Implementation of Artificial Bee Colony (ABC) Algorithm On Garlic Expert Advisory System

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Abstract:

This paper deals with the development of garlic expert systems, designed using one of the evolutionary algorithms, to advice the farmers in villages through online. An expert system is a computer program that simulates the judgments and behavior of a human or an organization that has expert knowledge and experience in a particular field. The knowledge base of this system is containing accumulated experience and a set of rules for applying the knowledge base to each particular situation. Here one of the evolutionary algorithms (ABC Algorithm) is considered to find a good match of symptoms in the knowledge base. Artificial Bee Colony (ABC) Algorithm[1] is one of the mostly used Evolutionary Algorithms. In the present system, Artificial Bee Colony[1] (ABC) algorithm is used to develop a new 'Garlic Expert Advisory System. This system is mainly aimed to identify the diseases and disease management in garlic crop production to advise the farmers in the villages to obtain standardized yields. This advisory system is designed by using Java Server Pages (JSP) as front end and MYSQL as backend.

Key words: Expert Systems, Evolutionary Algorithms, ABC Algorithm, Garlic Crop, Java Server Pages (JSP) and MYSQL.

1. Introduction:

Expert systems can be defined as a tool for information generation from knowledge. Expert System (ES) implementations automatically perform tasks for which specially trained or talented people required. Expert systems are most common in a specific problem domain, traditional application and subfield of artificial intelligence. A wide variety of methods can be used to study the performance of an expert system. An expert system is typically composed of at least three primary components. These are: 1. the inference engine, 2. the knowledge base, and 3. the working memory. The inference engine is the main processing element of the expert system. The inference engine chooses rules from the agenda to fire. If there are no rules on the agenda, the inference engine must obtain information from the user in order to add more rules to the agenda. Knowledge base is a collection of rules or other information structures derived from the human experts. Rules are typically structured as If / Then statements. Working memory contains the data that is received from the user during the expert system session. Values in working memory are used to evaluate antecedents in the knowledge base. Consequents from rules in the knowledge base may create new values in working memory, updates old values, or removes existing values.

1.1Introduction to Garlic:

Garlic is one of the most commonly used vegetables in India. Garlic is also known as Lassan and its botanical name is Allium sativa Linn. It belongs to the Lilliaceae family and is known by several many names in different parts of India. Its Sanskrit name is Lashuna. Garlic is called as Velluri in Telugu. Even though garlic is cultivated in all over India but the states Rajasthan, Karnataka, Tamil Nadu, Maharashtra and Bihar are the premium producers of Garlic in India. There are about six popular varieties in garlic. Garlic has germanium in it. Germanium is an anti-cancer agent, and garlic has more of it than any other herb. Another benefit of garlic is it helps regulate the body's blood pressure. So whether you have problems with low or high blood pressure, garlic can help equalize it. In addition to all these health benefits, garlic is packed with vitamins and nutrients. Some of these include protein, potassium, Vitamins A, B, B2 and C, Calcium, Zinc and many others.

The diseases found in garlic crop are White Rot, Basal Rot, Pink Rot, Botrytis, Fusarium, Pencillium Molds and Garlic Rust. Some of the insects observed in the garlic crop are, armyworms, wireworms, Nematodes etc.

1.2. Evolutionary Algorithms:

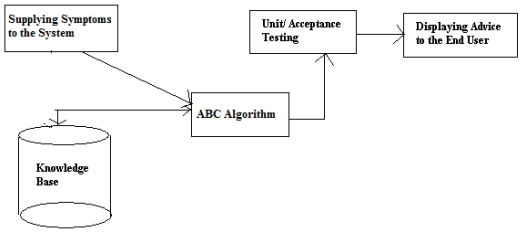
An evolutionary algorithm (EA) is a generic and population-based metaheuristic optimization algorithm. An EA uses some mechanisms inspired by biological evolution: reproduction, mutation, recombination, and selection. Evolution of the population then takes place after the repeated application of the above operators. Evolutionary algorithms often perform well approximating solutions to all types of problems, because they ideally do not make any assumptions about the underlying fitness in fields as diverse as engineering, art, biology, economics, marketing, genetics, operations research, robotics, social sciences, physics, politics and chemistry.

1.3. ABC Algorithm:

Several approaches have been proposed to model the specific intelligent behaviors of honey bee swarms. Artificial Bee Colony (ABC)[1] is a relatively new member of swarm intelligence. Karaboga has described the Artificial Bee Colony (ABC) algorithm based on the foraging behavior of honey bees for numerical optimization problems. Optimization problems depend on a number of parameters and the choice of these parameters affects the performance of the algorithm. In the ABC algorithm, the colony of artificial bees contains three groups of bees: employed bees, onlookers and scouts. Many meta-heuristic algorithms, inspired from nature, are efficient in solving numerical optimization problems. Improvements to the performance of the algorithm and a hybrid version of the algorithm also been proposed. This algorithm is good at solving unimodal and multimodal numerical optimization problems. It is very simple and flexible when compared to the other Swarm Based algorithms such as Particle Swarm Optimization (PSO). It does not require external parameters like mutation and crossover rates, which are hard to determine in prior. It combines local search methods with global search methods and tries to attain a balance between exploration and exploitation. Researchers have come up with several real-world applications for the ABC algorithm.

2. Proposed System:

. The present system mainly consists of two parts. They are: i). Information System, ii) Expert System. The proposed Architecture is as follows:



i). Information System:

In this information system the user can get all the static information about the garlic crop and its cultivation details. This system provides the data regarding the history of garlic, varieties in garlic and the cultivating areas and the seasons of cultivation for garlic and the mostly observed diseases and insects in garlic crop. Cure for such diseases is also be available to the user in the information system.

ii). Garlic Expert System using Evolutionary Algorithmic Technique:

In this system, the user can directly communicate with the system and can get the appropriate advices suggested by the expert system through online. In this system the user will submit the symptoms of the crop in his field observed by him to the system through online. Then the system processes the information provided by the user and suggests him with appropriate advice like a domain experts. The system uses the ABC Algorithm as a backend evolutionary algorithmic technique for finding the appropriate solutions for the symptoms provided by the user.

2.1. Implementation of ABC Algorithm:

In ABC model, the colony consists of three groups of bees: employed bees, onlookers and scouts. It is assumed that there is only one artificial employed bee for each food source. In other words, the number of employed bees in the colony is equal to the number of food sources around the hive. Employed bees go to their food source and come back to hive and dance on this area. The employed bee whose food source has been abandoned becomes a scout and starts to search for finding a new food source. Onlookers watch the dances of employed bees and choose food sources depending on dances. The main steps of the algorithm and interpretation of this algorithm to our developed system are given below:

Step 1: Initialize the food source to employed bees

Supply symptoms to obtain the major disease

Step 2:

Repeat

Each employed bee gets its food source, and dances in its hive

Check any exact matching for the entered symptoms and display.

Step3: Onlookers identify the employed bee positions and takes the nearest positions which are empty

If matching disease is not there, go with the neighbor disease and display

Step 4: Scouts are the bees where they don't have a single match of food sources in hive

If not even single symptom doesn't match with the symptoms in the knowledge base then it displays knowledge is insufficient

Step 5: Display the best food source which *shows the place in the hive*

Step 6: Until our requirement is satisfied, loop is to be runned.

The solutions are thus made available to all the processors and are displayed to the end user.

2.2. Database Generation:

In this section, the setup for production rules in the knowledge base is presented. Generally the rules are of the form,

Rule 1: S1=1, S2=0, S3=0, S4=0, S5=0, S6= 1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D1

Rule 2: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D3

Rule 3: S1=0, S2=1, S3=0, S4=0, S5=1, S6=1 , S7=0, S8=0, S9=0, S10=1, S11=0, S12=0
Resultant disease may be D4.

Rule 4: S1=0, S2=0, S3=1, S4=0, S5=0, S6=1, S7= 0, S8=1, S9= 0, S10= 1, S11= 0, S12= 1
Resultant disease may be D2

Rule 5: S1=0, S2=1, S3=0, S4=0, S5=1, S6=0 , S7=1, S8=0, S9= 1, S10=0, S11=0, S12= 1
Resultant disease may be D2

Rule 6: S1=0, S2=1, S3=0, S4=0, S5=0, S6=1, S7= 0, S8=1, S9= 0, S10= 1, S11= 0, S12= 1
Resultant disease may be D5

Rule 7: S1=0, S2=1, S3=0, S4=0, S5=1, S6=0 , S7=1, S8=0, S9= 1, S10=0, S11=0, S12= 0
Resultant disease may be D1

Rule 8: S1=1, S2=0, S3=0, S4=1, S5=0, S6=1, S7= 0, S8=1, S9= 1, S10= 0, S11=10, S12= 0
Resultant disease may be D3

Rule 9: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D2

Rule 10: S1=1, S2=0, S3=0, S4=0, S5=0, S6= 1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D4

Rule 11: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D3

Rule 12: S1=1, S2=0, S3=0, S4=0, S5=0, S6= 1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D5

Rule 13: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D3

Rule 14: S1=1, S2=0, S3=0, S4=0, S5=0, S6= 1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D1

Rule 15: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D2

Rule 16: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D4

Rule 17: S1=1, S2=0, S3=0, S4=0, S5=0, S6=1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D1

Rule 18: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D3

Rule 19: S1=1, S2=0, S3=0, S4=0, S5=0, S6=1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D5

Rule 20: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D4

Rule 21: S1=1, S2=0, S3=0, S4=0, S5=0, S6=1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D2

Rule 22: S1=1, S2=1, S3=0, S4=0, S5=0, S6=0 , S7=1, S8=0, S9= 0, S10=0, S11=0, S12= 1
Resultant disease may be D5

Rule 23: S1=1, S2=0, S3=0, S4=0, S5=0, S6=1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D3

Rule 24: S1=1, S2=0, S3=0, S4=0, S5=0, S6=1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D4

Rule 25: S1=1, S2=0, S3=0, S4=0, S5=0, S6=1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Resultant disease may be D2

3. Results and Discursions:

Report 1:

In this screen shot the user can see the symptoms which were observed in the mango fruits and plants and submit the observed symptoms by him to the system for finding the disease affected to the mango fruits and plants. It contains,

Fig:1. Selection of Symptoms

1. Is foliage brown in color present? Yes or No
2. Is grayish color in leaves found ? Yes or No
3. Is grayish violet in seeds? Yes or No
4. Is leaves fold over? Yes or No
5. Is cool temperature present? Yes or No

Report 2:

In this screen shot the user can see the symptoms which were observed in the mango fruits and plants and submit the observed symptoms by him to the system for finding the disease affected to the mango fruits and plants. It contains,

Fig: 2. Selection of Symptoms

1. White growth of bulbs present? Yes or No
2. White and yellow of plants? Yes or No
3. White and yellowing of plants? Yes or No
4. Reduced growth of plants? Yes or No
5. Yellowing of bulbs? Yes or No
6. Swelling of stems? Yes or No
7. Water soaked stem present? Yes or No
8. Stored bulbs? Yes or No
9. Drying of leaves? Yes or No

Report 3:

In this screen shot, the user can see the disease affected to the mango plant or fruit with appropriate cure to that particular disease. It contains,

Fig: 3. Displaying disease with cure and advice to the end user

Disease1: Affected with Botrytis
Cure: Rapid drying during harvest and good aeration during storage

4. Conclusions:

In the garlic expert advisory system, an Artificial Bee Colony (ABC) Algorithm was implemented which gives better results compared to implementation of Rule Based Algorithm on the system. In the present investigation it was found that, the ABC Algorithm of evolutionary algorithms gives a better solutions compared with general Rule Based Algorithm. The algorithm used in the present system can be treated as quite effective in most of the cases, because the rule based system failed to find a solution to the unmatched symptoms in the knowledge base and the ABC Algorithm finds a solution which represents a good approximation to the optimal one. The presently developed systems main emphasis is to have a well designed interface for giving garlic plant related advices and suggestions in the area to farmers by providing facilities like online interaction between expert system and the user without the need of expert all times. By the thorough interaction with the users and beneficiaries the functionality of the System can be extended further to many more areas in and around the world. The present algorithm can be extended further by incorporating the Shared Memory Architectures to obtain better performance of the algorithm.

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