Implementation of Parallel Optimized ABC Algorithm with SMA Technique for Garlic Expert Advisory System

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Abstract- The present paper deals with the development of web based expert systems using machine learning techniques to advice the farmers in villages through online. An expert system is a computer program, with a set of rules encapsulating knowledge about a particular problem domain.

Parallel Optimized ABC Algorithm with SMA Technique is a new machine learning algorithm developed by taking ABC Algorithm as base and modified this ABC Algorithm with Shared Memory Architecture Technique (SMA Technique). As an application of this Algorithm, a new 'Garlic Expert Advisory System' was developed for advising the farmers in villages.

This system is mainly aimed at identifying the diseases for garlic crop and suggesting the farmers in the villages about disease management to obtain standardized yields. This system is developed by using JSP as front end and MYSQL as backend.

Keywords**:** Expert Systems, Machine Learning Techniques, ABC Algorithm, Shared Memory Architecture Technique, Garlic Crop, Optimization, JSP & MYSQL.

1. Introduction:

Expert systems (ES) are most popular traditional applications in the field of artificial intelligence. An Expert system can be defined as a tool for information generation from knowledge in a specific problem domain. Expert System implementations automatically perform tasks for which specially trained or talented people required. Expert systems might have extensive learning components but once the system is developed, it is proven, it can be placed in the same real world problem solving situation as the human SME (Subject Matter Expert). Typically it is an aid to human workers. The sequence of steps followed to reach any conclusion is dynamically synthesized with each new case and it is not explicitly confined to the cases, programmed when the system is built. Problem solving is accomplished by applying specific knowledge rather than specific technique. This is a key idea in expert systems technology. A wide variety of methods can be used to study the performance of an expert system.

Machine Learning is a mechanism that concerned with writing a computer program that automatically improves the knowledge with experience. It is a very young scientific discipline whose birth can be placed in the mid-seventies. The First Machine Learning Workshop was taken place in 1980 at Carnie-Mellon University (USA). The goal of machine learning is to program the computers such that to use example data or past experience to solve a given problem. There were many successful applications of machine learning exists today, including systems that analyze past sales data to predict customer behavior, recognize faces or spoken speech, optimize robot behavior so that a task can be completed using minimum resources, and extract knowledge from bioinformatics data.

1.1. ABC Algorithm:

The Artificial Bee Colony (ABC) Algorithm [1, 3, and 4], Proposed by Karaboga in 2005, is a meta-heuristic algorithm for numerical optimization. Meta-heuristics are high-level strategies for exploring search spaces. Many meta-heuristic algorithms, inspired from nature, are efficient in solving numerical optimization problems. ABC algorithm is motivated by the intelligent foraging behavior of honey bees. The ABC algorithm was first proposed for unconstrained optimization problems [5, 6]. Subsequently, the algorithm has been developed by Karaboga and Basturk and extended to constrained optimization problems. Improvements to the performance of the algorithm and a hybrid version of the

algorithm can also be seen in the literature. The ABC algorithm is a swarm-based algorithm good at solving unimodal and multimodal numerical optimization problems. It is very simple and flexible when compared to 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. The algorithm 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.

1.2. About Garlic Crop:

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. 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. Garlic is packed with vitamins and nutrients which include Protein, Potassium, Vitamins A, B1, B2 and C, Calcium, Zinc and many others. The main diseases of the garlic crop and its control measurers are given here under.

Disease1: White Rot **Cure:** Control by rotating out of Allium.

Disease2: Fusarium (basal or bottom rot) **Cure:** Proper crop rotation with non-susceptible crops for four years.

Disease3: Pink Rot **Cure:** Using at least a three- to four-year rotation without Allium.

Disease4: Botrytis **Cure:** Rapid drying during harvest.

Disease5: Penicillium Molds **Cure:** Prevent the disease by planting clean stock.

Disease6: Garlic Rust **Cure:** Use healthy seed in well-drained soil and rotate with Non-Allium crops.

Disease7: Purple Blotch **Cure:** Spraying of Mancozeb.

Disease8: Powdery Mildew **Cure:** Spraying of Sulphur Fungicides

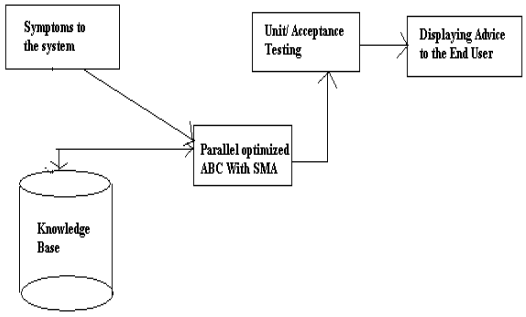
Disease9: Mosaic Disease **Cure:** Spraying of Monocrotophos

Disease10: Leaf Blight **Cure:** Spraying of Ziram or Copper Oxychloride.

Disease11: Stemphylium Blight **Cure:** Spraying of ziram or captan.

2. Proposed System:

The Architecture of the proposed Expert advisory system for garlic crop by using ABC Algorithm with SMA Technique is as follows:



2.1. Proposed Algorithm:

In general, parallel architectures may use either a shared memory or a message passing mechanism to communicate in between the multiple processing elements. Parallel metaheuristic algorithms have been developed for both these kinds of architectures. A parallel implementation of the algorithm is designed for optimized shared memory architecture. The entire colony of bees is divided equally among the available processors. Each processor has a set of solutions in a local memory. A copy of each solution is also maintained in a global shared memory. During each cycle the set of bees at a processor improves the solutions in the local memory. The output optimization can be taken as the sum of the total number of symptoms matching divided by the total number of symptoms present in the system. At the end of the cycle, the solutions are copied into the corresponding slots in the shared memory by overwriting the previous copies. The solutions are thus made available to all the processors.

The proposed Parallel ABC Optimized Algorithm with SMA Technique is as follows:

Step.1. Divide the solutions (symptoms) equally among p processors by copying SNp solutions to the local memory of each processor.

Step.2. Steps 3 to 9 are carried out in parallel at each processor Pr.

Step.3. For each solution in the local memory Mr ( ) of the range processor Pr (Processes), determine a neighbor.

Step.4. Calculate the optimization for the solutions in Mr.

Step.5. Place the onlookers on the food sources in Mr and improve the corresponding solutions.

Step.6. Determine the abandoned solution (if any) in Mr and replace it with a new randomly produced solution.

Step.7. Record the best local solution obtained till now at Pr.

Step.8. Copy the solutions in Mr to the corresponding slots in S.

Step.9. Repeat steps 4 to 9 until MCN (Maximum Cycle Number) cycles are completed.

Step.10. Determine the global best solution among the best local solutions recorded at each processor.

2.2. Database Generation:

Production rules discussed 1.2 are stored in the knowledge base in the following format.

Rule 1: **Symptoms:** S1=0, S2= 0, S3= 1, S4= 0, S5=1, S6=1, S7= 0, S8=1, S9= 0, S10= 0, S11= 0, S12= 0
Result: Disease may be D2

Rule 2:
Symptoms: S1=1, S2=0, S3=0, S4=0, S5=0, S6=0, S7=0, S8=0, S9=1, S10=0, S11=0, S12=1
Result: Disease may be D4

Rule 3:
Symptoms: S1=1, S2=1, S3= 0, S4=1, S5=1, S6=1, S7=0, S8=1, S9=0, S10=1, S11=1, S12= 0
Result: Disease may be D5.

Rule 4:
Symptoms: S1=0, S2=0, S3= 0, S4=1, S5=1, S6=0, S7=0, S8=1, S9=1, S10=1, S11=1, S12= 0
Result: Disease may be D1.

Rule 5:
Symptoms: S1=0, S2=0, S3=1, S4=1, S5=0, S6=1, S7=0, S8=1, S9=1, S10=1, S11=0, S12= 1
Result: Disease may be D2.

Rule 6:
Symptoms: S1=1, S2=1, S3=0, S4=0, S5=1, S6=0, S7=1, S8=1, S9=1, S10=1, S11=1, S12= 0
Result: Disease may be D3.

Rule 7:
Symptoms: S1=0, S2= 1, S3=0, S4=1, S5=1, S6=1, S7=0, S8=0, S9=0, S10=1, S11=0, S12=1
Result: Disease may be D1.

Rule 8:
Symptoms: S1=1, S2=1, S3=0, S4=1, S5=1, S6=1, S7=0, S8=1, S9=0, S10=1, S11=1, S12= 0
Result: Disease may be D4.

Rule 9:
Symptoms: S1=1, S2=1, S3=0, S4=1, S5=1, S6=1, S7=0, S8=1, S9=0, S10=1, S11=1, S12= 0
Result: Disease may be D2.

Rule 10:
Symptoms: S1=0, S2=1, S3=0, S4=0, S5=1, S6=0, S7=0, S8=1, S9=0, S10=0, S11=1, S12= 1
Result: Disease may be D3.

Rule 11:
Symptoms: S1=0, S2=0, S3=1, S4=1, S5=1, S6=0, S7=1, S8=1, S9=0, S10=1, S11=1, S12= 1
Result: Disease may be D4.

Rule 12:
Symptoms: S1=0, S2=1, S3=0, S4=1, S5=1, S6=0, S7=1, S8=1, S9=1, S10=1, S11=0, S12=1
Result: Disease may be D2.

Rule 13:
Symptoms: S1=1, S2=1, S3=0, S4=0, S5=1, S6=0, S7=1, S8=0, S9=1, S10=1, S11=0, S12= 1
Result: Disease may be D1.

3. Results and Discussions:

Screen shot 1: In the following screen shot the user selects the symptoms which were observed by him in the garlic crop and submits the symptoms to the expert system for processing.

Fig.1: Selection of Symptoms

This screenshot contains:

1. Was foliage brown in color? Yes or No
2. Was leaves grayish violet in color? Yes or No
3. Was the seeds violet in color? Yes or No
4. Was lesions turn violet to purple? Yes or No
5. Was the leaves fold over? Yes or No

Screen shot 2: In this screen shot the user selects the symptoms which were observed by him in the garlic crop and submits the symptoms to the expert system for processing

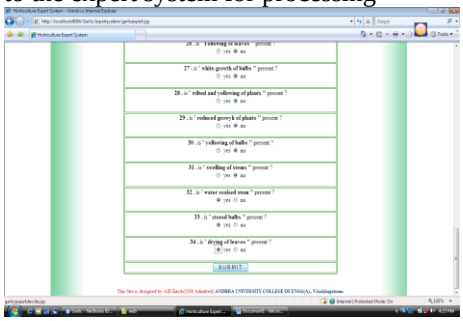


Fig.2: Selection of Symptoms

This screenshot contains:

1. Was your leaves are in Yellow? Yes or No
2. Is there any white growth in bulbs? Yes or No
3. Is there wilting of garlic 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? Yes or No
8. Stored bulbs present? Yes or No
9. Drying of leaves present? Yes or No

Screen shot 3: In this screen shot the user can see the resultant disease affected to the garlic crop with proper cure to that particular disease as

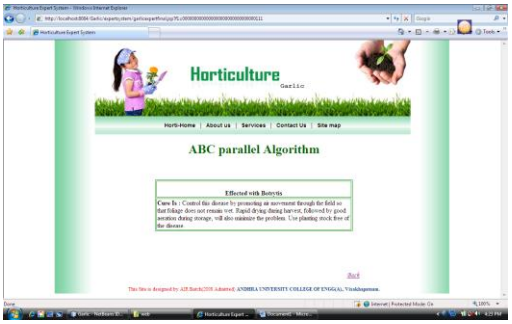


Fig: 3. Displaying Advice to the end user

affected with Botrytis and cure is rapid drying during harvest and good aeration during storage.

4. Conclusions:

In the proposed system, A Parallel Implementation of Optimized Artificial Bee Colony (ABC) Algorithm was developed which gives better results than the general ABC Algorithm. The algorithm used in the present system can be treated as quite effective; in most of the cases it finds a solution which represents a good approximation to the optimal one. Its main emphasis is to have a well designed interface for giving garlic plant related advices and suggestions to farmers by providing facilities like online interaction between expert system and the user without the need of subject expert all times. By the thorough interaction with the users and beneficiaries the functionality of the system and the algorithm can be extended further to many more areas. The results are tested by placing the system in the web portal www.bharathgramarogya.net/newindex.html.

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