Intelligence(AI), Probability, Database, Agriculture, Statistics.

I. INTRODUCTION

Although Artificial Intelligence is a new field of explore or research, its existence hails to the time of World War II when, Alan Turing designed a machine which decode, the Enigma code of the Germans, thus savings millions of lives. His paper "The Imitation Game" speaks of the machine, intelligent enough to come up with solutions to address human problems. AI is branch of computer science and Statistics that is purely based on data and its organization. AI when applied to agriculture can address many issues as the field of agriculture is collection of data about crops, its yields, market share, transportation, implementation of technology etc. Few of the keys issues to address are

1) Methodology to increase productivity.
2) Improve soil health.
3) Predict Market for crops and the location.
4) Overcome the issue of transportation.
5) Storage availability for produce.
6) Real time data about produce availability and location.

Artificial Intelligence System Model.

Real-Time data processing using data gathering algorithms is employed in the model. The data available can be harnessed using algorithms to address complex problems and also arrive at solutions. In order to get data about the current availability and demand of the produce, a system must be employed which enables us to understand the requirements and location of the availability. Data gathering algorithms can be used to collect data related to various sections of the agriculture and its diversities.

Data collection from a set of sensors to a common sink over a tree-based routing topology is a fundamental traffic pattern in wireless sensor networks (WSNs). This many-to-one communication paradigm in which data flows from many nodes to a single node is known as "convergecast". One may view convergecast as opposite to broadcast or multicast in which data flows from a single node to a set of nodes in the network. Fig. 1 shows a simple example that illustrates the characteristics of a typical broadcast and convergecast. In a broadcast, as shown in Fig. 1(a), node 's' is the message source and nodes a, b, and c are expected recipients. Node 'a' hears the message directly from 's' and forwards a copy to nodes 'b' and 'c'. In case of a convergecast, as shown in Fig. 1(b), nodes 'a', 'b', and 'c' each has a message destined to the sink node 's', and 'a' serves as a relay for 'b' and 'c'.

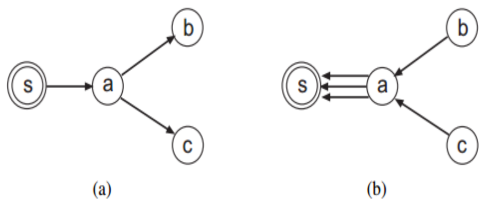

Fig.1 (a) Broadcast - data flows from a single node s to a set of nodes a, b, c. (b) Convergecast - data flows from nodes a, b, and c to a single node s.

Once data is collected at the sink, it can either be recorded and stored for future analysis, or can be processed immediately to take certain actions depending on application requirements. This technique can be used to develop an algorithm which can collect data about agriculture. Certain additional methods are have to collaborated with the algorithm to get desired result are,

1) Traditional data collection techniques.
2) Frequency of requests to attend a particular need.
3) Analyzing past updates or information.
4) Probability and its tool to predict the occurrence of a need.

A cloud system will enable efficient data management, processing and enables user to derive solutions locally. Cloud as a service model will be efficient in the process. Artificial Intelligence as a platform is best suited to address the problems mentioned above as it is compatible with any kind of database, user friendly, can be designed to meet user requirements.

II. METHODOLOGY

ARCHITECTURE FOR AI SYSTEM.

The system proposed further in the paper is knowledge based system. Unlike Newell and Simon, John McCarthy felt that machines did not need to simulate human thought, but should instead try to find the essence of abstract reasoning and problem solving, regardless of whether people used the same algorithms.

The architecture mainly consists of four elements.

1. Data collection &organization
2. Probabilistic methods for Uncertain Reasoning.
3. Search and Optimization.
4. Statistical Tools and Logic

1. Data Collection and Organizer.

As discussed earlier, data can be collected using data gathering algorithms. To address the issues of agriculture, basically we have fields related to soil health, transportation, demand for particular crop etc. To illustrate the scenario, consider an agro based area related to cotton plantation. Data related to it can be,

1.1 Moisture required for best field.
1.2 Transportation availability to send produce to market.
1.3 Demand for cotton in the coming season.
1.4 Location for best marketing.

When data collected, is organized accordingly in sections related to various attributes, the data interpreter and data updater can easily adapt to the operations. Data collector generally is microchips, service request tools, traditional data collection etc.

2. Probabilistic methods for uncertain reasoning.

Most tasks requiring intelligent behavior have some degree of uncertainty associated with them. The type of uncertainty that can occur in knowledge-based systems may be caused by problems with the data. For example:

a. Data might be missing or unavailable. (I.e. crop yield data, type of crop, location etc.)
b. Data might be present but unreliable or ambiguous due to measurement errors. (No standards of measurement are employed, resulting in inaccurate data.)
c. The representation of the data may be imprecise or inconsistent. (Tools used for representation are not user friendly and easily understood)
d. Data may just be user's best guess.
e. Data may be based on defaults and the defaults may have exceptions. (Constant assumption without considering constraints like weather, seed availability etc.)

We will introduce three ways of handling uncertainty:

1 Probabilistic reasoning.
2 Certainty factors
3 Dempster-Shafer Theory

3. Classical Probability.

The oldest and best defined technique for managing uncertainty is based on classical probability theory. Let us start to review it by introducing some terms.

Sample space: Consider an experiment whose outcome is not predictable with certainty in advance. However, although the outcome of the experiment will not be known in advance, let us suppose that the set of all possible outcomes is known. This set of all possible outcomes of an experiment is known as the *sample space* of the experiment and denoted by *S*.

1.1 For example: If the outcome of an experiment consists in the determination of the sex of a newborn child, thenS = {g, b}where the outcome *g* means that the child is a girl and *b* that it is a boy.
1.2 If the experiment consists of flipping two coins, then the sample space consists of the following four points:

S = {(H, H), (H, T), (T, H), (T, T)}

1.3 Event: any subset *E* of the sample space is known as anevent.

That is, an event is a set consisting of possible outcomes of the experiment. If the outcome of the experiment is contained in E, then we say that E has occurred.

For example, if E = {(H, H), {H, T)}, then E is the event that a head appears on the first coin. For any event E we define the new event E', referred to as the complement of E, to consist of all points in the sample space S that are not in E.

1.4 Mutually exclusive events: A set of events E_1, E_2, ..., E_n in a sample space S, are called mutually exclusive events if $E_i \cap E_j = \emptyset$, $i \neq j$, $1 \leq i, j \leq n$.

A formal theory of probability can be made using three axioms:

1.4.1 $0 \leq P(E) \leq 1$.

1.4.2 $\sum_i P(E_i) = 1$ (or P(S) = 1)

This axiom states that the sum of all events which do not affect each other, called mutually exclusive events, is 1.

As a corollary of this axiom:

$P(E_i) + P(E_i') = 1$, where E_i' is the complement of event E_i.

1.4.3 $P(E_1 \cup E_2) = P(E_1) + P(E_2)$, where E_1 and E_2 are mutually exclusive events. In general, this is also true.

1.5 Conditional Probabilities:

1.5.1 The probability of an event A, given B occurred, is called a conditional probability and indicated by P(A | B)

1.5.2 Multiplicative Law of probability for two events is then defined as, $P(A \cap B) = P(A \mid B) P(B)$. Which is equivalent to the following $P(A \cap B) = P(B \mid A) P(A)$

1.5.3

4. Certainty factors:

Certainty factor is another method of dealing with uncertainty. This method was originally developed for the MYCIN system.One of the difficulties with Bayesian method is that there are too many probabilities required. Most of them could be unknown. The problem gets very bad when there are many pieces of evidence. For the case of a posterior hypothesis that relies on evidence, E, $P(H \mid E) = 1 - P(H' \mid E)$.

5. Dempster-Shafer Theory:

Here we discuss another method for handling uncertainty. It is called Dempster-Shafer theory. It is evolved during the 1960s and 1970s through the efforts of Arthur Dempster and one of his students, Glenn Shafer. This theory was designed as a mathematical theory of evidence.The development of the theory has been motivated by the observation that probability theory is not able to distinguish between uncertainty and ignorance owing to incomplete information.

3.1 Mass Functions and Ignorance: In Bayesian theory, the posterior probability changes as evidence is acquired. Likewise in Dempster-Shafer theory, the belief in evidence may vary.It is customary in Dempster-Shafer theory to think about the degree of belief in evidence as analogous to the mass of a physical object.That is, the mass of evidence supports a belief.The reason for the analogy with an object of mass is to consider belief as a quantity that can move around, be split up, and combined. A fundamental difference between Dempster-Shafer theory and probability theory is the treatment of ignorance. Probability theory must distribute an equal amount of probability even in ignorance. For example, if you have no prior knowledge, then you must assume the probability P of each possibility is P = (1/N) where N is the number of possibilities. E.g., The formula P(H) + P(H') = 1 must be enforced.

The Dempster-Shafer theory does not force belief to be assigned to ignorance or refutation of a hypothesis. The mass is assigned only to those subsets of the environment to which you wish to assign belief.

6. Search and Optimization.

Many problems in AI can be solved in theory by intelligently searching through many possible solutions. Reasoning can be reduced to performing a search. For example, logical proof can be viewed as searching for a path that leads from premises to conclusions, where each step is the application of an inference rule. Planning algorithms search through trees of goals and sub goals, attempting to find a path to a target goal, a process called means-ends analysis. Robotics algorithms for moving limbs and grasping objects use local searches in configuration space. Many learning algorithms use search algorithms based on optimization. Search speed can be improved by using in-memory database where in the data is stored in the primary memory and the retrieval is very fast. Example for in-memory database is SAP-High-Performance Analytic Appliance (HANA).

7. Statistical Tools and Logic.

Statistical tools like bar-graph, line representation can be used to represent the system behavior relating to various attributes of agriculture. Few representative images are shown below. The line graph in Fig.2 depicts the *Yearly Produce vs. Loss in Produce (Cotton& Paddy)* from 2010 to 2014. This representation can help analyze the losses faced. The data representations can indicate the measures that should be taken to reduce the losses and thus improve the productivity. Improved data representations can display the causes of the losses with the corresponding mathematical data.

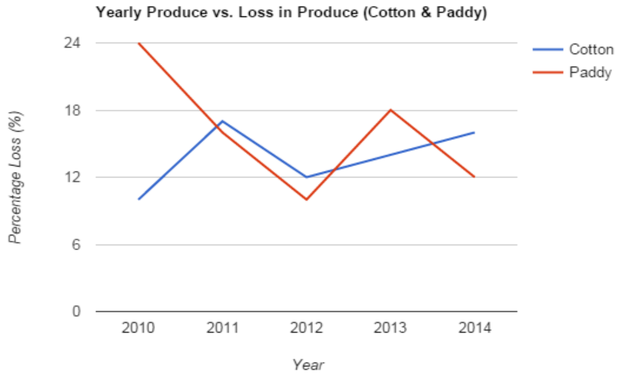

Fig.2Yearly Produce vs. Loss in Produce (Cotton& Paddy)

The figureFig.3 represents the *transportation needed in certain areas of Cotton& Paddy producing states*. This information is derived on the right time can be useful to arrange appropriate transport facility and hence meeting the deadlines of the business. The mass transport systems like train and waterways can be arranged accordingly for season crops and its easy transport. It is a win-win situation for both the agro producer and the transporter.

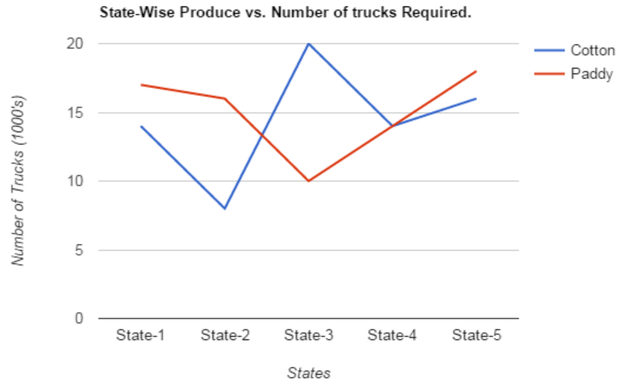

Fig.3State-wise Produce vs. Number of Trucks required.

The figure Fig.4 shows the *availability of resources(Cotton & Paddy) in a particular location* at a given instant of time. This information is derived by efficient search algorithms and data representation tools. Fig.4 represents instant data report generated through algorithms for resource availability. The availability is resources, helps to control the import of goods at a higher currency exchange and also improving the sale locally.

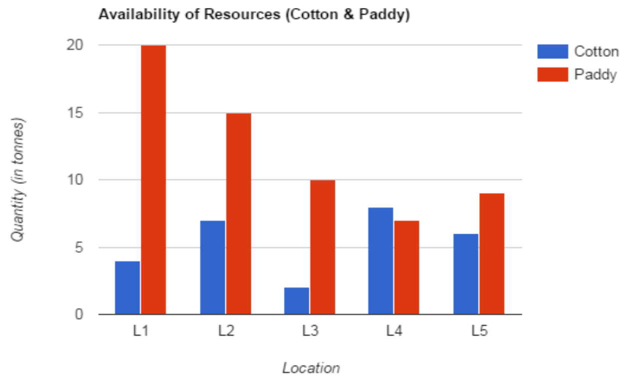

Fig.4 Availability of Resources (Cotton & Paddy) in different locations.

III. ADVANTAGES OF AI IN AGRICULTURE

The advantages of using AI are numerous and well documented. Some of them include:

1. The ability to use sires of superior genetic merit (the best bulls of the breed).
2. Improving production by carrying out *soil health tests*.
3. The ability to sell produce at the right time.
4. Reducing the *amount of fertilizer* used by checking chemical composition of the soil.
5. Knowledge about the drop in *crop prices* will help to shift from one crop to another.
6. Control import of goods by knowing the local availability of the goods and the quantity.

IV. CONCLUSION

The artificial intelligence (AI) methodology discussed addresses knowledge based system (i.e., the moving of functional and useful *agricultural models* that are developed to predict the needs of attributes based on the outputs of Algorithms

ISSN: 2278-9359 (Volume-4, Issue-9)

and Statistical tools). In particular, it addresses one of the major difficulties within this area, namely, retrieving data such as *availability of resources, location and also providing user friendlydata representations* as shown in the figure. The data representations can enable the user to employ quick measures to increase his productivity and reduce the losses. This knowledge based system would be a technological solution to the field of agriculture for the chronic problems mentioned above.

REFERENCES

[1] Carnegie Mellon University-Research Showcase, Department of Electrical and Computer Engineering, Combining artificial intelligence and optimization in engineering design.

[2] MIT COMPUTER SCIENCE AND ARTIFICIAL INTELLIGENCE LABORATORY, PRECISION AGRICULTURE: SUSTAINABLE FARMING IN THE AGE OF ROBOTICS. April, 2009.

[3] AN ENERGY-EFFICIENT DEADLINE-BASED DATA GATHERING ALGORITHM IN HIERARCHICAL WSN WITH MOBILE SINK by FARZAD TASHTARIAN, MOHAMMAD HOSSEIN YAGHMAEE MOGHADDAM ,Department of Computer Engineering, Ferdowsi University of Mashhad, Mashhad, Iran.SOHRAB EFFATI, Department of Mathematics, Ferdowsi University of Mashhad, Mashhad, Iran.

[4] Scheduling Algorithms for Tree-Based Data Collection in Wireless Sensor Networks by OzlemDurmazIncel and AmitabhaGhosh and BhaskarKrishnamachari

[5] Efficient algorithms for maximum lifetime data gathering and aggregation in wireless sensor networks by KonstantinosKalpakis, KoustuvDasgupta and ParagNamjoshi.

[6] AN ARTIFICIAL INTELLIGENCE METHODOLOGY FOR THE ADAPTATION OF AGRICULTURAL MODELS by Gianni Jacucci, Mark Foy and Carl Uhrik.

