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PERFORMANCE ANALYSIS OF ARTIFICIAL AND IMPROVED ARTIFICIAL BEE COLONY OPTIMIZATION ALGORITHM

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Abstract—*WSNs are networks that consist of sensors which are distributed in an Ad hoc manner. WSNs consist of protocols and algorithms with self-organizing capabilities. Many natural systems of the most creatures in the world are very rich topics for the scientific researchers. However, simple individual actions can assist to create a system able to solve a real complex problem and perform very complicated tasks. In reality there are many patterns of such systems like ant colonies, bird flocking, fish shoaling, animal herding, bacterial growth, bee colonies, and human neuron system. The artificial bee colony (ABC) algorithm is a simple and effective optimization algorithm that can be applied to solve many real-world optimization problems. In this paper, an improved artificial bee colony algorithm, named IABC, is proposed. In this algorithm, a new search equation for onlooker bees is presented, in which the optimal and sub-optimal solutions are considered in the iteration process. In this paper ABC and IABC algorithm are analyzed on the basis of performance parameters such as best cost, time delay, distance traveled and system lifetime.*

Keywords— *Artificial bee colony, improved artificial bee colony,WSN,Optimization.*

I. INTRODUCTION

Wireless sensor networks are a special kind of Ad hoc networks that became one of the most interesting areas for researchers. Typically, a wireless sensor network comprises of hundreds or thousands of low cost sensor nodes. A sensor node consists of small sensors able to detect light, sound, temperature and motion, an intelligent computing device that enables the processing of raw data collected from the sensors, and communication capabilities with other nodes through wireless networks. There are many practical applications of wireless sensor networks. Some of the most promising application areas are environmental monitoring, battlefield tracking and disaster recovery operation, building control systems, and smart entertainment devices that adjust audio and video signals based on their surroundings.

Many natural systems of the most creatures in the world are very rich topics for the scientific researchers. However, a simple individual behavior can cooperate to create a system able to solve a real complex problem and perform very sophisticated tasks. In realty there are many patterns of such systems like ant colonies, bird flocking, fish shoaling, animal herding, bacterial growth, bee colonies, and human neuron system. There are some latest developments of nature-inspired algorithms, such as genetic algorithm, particle swarm optimization, ant colony optimization, migrating birds optimization, neural networks, gravitational search algorithm. Artificial Intelligence based on study of actions of individuals in various decentralized systems. The artificial bee colony Optimization (ABC) met heuristic has been introduced fairly recently as a new direction in the field of Swarm intelligence. Artificial bees represent agents, which collaboratively solve complex combinatorial optimization problem. In [1] the adaptation of a bio inspired algorithm called the "infection algorithm" for the energy-efficient dissemination of data from a sensor field to the sink node is presented.

Several modern heuristic algorithms have been developed for solving combinatorial and numeric optimization problems . These algorithms can be classified into different groups depending on the criteria being considered, such as population based, iterative based, stochastic, deterministic, etc. While an algorithm working with a set of solutions and trying to improve them is called population based, the one using multiple iterations to approach the solution sought is named as iterative algorithm. If an algorithm employs a probabilistic rule for improving a solution then it is called probabilistic or stochastic [2].

A fundamental problem in QoS routing is to find a path between a source and destination that satisfies two or more end-to-end QoS constraints. The wireless routing is complex than wired routing due to many constraints and more computational effort. Therefore some more tasks in addition to wired network are added to meet the wireless environment. These specific tasks are very important for the design of wireless network routing protocol due to minimization of power requirement, utilizing minimal network resources like bandwidth and gathering information and updating link failures [3].

The primary goal of this paper is to acquaint readers with the basic principles of artificial bee colony Optimization (ABC) and improved artificial bee colony Optimization (IABC).In this paper, for improving the exploitation of onlooker bees, the solution search equation is modified.

In thenew search equation, the information of the optimal and suboptimal solutions is used to guide the search of new candidate solutions. Based on this search equation, an improved ABC algorithm is proposed, which is named IABC. Analysis of the results achieved using artificial bee colony Optimization (ABC) and improved artificial bee colony Optimization (IABC) to model complex mathematical functions are presented. The remaining of the paper is arranged as follows. Section 2 describes the original Artificial bee colony. The improved ABC (IABC) is presented in Section

3. The algorithm steps for ABC are offered in section

4. The algorithm steps for IABC are accessible in section 5. The flow chart is existing in section 6.The computational results are reported in Section 7. Finally, the conclusion is given in Section 8.

II. ARTIFICIAL BEE COLONY (ABC)

The Round dance communicates sites close to the hive, typically less than 100m, and consists of a serious of circular movements. This dance portrays distance, but not any kind of directional instruction. The honey bee performs quickly in the central part of the hive, turning in tight circles in both directions (Gould, 1974). The Waggle dance is used when the food source occurs further than 150m away from the hive, and describes both distance and direction. The honey bee will dance in a semi-circle, then make a straight line back to the start and perform the semi-circle in the other direction. Patterned like a figure 8as shown in figure 1, the straight movement of the dance involves the lateral wagging of the abdomen, pertaining to the name. The bees wings will emit a low audio frequency of of 250 to 300 hertz per second (Von Frisch, 1967).

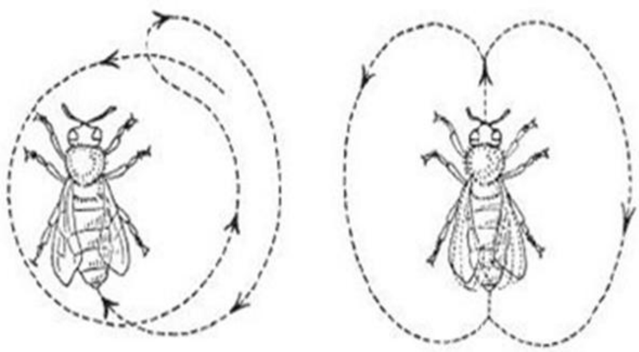

Figure 1 Round dance and waggle dance of honey bees

The artificial bee colony (ABC) algorithm is a swarm- based met heuristic optimization technique ,developed by inspiring foraging and dance behaviors of honey bee colonies. ABC consists of four phases named as initialization, employed bee, onlooker bee and scout bee.The employed bees try to improve their solution in employed bees phase. If an employed bee cannot improve self-solution in a certain time, it becomes a scout bee. This alteration is done in the scout bee phase. The onlooker bee phase is placed where information sharing is done. Although a candidate solution improved by onlookers is chosen among the employed bee population according to fitness values of the employed bees, neighbor of candidate solution is randomly selected. In this paper, we propose a selection mechanism for neighborhood of the candidate solutions in the onlooker bee phase. The proposed selection mechanism was based on information shared by the employed bees. Average fitness value obtained by the employed bees is calculated and those better than the average fitness value are written to memory board. Therefore, the onlooker bees select a neighbor from the memory board.

The bee-inspired protocol has a number of features that make it desirable for deployment in sensor networks: (1) a simple model of routing agent(s) behavior, (2) agent-to-agent communication for discovering optimal paths, (3) fixed size of route-discovery-agent(s) that not only saves energy during their transmission but also makes the algorithm scale to large networks, and (4) a formal model to analyze the behavior of protocol [1].

This system is characterized by the interacting collective behaviour through labour division, distributed simultaneous task performance, specialized individuals, and self- organization.

i) Food Sources: The value of a food source depends on many factors such as its proximity to the nest, its richness or concentration of its energy, and the ease of extracting this energy. For the sake of simplicity, the “profitability” of a food source can be represented with single quantity.

ii) Employed foragers: They are associated with a particular food source which they are currently exploiting or are “employed” at. They carry with them information about this particular source, its distance and direction from the nest, the profitability of the source and share this information with a certain probability.

iii) Unemployed foragers: They are continually at look out for a food source to exploit. There are two types of unemployed foragers:

Scouts: searching the environment surrounding the nest for new food sources. Onlookers: waiting in the nest and establishing a food source through the information shared by employed foragers.

The mean number of scouts averaged over conditions is about 5-10%. The exchange of information among bees is the most important occurrence in the formation of the collective knowledge. While examining the entire hive it is possible to distinguish between some parts that commonly exist in all hives. The most important part of the hive with respect to exchanging information is the dancing area. Communication among bees related to the quality of food sources takes place in the dancing area. This dance is called a waggle dance[4]. Since information about all the current rich sources is available to an onlooker on the dance floor, probably she can watch numerous dances and decides to employ herself at the most profitable source. There is a greater probability of onlookers choosing more profitable sources since more information is circulated about the more profitable sources. Employed foragers share their information with a probability proportional to the profitability of the food source, and the sharing of this information through waggle dancing is longer in duration. Hence, the recruitment is proportional to the profitability of the food source[5].

Here the search space is n-dimensional; the position of the i-th food source can be expressed as a n-dimension vector $X_i = (X_{i,1}, X_{i,2}, \cdots, X_{i,n})$, $i = 1, \cdots, SN$, SN is the number of food sources.

ABC algorithm contains four phases: initialization phase, employed bees phase, onlooker bees phase and scout bees phase.

A. Initialization phase:

In this phase, the initial food sources can be generated randomly by the following equation:

$X_{i,j} = X_{jl} + rand(0,1) * (X_{ju} - X_{lj})$ ------(1)

Where $i \in \{1, 2, \cdots, SN\}$, $j \in \{1, 2, \cdots, n\}$, X_{jl} and X_{ju} are the lower bound and upper bound for the jth dimension,

respectively. After initialization, compute the fitness fit(xi) for each solution xi by using the following equation :

$$fit(x_i) = \begin{cases} 1/1+f(x_i), & \text{if } f(x_i) \geq 0, \\ 1 + abs(f(x_i)), & \text{if } f(x_i) < 0. \end{cases} \quad \text{-----(2)}$$

B. Employed bees phase:

In this phase, each employed bee generates a new food source Vi in the neighbourhood of its present position Xi by using the following equation:

$V_{i,j} = X_{i,j} + \phi_{i,j}(X_{i,j} - X_{k,j})$, ------(3)

where $k \in \{1, 2, \cdots, SN\}$, $j \in \{1, 2, \cdots, n\}$ are selected

randomly, and $k \neq i$, $\phi_{i;j}$ is a random number within the range

[-1,1]. Once vi is obtained, a greedy selection mechanism is employed between Vi and Xi: if $f(V_i) \leq f(X_i)$, Vi will replace Xi and become a new member of the population, otherwise, Xi is retained.

C. Onlooker bees phase:

Each onlooker bee selects a food source according to the probability based on its fitness value, which is defined by the following equation:

$p_i = fit(X_i)/\sum fit(X_i)$ where i=1to SN ------(4)

Here higher the fit(Xi) is, the more probability that the ith food source is selected. Once a food source Xi is selected, as in the case of the employed bees, a neighbour source vi will be generated by employed bee equation, and its fitness value fit(Vi) will be computed. Then, a greedy selection is applied between Xi and Vi

D. Scout bees phase:

In this phase, if a food source Xi can not be improved further through a predetermined number of trail limit, then the source is assumed to be abandoned. If such an abandonment is detected, the related employed bee is converted to a scout bee, and produces a new food source randomly as follows:

$X_{i,j} = x_{jl} + rand(0, 1) * (X_{ju} - X_{jl})$, ----(5) Where $j \in \{1, 2, \cdots, n\}$.

.III. IMPROVED ARTIFICIAL BEE COLONY (IABC)

In the standard ABC algorithm, both the employed and the onlooker bee use the same expression for finding out the candidate food source position. This clearly depicts that the movement of onlooker bee is based on nectar amount of food source hold by a single employed bee which is selected randomly using a roulette wheel selection. Since only one employed bee is selected, this will not guarantee maximum exploitation capacity of the solution variables. To address this issue, a modification in the production of candidate

food source position is introduced in the onlooker phase by employing the Newtonian law of universal gravitation between the onlooker bee and the selected employed bees[6].
In population-based optimization algorithms, both exploration and exploitation process must be carried out together.
However, ABC algorithm is good at exploration, but poor at exploitation.
Modified search equation for onlooker bees Once a food source xi is selected, for generate a new candidate food source vi, we present a new search equation IABC for the onlooker bees by considering the information of the optimal solution x best and sub-optimal solution X sub best of the population in the process of iteration, which is defined as follow:

$V_{i,j} = \omega * X_{best,j} + C1 * \phi_j * (X_{best,j} - X_{i,j}) + c2 * \psi_j * (X_{subbest,j} - X_{i,j})$, ------(6)

where ω is the inertia weight that controls the impact of the optimal solution at current iteration; C1, C2 are positive constant parameters; ϕ_j , ψ_j are uniform random numbers in the range [-1,1],j = 1, 2, · · · , n.
In IABC algorithm, the parameter ω is updated dynamically, which is described by the following equation

$\omega = \omega_{min} + (\omega_{max} - \omega_{min})/max\ cycle * t$, -----(7)

where ω_{min} and ω_{max} represent the lower bound and upper bound of the ω; max cycle is the maximum number of iteration; t is the number of iterations.

IV. ABC ALGORITHM

1. Set parameters :SN, max cycle, imit.
2. Use the(1) to initiate, the position of food source{Xi|i=1, …,SN},and Evaluate the solutions Set t=0.
3. While t max cycle do
4. Employed bee phase
5. For each employed bee, use(3) to generate a new candidate solution Vi in the neighbourhood of Xi and evaluate it. Apply a greedy selection between Xi and Vi
6. Compute the fitness value for its solution using(2),And compute its probability values Pi by utilizing(4).
7. Onlooker bees phase.
8. For each onlooker bee, Select a solution depending on Pi values, generate a new candidate solution Vi with(3),And evaluate it.
9. Apply a greedy selection between Xi And Vi.
10. Save the best solution found so far.
11. Scout bees phase.
12. Determine the abandoned solution by utilising the limit parameter value limit. If exists, Replace it with a new solution for the scout bee by using(1)
13. t=t+1.
14. Until t= max cycle.

V. IABC ALGORITHM

1. Set parameters: SN, max cycles, limit ,w_{min}, w_{max}, c1,c2.
2. Use the (1) to initialize the position of the food sources {xi | i=1,...,SN} ,and evaluate the solutions. Set t=0.
3. While t≤ max cycles do
4. Employed bees phase
5. For each employed bee, use (3) to generate a new candidate solution vi in the neighbourhood of xi and evaluate it. Apply a greedy selection between xi and vi.
6. Compute the fitness value for each solution by using (2), and compute its probability values pi by utilizing (4).
7. Onlooker bees phase.
8. For each onlooker bee, select a solution depending on pi values generate a new candidate solution vi with (8),and evaluate it.
9. Apply a greedy selection between xi and vi.
10. Save the best solution found so far .
11. Scout bees phase.
12. Determine the abandoned solution by utilizing the limit parameter value limit. If exists, replace it with a new solution for the scout bee using (1).
13. By (10)-(13), to chaotic search in xbest , and update xbest (if necessary).
14. t=t+1.
15. Until t=max cycle.

VII. RESULT

Parameters and cost function taken for the implementation are shown in table 1. Cost function taken for implementation is sum of x square values. Population size or colony size is 100. The number of decision variables is 5. All the coding part is done in MATLAB software to analyze and design the system. MATLAB is used for machine learning, signal processing, image processing, computer vision, communications, computational finance, control design, robotics, and much more. Figure 3 shows best cost value variations for ABC for 200 iterations. Figure 4 shows best cost value variations for IABC for 200 iterations. IABC gives improved value of best cost. Comparison of ABC and IABC is shown in Figure 5 for best cost value, delay required for implementation, and system logitivity.

Sr. No.	Parameter	Value
1	Cost Function	F=∑x2
2	Number of Decision Variables	5
3	Decision Variables Lower Bound	-10
4	Decision Variables Upper Bound	10
5	Maximum Number of Iterations	200
6	Population Size (Colony Size)	100
7	Number of Onlooker Bees	100

Table 1: Different parameters and values for implementation of ABC and IABC

VI. FLOW CHART

Figure 2 shows flow chart for implementation of Artificial Bee colony optimization algorithm.

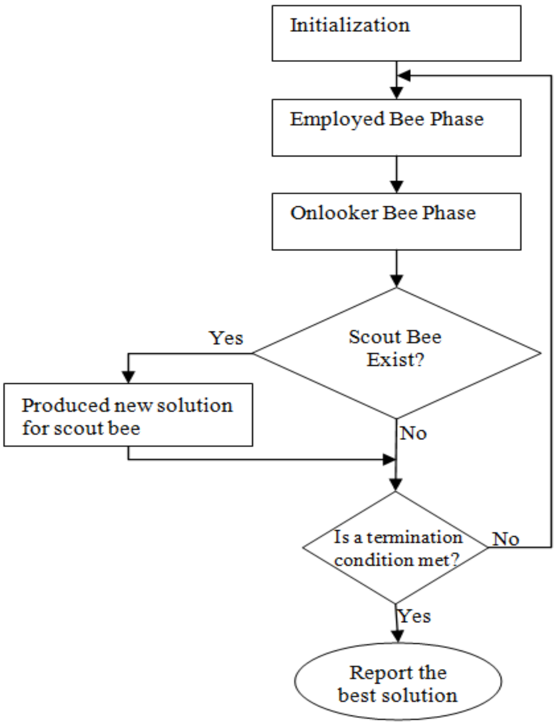

Figure 2 Flow chart for implementation of ABC.

Table 1: Different parameters and values for implementation of ABC and IABC

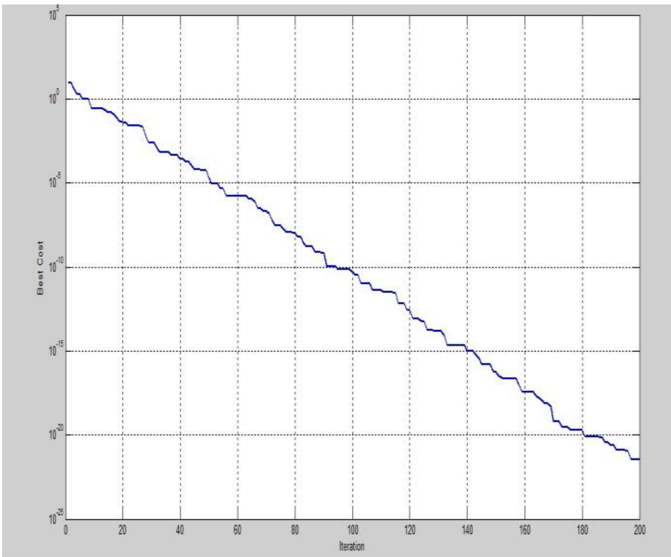

Figure 3 Best cost value of ABC

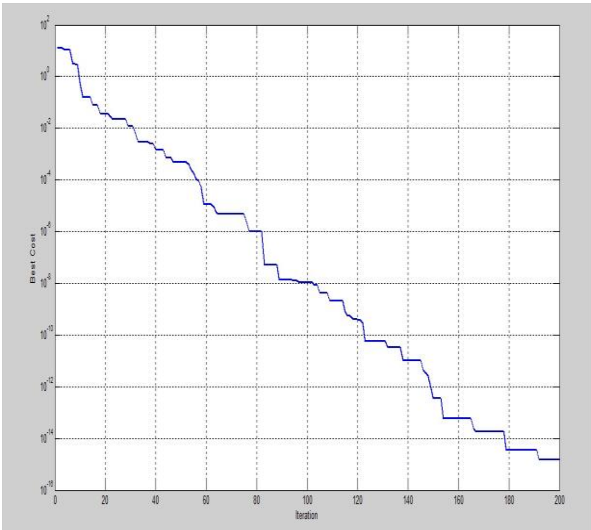

Figure 4 Best cost value of IABC

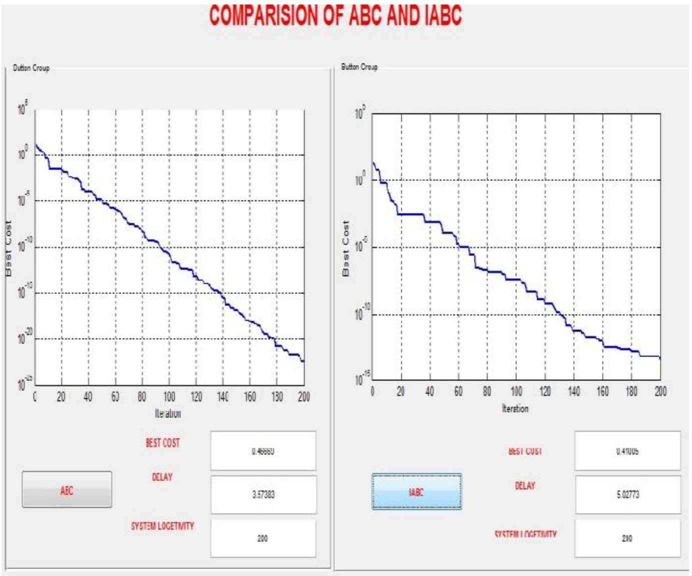

Figure 5 Comparisons of ABC and IABC. Advantages of Artificial Bee colony Algorithm:

- Simplicity, flexibility and robustness
- Ability to explore local solutions
- Ease of implementation
- Ability to handle the objective cost
- Population of solutions
- High flexibility, which allows adjustments
- Broad applicability, even in complex functions

Limitations of Artificial Bee colony Algorithm:

- Lack of use of secondary information
- Requires new fitness tests on the new algorithm parameters
- The population of solutions increases the computational cost

Application of Artificial Bee colony Algorithm:

- Benchmarking Optimization
- Bioinformatics application
- Scheduling Applications
- Clustering and Mining Applications
- Image processing Applications
- Economic Dispatch Problems
- Engineering Designs and Applications

VIII. CONCLUSION

In this paper, a new search equation for onlooker bees is projected. After that, an improved artificial bee colony algorithm IABC was developed. The performance of IABC was compared with the standard ABC. The results showed that IABC presents promising results for considered problems. The delay time, is fairly important for IABC algorithm and should be tuned considering the characteristics of optimization problems. Our immediate future work will involve building and testing the architecture by the implementation of proposed system in the real WSN.

References

[1] Chun-Feng Wang, and Yong-Hong Zhang," An Improved Artificial Bee Colony Algorithm for Solving Optimization Problems", IAENG International Journal of Computer Science, 43:3, IJCS_43_3_09.

[2] Mustafa Servet Kiran, Ahmet Babalik," Improved Artificial Bee Colony Algorithm for Continuous Optimization Problems", Journal of Computer and Communications, 2014, 2, 108-116 Published Online March 2014 in SciRes.http://www.scirp.org/journal/jcc

[3] Swarm Intelligence: A Whole New Way to Think About Business, Eric Bonabeau and Christopher Meyer, Harvard business review, r0105g, (May 2001).

[4] Beni, G., and J. Wang. Swarm Intelligence. In Proceedings Seventh Annual Meeting of the Robotics Society of Japan, Tokyo, RSJ Press, pp. 425-428 (1989).

[5] Von Frisch, Karl: Decoding the Language of the Bee, Science, Volume 185, Issue 4152, pp. 663-668 (1974).

[6] Kamil, Alan C., John R. Krebs and H. Ronald Pulliam, Foraging

Behavior, Plenum Press, New York and London (1987).
[7] Corbet, S.A., Kerslake, C.J.C., Brown, D. &Morland, N.E. Can bees select nectar-rich flowers in a patch? Journal of Apicultural Research, 23, pp. 234–242 (1984).
[8] Hussein Owaied, Saif Saab: Modeling Artificial Bees Colony System. IC-AI: pp. 443-446 (2008).
[9] T. D. Seeley, The Wisdom of the Hive (Harvard University Press, Cambridge, MA,(1995).
[10] X. Cai, Z. Cui, J. Zeng, and Y. Tan, Particle Swarm Optimization with Self-adjusting Cognitive Selection Strategy, International Journal of Innovative Computing, Information and Control, vol.4, no.4, pp.943-952, 2008.
[11] J.E. Onwunalu, L.J. Durlofsky A new well-pattern-optimization procedure for large-scale field development SPE J. (2011) http://dx.doi.org/10.2118/124364-PA
[12] P. Civicioglu, E. Besdok A conceptual comparison of the cuckoo-search, particle swarm optimization, differential evolution and artificial bee colony algorithms Artif. Intell. Rev. (2011) http://dx.doi.org/10.1007/s10462-011-9276-0
[13] V. Artus, L.J. Durlofsky, J. Onwunalu, K. Aziz Optimization of nonconventional wells under uncertainty using statistical proxies Comput. Geosci. (2006) http://dx.doi.org/10.1007/s10596-006-9031-9
[14] X. Yan, Y. Zhu, W. Zou A hybrid artificial bee colony algorithm for numerical function optimization 11th International Conference on Hybrid Intelligent Systems, Melacca (2011) http://dx.doi.org/10.1109/HIS.2011.6122092

