International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)

ISSN: 2456-236X

Vol. 04 Issue 02 |2020

Energy Efficient Routing Scheme by Using ACO

[1]Khushboo Singh

[1]Department of MCA, Computer Science, Jain (Deemed-to-be) University, Bangalore, Karnataka, India

ABSTRACT

Ant Colony Optimization (ACO) is a population-based met heuristic approach that can be used to find approximate solution to difficult optimization problem. We attempt to develop an algorithm inspired by one aspect of ant behaviour i.e. the ability to find the shortest paths. ACO is a derivative of Swarm intelligence (SI). The ACO, introduced by Marco Dorigo, in the year 1992 and it is a paradigm for designing met heuristic algorithms for optimization problems and is inspired by the foraging behaviour of ant colonies. ACO targets discrete optimization problems and can be extended to continuous optimization problems which is useful to find approximate solutions. Now-a-days, a number of algorithms inspired by the foraging behaviour of ant colonies have been applied to solve difficult discrete optimization problems. In fact, ACO algorithm is the most successful and widely recognized algorithmic based on the ant behaviour. This paper proposes an efficient routing scheme for wireless sensor network with energy saving scheme. The proposed works has been validated against Particle Swarm Optimization (PSO).

Keywords: ACO, Wireless Sensor Network, Energy efficiency, clustering

1. INTRODUCTION

Wireless sensor networks (WSNs) are interconnected sensor nodes that communicate wirelessly to collect data about the surrounding environment. It is an ad hoc network mainly comprising sensor node which are normally used to monitor and observe a phenomenon or a scene[1]. The sensor nodes are physically deployed within or close to the phenomenon or the scene. The collected data will be sent back to a base station from time to time through routes dynamically discovered and formed by sensor nodes. Ant colony optimization (ACO) methodology is based on the ant's capability of finding the shortest path from the nest to a food source. An ant repeatedly hops from one location to another to ultimately reach the destination (food). ACO algorithms are inspired by the foraging behaviour of Ants [2]. During searching for food, normally the ant's releases pheromones to establish a route from source to destination. By releasing pheromones, ants can mark the route they have walked, providing clues for other ants foraging. As time and the number of foraging ants increase, the concentration of pheromone will become dense. It changes the environment, based on which ants can gradually find the shortest route between their nest and the food.

Advanced technology has become the integral part of our life [3]. To satisfy the need of the society, almost in each work, we use the technology [4] [5]. In current era computer science is major subject [6]. It has many real life applications such as cloud computing [7], artificial intelligence [8], remote monitoring [9], Wireless sensor network [10, 11, 12], internet of things [13, 14, 15], Neural network [16, 17], FSPP [18, 19, 20], NSPP [21, 22, 23, 24, 25], TP [26, 27, 28], internet Security [29], uncertainty [30, 31, 32, 33, 34] and so on. Technology is the mode by which user can store, fetch, communicate and utilize the information [35]. So, all the organizations, industries and also every individual are using computer systems to preserve and share the information [36] . The internet security plays a major role in all computer related applications. The internet security appears in many real-life applications, e.g., home security, banking system, education sector, defence system, Railway, and so on. In this manuscript we discuss about the protection of authentication which is a part of internet security.

The most well-known monitoring test on ant's foraging behaviour is the "double bridge experiment" [3]. This approach says the populace of ants influences foraging behaviour which implies a shortest route from nest to food. Assume two routes, a long one and a short one, connecting the nest to food. At first, ants choose each route but, after a while, all the ants selected the shorter one. In this experiment, at the preliminary stage, none of the two routes have pheromone, so ants had no reference for choosing, so there's no bias, and ants can solely select at random, so the likelihood of selecting one of the two routes is equal. However, the ant's deciding on the shorter route would arrive at the meals supply earlier, so they can get lower back earlier. They depart the pheromone on the shorter route subsequent time that means that there is plenty extra pheromone on the shorter route than on the longer one throughout the identical period. Thus, as time passes by, accumulative concentrations of pheromone end up higher and greater, in contrast with the shorter one, and the ants observed have a tendency to select the shorter route.

1.1 Natural Behaviour of Ant

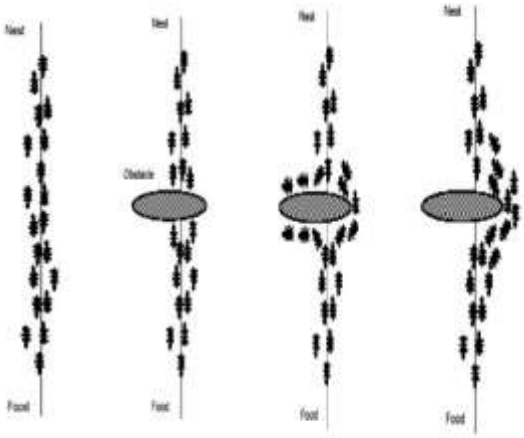

Fig.1Natural Behaviour of Ant

ACO algorithms are stimulated through the foraging conduct of ants in the nature. In nature, some species of ants in searching for food will leave chemicals that can be smelled by others on the route, called pheromones. By releasing pheromones, ants can mark the route they have walked, offering clues for different ants foraging for food. As time and the variety of foraging ants increase, the awareness of pheromone in the surroundings will change, based totally on which ants can progressively discover the shortest route between their nest and the food.

2. LITERATURE REVIEW

ACO is an ongoing met heuristic approach for solving hard combinatorial optimization problems. The inspiring supply of ACO is the pheromone trail laying and following behaviour of real ants which use pheromones as a communication medium[37]. The pheromone trails in ACO serve as distributed, numerical information which the ants use to probabilistically construct solutions to the problem being solved and which the ants adapt during the algorithm's execution to reflect their search experience. The artificial ants in ACO implement a randomized construction heuristic which makes probabilistic decisions as a function of artificial pheromone trails and possibly available heuristic information based on the input data of the problem to be solved. As such, ACO can be interpreted as an extension of traditional construction heuristics which are readily available for many combinatorial optimization problems [38].

The behaviour of real ants looking for food inspires the ACO algorithm. The ants spread pheromone during their search, creating a trail which influences the path choice of other ants. The algorithm uses numerical information to represent the pheromone trails and keeps information about the search experience[39]. Each ant takes randomized decisions iteratively until achieving a complete solution these decisions follow a probability that considers all information available at the moment.

Each artificial ant in ACO develops a stochastic arrangement, leading to a wide range of courses. The development utilizes the data accessible right now and furthermore the experience got with different answers for include parts, individually, in the arrangement. In the event that it is conceivable to make a system that produces an answer for a discrete improvement issue at that point, on a basic level, it is conceivable to apply the ACO[7].

Swarm intelligence (SI) is a moderately new way to deal with critical thinking that takes motivation from the social practices of creepy crawlies and of different creatures. Specifically, insect have enlivened various strategies and methods among which the most contemplated and the best is the broadly useful advancement strategy known as subterranean insect province streamlining. ACO takes motivation from the rummaging conduct of some subterranean insect species. These ants store pheromone on the ground so as to stamp some positive way that ought to be trailed by different individuals from the state.

Subterranean insect state improvement misuses a comparative instrument for tackling streamlining issue. From the mid-nineties, when the primary insect state streamlining calculation was proposed, ACO pulled in the consideration of expanding quantities of analysts and numerous fruitful applications are currently accessible. In addition, a significant corpus of hypothetical outcomes is opening up that gives valuable rules to analysts and experts in further utilizations of ACO.

3. PROPOSED MODEL

In this paper, I propose an ACO algorithm using Travelling Salesman Problem which is developed according to the observation that real ants are capable of finding the shortest path from a food source to the nest destination.

3.1 Travelling Salesman Problem

The travelling salesman problem was defined in the 1800s by the Irish mathematician W. R Hamilton and by the British mathematician Thomas Kirkman. The travelling salesman problem is a classic algorithm problem in the field of computer sciences. It is mainly used for optimization problem.

The motivation behind the Travelling Salesman Problem Travelling is the problem faced by a salesman who needs to visit a number of customers located in different cities and tries to find the shortest route accomplishing this task.

In the travelling salesman problem, a set of cities is given and the distance between each of them is known. The goal is to find the shortest path that allows each city to be visited once and only once[40][41].

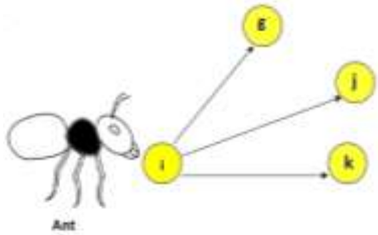

Fig.2 An Ant

In ACO, the problem is tackled by simulating a number of artificial ants moving on a graph that encodes the problem itself: each vertex represents a city and each edge represents a connection between two cities. A variable called pheromone is associated with each edge and can be read and modified by ants[42] . In a fig 2, An ant in city i chooses the next city to visit via a stochastic mechanism: if j has not been previously visited, it can be selected with a probability that is proportional to the pheromone associated with edge (i,j)[43]. ACO is an iterative algorithm. At each iteration, a number of artificial ants are considered. Each of them builds a solution by walking from vertex to vertex on the graph with the constraint of not visiting any vertex that she has already visited in her walk. At each step of the solution construction, an ant selects the following vertex to be visited according to a stochastic mechanism that is biased by the pheromone: when in vertex i, the following vertex is selected stochastically among the previously unvisited ones[44]. In particular, if j has not been previously visited, it can be selected with a probability that is proportional to the pheromone associated with edge (i, j)[45].

At the end of an iteration, on the basis of the quality of the solutions constructed by the ants, the pheromone values are modified in order to bias ants in future iterations to construct solutions similar to the best ones previously constructed[46].

4. FLOW CHAT FOR ACO

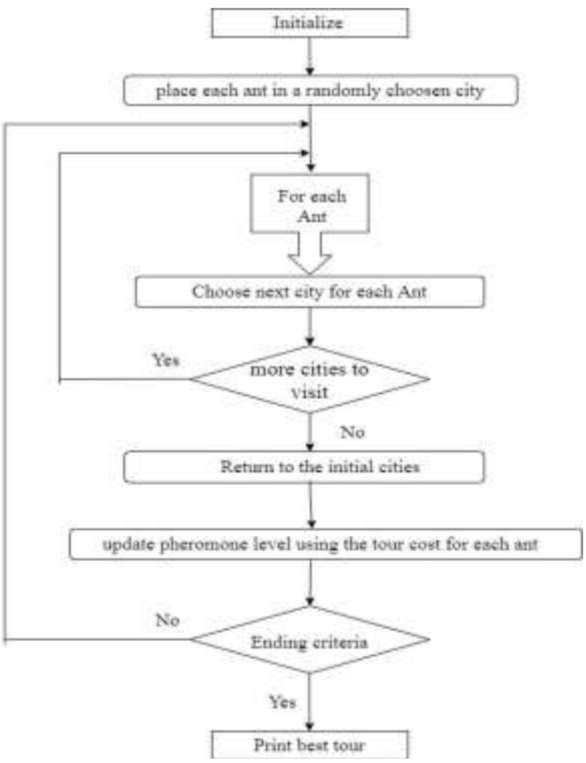

Fig.3 ACO Flow Chat

Algorithm1: The generic ACO Algorithm for TSP
Algorithm ACO for TSP
Initialize Trail
Do While (Ending Criteria Not Satisfied)
Cycle Loop
Do Until (Each Ant Completes a Tour)
Tour Loop
Local Trail Update
End Do
Analyse Tour
Global Trail Update
End Do

5. RESULTS

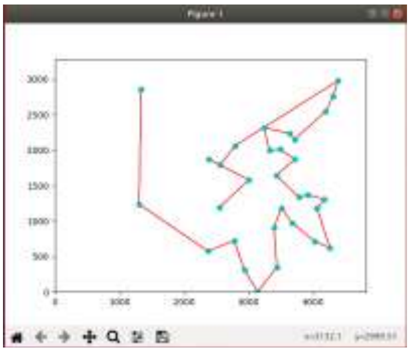

Fig.3.1 Optimal tour cost found [16541]

In the above fig.3.1,To reach city 1 from city 2 the cost is [16541.720710416905] and the path we should follow is [14,0,30,29,26,27,25,24,23,19,20,21,17,2,16,18,22,22,15,4,5,6,1,3,7,8,9,12,11,13,10,28].14 is the starting node and 28 is the ending node.

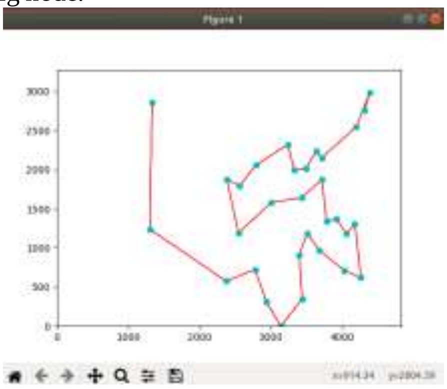

Fig.3.2 Optimal tour cost found [16537]

In the above fig.3.2, To reach city 1 from city 2 the cost is [16537.41099931273] and the path we should follow is [8,9,7,3,1,4,5,6,12,11,13,28,10,22,15,18,16,17,2,21,20,19,23,24,25,27,26,29,30,0,14].8 is the starting node and 14 is the ending node.

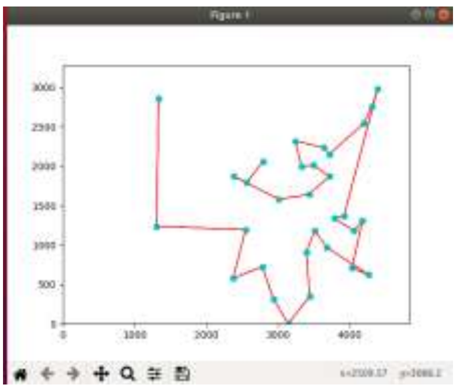

Fig.3.3 Optimal tour cost found [16280]

In the above fig.3.2, To reach city 1 from city 2 the cost is [16280.862583371596] and the path we should follow is [12,11,13,10,22,15,4,5,6,1,3,7,8,9,16,18,17,2,20,21,19,23,24,25,37,26,29,30,28,0,1].12 are the starting node and 14 is the ending node.

6. ACKNOWLEDGEMENT

I would like to express my profound gratitude to Professor Dr.MN Nachappa and project coordinators for their patient, encouragement and valuable assessments of this research work.

7. CONCLUSION

In this paper, ACO is an ongoing proposed metaheuristic approach for solving hard combination optimization problems. Artificial ants implement a randomized construction heuristic which makes probabilistic decisions. In ACO Local Search is extremely important to obtain good results. It is shown in the iteration that all the ants converge to the best path which gives minimum distance. The pheromone distribution for iteration and the next city selection based on maximum probability is determined in the iteration. It is evident from the analysis that the rich pheromone edge is converges the best path for the travelling salesmen problems.

8. REFERENCES

[1] M. D. IRIDIA, "Université Libre de Bruxelles, Belgium E-mail: mdorigo@ulb.ac.be URL: http://iridia.ulb.ac.be/~mdorigo".

[2] S. Goss and D. J.L, "Trails and U-turns in the selection of the shortest path by the ant Lasius Niger.," Journal of theoretical biology,, Vols. 397-415,, pp. 159,, 1992.

[3] M. BM and H. Mohapatra, "Human centric software engineering," International Journal of Innovations & Advancement in Computer Science (IJIACS), vol. 4, no. 7, pp. 86-95, 2015.

[4] H. Mohapatra, C Programming: Practice, Vols. ISBN: 1726820874, 9781726820875, Kindle, 2018.

[5] H. Mohapatra and A. Rath, Advancing generation Z employability through new forms of learning: quality assurance and recognition of alternative credentials, ResearchGate, 2020.

[6] H. Mohapatra and A. Rath, Fundamentals of software engineering: Designed to provide an insight into the software engineering concepts, BPB, 2020.

[7] V. Ande and H. Mohapatra, "SSO mechanism in distributed environment," International Journal of Innovations & Advancement in Computer Science, vol. 4, no. 6, pp. 133-136, 2015.

[8] H. Mohapatra, "Ground level survey on sambalpur in the perspective of smart water," EasyChair, vol. 1918, p. 6, 2019.

[9] H. Mohapatra, S. Panda, A. Rath, S. Edalatpanah and R. Kumar, "A tutorial on powershell pipeline and its loopholes," International Journal of Emerging Trends in Engineering Research, vol. 8, no. 4, 2020.

[10] H. Mohapatra and A. Rath, "Fault tolerance in WSN through PE-LEACH protocol," IET Wireless Sensor Systems, vol. 9, no. 6, pp. 358-365, 2019.

[11] H. Mohapatra, S. Debnath and A. Rath, "Energy management in wireless sensor network through EB-LEACH," International Journal of Research and Analytical Reviews (IJRAR), pp. 56-61, 2019.

[12] H. Mohapatra and A. Rath, "Fault-tolerant mechanism for wireless sensor network," IET Wireless Sensor Systems, vol. 10, no. 1, pp. 23-30, 2020.

[13] H. Mohapatra and A. Rath, "Detection and avoidance of water loss through municipality taps in india by using smart tap and ict," IET Wireless Sensor Systems, vol. 9, no. 6, pp. 447-457, 2019.

[14] M. Panda, P. Pradhan, H. Mohapatra and N. Barpanda, "Fault tolerant routing in heterogeneous environment," International Journal of Scientific & Technology Research, vol. 8, pp. 1009-1013, 2019.

[15] D. Swain, G. Ramkrishna, H. Mahapatra, P. Patra and P. Dhandrao, "A novel sorting technique to sort elements in ascending order," International Journal of Engineering and Advanced Technology, vol. 3, pp. 212-126, 2013.

[16] H. Mohapatra, "HCR using neural network," 2009.

[17] V. Nirgude, H. Mahapatra and S. Shivarkar, "Face recognition system using principal component analysis & linear discriminant analysis method simultaneously with 3d morphable model and neural network BPNN method," Global Journal of Advanced Engineering Technologies and Sciences, vol. 4, p. 1, 2017.

[18] R. Kumar, S. Edalatpanah, S. Jha, S. Gayen and R. Singh, "Shortest path problems using fuzzy weighted arc length," International Journal of Innovative Technology and Exploring Engineering, vol. 8, pp. 724-731, 2019.

[19] R. Kumar, S. Jha and R. Singh, "A different approach for solving the shortest path problem under mixed fuzzy environment," International Journal of fuzzy system Applications, vol. 9, no. 2, pp. 132-161, 2020.

[20] R. Kumar, S. Jha and R. Singh, "Shortest path problem in network with type-2 triangular fuzzy arc length," Journal of Applied Research on Industrial Engineering, vol. 4, pp. 1-7, 2017.

[21] S. Broumi, A. Dey, M. Talea, A. Bakali, F. Smarandache, D. Nagarajan, M. Lathamaheswari and R. Kumar, "Shortest path problem using Bellman algorithm under neutrosophic environment," Complex & Intelligent Systems, vol. 5, pp. 409--416, 2019.
[22] R. Kumar, S. Edalatpanah, S. Jha, S. Broumi, R. Singh and A. Dey, "A multi objective programming approach to solve integer valued neutrosophic shortest path problems," Neutrosophic Sets and Systems, vol. 24, pp. 134-149, 2019.
[23] R. Kumar, A. Dey, F. Smarandache and S. Broumi, "A study of neutrosophic shortest path problem," in Neutrosophic Graph Theory and Algorithms, F. Smarandache and S. Broumi, Eds., IGI-Global, 2019, pp. 144-175.
[24] R. Kumar, S. Edalatpanah, S. Jha and R. Singh, "A novel approach to solve gaussian valued neutrosophic shortest path problems," International Journal of Engineering and Advanced Technology, vol. 8, pp. 347-353, 2019.
[25] R. Kumar, S. Edaltpanah, S. Jha, S. Broumi and A. Dey, "Neutrosophic shortest path problem," Neutrosophic Sets and Systems, vol. 23, pp. 5-15, 2018.
[26] R. Kumar, S. Edalatpanah, S. Jha and R. Singh, "A Pythagorean fuzzy approach to the transportation problem," Complex and Intelligent System, vol. 5, pp. 255-263, 2019.
[27] J. Pratihar, R. Kumar, A. Dey and S. Broumi, "Transportation problem in neutrosophic environment," in Neutrosophic Graph Theory and Algorithms, F. Smarandache and S. Broumi, Eds., IGI-Global, 2019, pp. 176-208.
[28] J. Pratihar, S. E. R. Kumar and A. Dey, "Modified Vogel's Approximation Method algorithm for transportation problem under uncertain environment," Complex & Intelligent Systems (Communicated).
[29] J. Sakhnini, H. Karimipour, A. Dehghantanha, R. Parizi and G. Srivastava, "Security aspects of Internet of Things aided smart grids: A bibliometric survey," Internet of Things, pp. 100-111, 2019.
[30] S. Gayen, F. Smarandache, S. Jha and R. Kumar, "Interval-valued neutrosophic subgroup based on interval-valued triple t-norm," in Neutrosophic Sets in Decision Analysis and Operations Research, M. Abdel-Basset and F. Smarandache, Eds., IGI-Global, 2019, p. 300.
[31] S. Gayen, F. Smarandache, S. Jha, M. Singh, S. Broumi and R. Kumar, "Introduction to plithogenic subgroup," in Neutrosophic Graph Theory and Algoritm, F. Smarandache and S. Broumi, Eds., IGI-Global, 2020, pp. 209-233.
[32] S. Gayen, S. Jha, M. Singh and R. Kumar, "On a generalized notion of anti-fuzzy subgroup and some characterizations," International Journal of Engineering and Advanced Technology, vol. 8, pp. 385-390, 2019.
[33] S. Gayen, F. Smarandache, S. Jha, M. K. Singh, S. Broumi and R. Kumar, "Introduction to plithogenic hypersoft subgroup," Neutrosophic Sets and Systems, vol. 33, p. Accepted, 2020.
[34] S. Gayen, S. Jha and M. Singh, "On direct product of a fuzzy subgroup with an anti-fuzzy subgroup," International Journal of Recent Technology and Engineering, vol. 8, pp. 1105-1111, 2019.
A. Behura and H. Mohapatra, "IoT Based Smart City with Vehicular Safety Monitoring," EasyChair, vol. 1535, 2019.
[35] H. Panda, H. Mohapatra and A. Rath, "WSN-Based Water Channelization: An Approach of Smart Water," Smart Cities—Opportunities and Challenges. Lecture Notes in Civil Engineering, vol. 58, pp. 157-166, 2020.
[36] Monroy, C. Amaya and A. Langevin, "“Te periodic capacitated arc routing problem with irregular services,” Discrete Applied Mathematics, no. 4-5,," vol. vol. 161, p. pp. 691–701, 2013.
[37] P.-P. Grassé, "Les Insectes Dans Leur Univers, Paris, France: Ed. du Palais de la découverte,," 1946.
[38] M. Dorigo, V. Maniezzo and A. Colorni, "“Distributed Opti-mization by Ant Colonies,” in Proceedings of Proceedings of ECAL91," European Conference on Artificial Life,, pp. 132–142,, January 1991..
[39] "“Ant Colony System: A cooperative learning approach to the traveling salesman problem,”," IEEE Transactions on Evolutionary Computation, , Vols. 1, no. 1, , pp. 53–66, , 1997..
[40] G. S, S. Aron, J. Deneubourg and J. Pasteels, "“Self-organized shortcuts in the Argentine ant,," Naturwissenschaften,, Vols. 76,, pp. 579–581,, 1989..
[41] M. Dorigo and L. Gambardella, "“Ant colonies for the traveling salesman problem,”," BioSystems,, Vols. 43, no. 2,, pp. 73–81,, 1997,.
[42] D. M and T. S. utzle, "Ant Colony Optimization, MIT Press, Cambridge, MA,," 2004..
[43] D. M and G. D. Caro, "“The Ant Colony Optimization meta-heuristic,” in New Ideas in Optimization, D. Corne et al., Eds., McGraw Hill, London, UK,," pp. 11–32,, 1999,.
[44] "“ACO algorithms with guaranteed convergence to the optimal solution,” Informa- tion Processing Letters,," Vols. 82, no. 3,, pp. 145–153, , 2002. .
[45] B. C and D. M, "“Search bias in ant colony optimization: On the role of compe- tition balanced systems,”," IEEE Transactions on Evolutionary Computation,, Vols. 9, no. 2,, pp. 159–174,, 2005,.

[46] T. S. ützle and M. Dorigo, "“Ant colony optimization: overview and recent advances,” M. Gen-dreau and J.-Y. Potvin, Eds., Springer, 2nd edition,," in Handbook of Metaheuristics, Vols. vol. 272,, pp. pp. 227–263,, 2019..

[47] M. Dorigo, V. Maniezzo and A. Colorni, "“Ant System: Optimization by a colony of cooperating agents,”," IEEE Transactions on Systems, Man, and Cybernetics, Vols. Part B, 26, no. 1,, pp. 29–41,, 1996.