A Survey of Ant Colony Optimization with Social Network

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ABSTRACT
We are living world of virtual community, where people connect to each other through any kind of relationship. Social networking is platform where people share emotions, activities, area of interest etc. Communities in social network are deployed in user nodes with connecting people, second generation social network come in existence lot of emerging application which create service oriented environment, this paper is summarization of ant colony optimization with social networking, which is a growing discipline .Ant take decision with the help of special type of chemical 'pheromone'. Base on this concept ACO meta-heuristic which helps to solve combinational problems such as TSP, Graph color, job shop Network routing, machine learning etc. Hence social networking may be a new platform with ant colony optimization, to solve complex task in social phenomena.

Keywords
Swarm-Intelligence; ACO; pheromone

1. INTRODUCTION
Social networking is a virtual platform, which provides independency to user always connecting to each other. Boyd and Ellison [5] defined Social network site as "web based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system. Popularity of virtual community is growing day by day, extensive uses of community shows interest, pattern and behavior of individual user. Zhongju (John) Zhang [6] proposed research model which says social-networking deployed in, satisfaction, information-quality, and system-quality and investigate sense of community frame work.

1.1 Swarm Intelligence
Swarm intelligence based on self –organization, decentralization and emergent and collective behavior of small species like Ant, Bee, Fish, Bird. They lives in a group are and perform complex task .there are several area of computer science where we can apply swarm technique like ant colony optimization, particle swarm optimization to solve complex problems [1].

1.2 Ant Colony Optimization (ACO)
Small Swarm Insect like, Ant species (most of them) completely blind. But they can find food (in a group) with the help of special type of chemical which is called 'Pheromone'. pheromone plays important role in decision making when ant move nest -to-food (Forward-Direction) or food- to-nest (Backward-Direction), Ant performs 'foraging behavior' in which ants (always in a queue) deposit pheromone on a path during food search and make a pheromone trail. Foraging behavior of ants has been investigate by many experiment by several researchers, -but among all the experiment one particularly brilliant experiment which is known as 'Double Bridge' experiment, that shows decision making of ants ACO is mathematically implementation of real ants, nest and food denote by node, Path between node denote by 'arc' and Corresponding to each arc probabilistic rule is defined which helps movement between vertices and decision making [2].

1.3 About ANTs
Ant little swarm insect lives in group, performing 'foraging' 'autocatalytic' and 'stigmergy' behavior and find optimum path [2] during food search. Before 1992 nobody knew, this little bit species could helps us to solve combinational problem of computer science. In 1992 'Marco Dorigo' [2] introduced us concept of Ant colony optimization, Although most of the ant species are complete blind and also not acoustic sense, but they can find food (in a group) with optimal path with the help of following properties [2].

1.4 Stigmergy
During movement food to nest or vice versa ants release special type of chemical known as pheromone, which accomplish indirect communication between ants and environment, this entire procedure known as stigmergy. Pheromone plays important role to ants for any kind of decision making to choose appropriate path for further movement [2].

1.5 Foraging Behavior
During movement, while walking between nest to food or vice versa ants continuously release pheromone and create a 'pheromone trail'. Ants can smell concentration level of pheromone and choose highest probabilistic path with strong pheromone level [2][16][17].

1.6 Autocatalysis process
A larger amount of pheromone on a path attract ants to choose particular path, more number of ant create higher amount of pheromone on given path and finally highest concentrated path is common path for ants. This procedure is known as autocatalysis or positive feedback.

2. VERIFICATION OF PROPERTIES
There are many experiment which shows evidence in the favour of 'autocatalytic' and 'foraging' behavior of ants, but, one brilliant experiment known as 'Double Bridge Experiment'[2][17] performed by 'Aron', 'Goss', 'Deneubourg' and pastels in ,1989,1990[2].

2.1 Double Bridge Experiment
Deneubourg and all prepare this experiment to analyze behavior of ants, experiment divides in two parts that is,

2.1.1 Branch with Equal Length
Deneubourg established two paths between nest and food both are same length. At initial level due to absence of 'pheromone' no choice between paths, so because of random fluctuations ant select any branch with same probability. If half of ants Divides in path (both side) pheromone in same amount deposited on path due to equal length. During

movement forward [3] and backward direction figure [4], ants deposit pheromone with same amount [2][17].

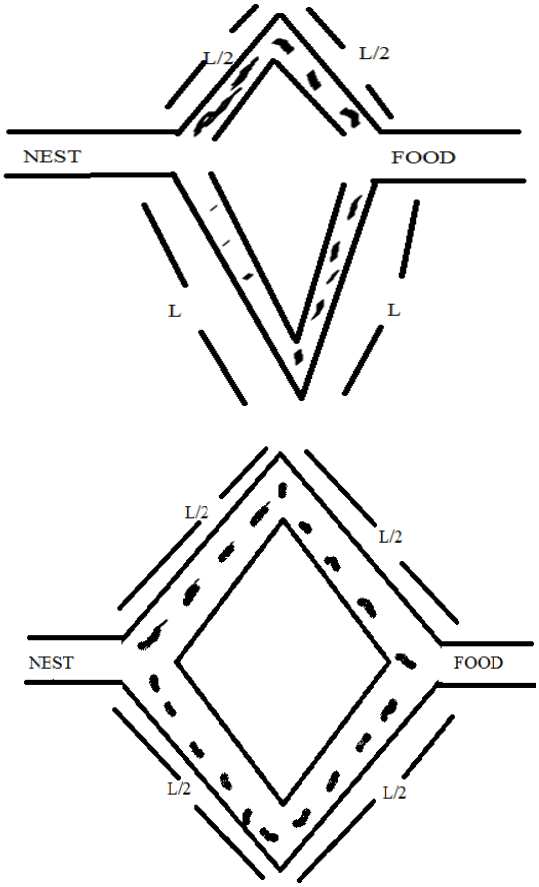

Fig2: Branch with equal length Fig1: Branch with Different Length

2.1.2 Branch *with Different Length*-

Now consider another fig 1 where both branch with different

Length one is L than other is 2L both branch having different Pheromone value.

3. ANT META-HEURISTIC

Ant meta-heuristic deployed in three inner processes that is 'construct solution', 'update pheromone' and 'Daemon action' [2][17]. All three processes can describe in following ways.

3.1 Construct Ant Solution

Ant apply decision policy between neighbor vertices, decision is carried out with the help of probabilistic rule on arcs.

$$P_{ij}^{k} = \tau_{ij}^{\alpha} / \sum_{n=1}^{Ni\,k} \tau_{ij}^{k} \text{ if } J \in N_i^k \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$P_{ij}^{k} = 0 \text{ (otherwise)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

3.2 Update Pheromone

Updating of pheromone trail is carried out in local and at last in global way, which we discussed in earlier. At each movement pheromone is decrease by constant factor due to pheromone evaporation. Deposit new pheromone on arc attract ants to choose that path, hence it increase probability that a particular connection is used by

Many ants. Pheromone evaporation prevents ants to use suboptimal region and explore new search space.

(a) Local updating-Let τ is pheromone between neighbour nodes local update carried out following way [2],[16],and [17].

$$\tau_{ij} \longleftarrow (1-\varphi)\tau_{ij} \ldots\ldots(3)$$

Where φ is constant factor (0,1] and $\boldsymbol{\tau_{ij}}$ is pheromone between i and j.Local update is carried out during movement between one node to another.

(b) Globally update-After evaporation has been applied to all arcs pheromone is updating global way.

$$\tau_{ij} \longleftarrow (1-\varphi)\tau_{ij} + del\tau^{k} \ldots\ldots\ldots(4)$$

Where delτ is total amount of pheromone deposited on all arc (edge)[2],[16],[17].

3.3 Daemon Actions (Optional)

It is centralized action which cannot perform by single ant. Among N number of path daemon action chose few or single path which is optimal solution in present iteration and also allow deposit more pheromone on particular path. States.

4. TRAVELLING SALES MAN PROBLEM (TSP)-

Ant colony optimization first introduced with TSP Which comes in NP- Hard area (due to Hamiltonian cycle).we can define problem in following way 'A person starts from one city visit to all city exactly ones and return to origin city with shortest distance (min cost)', let G (V, E) where 'V' is set of vertices such as { v_1, v_2.....v_n } represent cities and edges denote cost between vertices. Starts single vertices and complete Hamiltonian cycle. Due to Hamiltonian cycle, TSP problem comes in NP-Hard area .start from single vertices and select next vertices among (!n-1) combination is generates complexity $O(n^m)$ where n, m both are variables[4].TSP has many application such as DNA sequencing, planning, logistic, microchips etc[4] (1)TSP with ACO- ACO provides solution for Tsp which is optimal for some extent (not generaized..solution).we,can,divides,solution,inthree,major,partsthat,is[2],[16],[17][,9],[10],[11],[12].(a)Place randomly 'm' ants on 'n' cities (b) Construct Tour with apply probabilistic rule and local or 'Tabu search. (c) Update pheromone local or global way, (d) at the end shortest tour is optimal solution. Advantage of ACO solution is placement of ants on node in parallel, which start constructing solution from every node Although ACO for TSP not generates optimal universal solution but it is better for few hundred of nodes[2,][16].

Table 1: Pheromone value during city Movement [3]

From City	To City	Distance	Pher.
City_17	City_8	0.09667	14.75
City_8	City_7	0.4017	5.116
City_7	City_14	0.2531	5.459
City_14	City_9	0.192	10.73
City_9	City_16	0.1609	16.07
City_16	City_6	0.4085	0.9334
City_6	City_5	0.02541	4.135
City_5	City_11	0.09845	3.659
City_11	City_2	0.06801	11.67
City_2	City_15	0.1238	11.17
City_15	City_1	0.1104	16.74
City_1	City_13	0.2241	9.803
City_13	City_12	0.04789	13.21
City_12	City_0	0.06961	12.79
City_0	City_19	0.1799	11.32
City_19	City_4	0.06846	14.94
City_4	City_3	0.2754	13.9
City_3	City_18	0.49	1.836
City_18	City_10	0.1231	3.671
City_10	City_17	0.3642	0.8683

Figure [6] shows a best tour constructed by ants in 1000 iteration, next table[1] is about distance between cities and pheromone value, at last graphs [8] with some statistics which shows, Avg. length, travel length, avg. distance avg. branch in 1000 iteration[7]Related work about TSP- ACO first introduce with TSP [2],in which ant place randomly on node at starting ant start traversing from any random vertex and add vertices one by one and finally come to starting node, at the end there are many tour constructed by ants , smallest one tour is optimal solution of TSP[2], after this many modified solution and application (based on TSP) proposed such as ,Cao-Zhi-yi [9] proposed TSP optimization for 'cellular ant determine minimum ratio'(MRTSP), Wu-Junquiang [10] proposed ,'Delete –cross method for TSP' which speed up convergence of local search, Yang-yang[11] determine common optimal path based on common current sub optimal path and gave adaptive solution of TSP. Wiboonsak-watthayu[12] 'studies about Bangkok city and determine optimal path in Bangkok this case study is based on TSP.

5. RELATED WORK

Social network with ant colony optimization in growing discipline, base on this we are discussing some related proposed work which is combination of ant Meta heuristic and social network

5.1 Food Node

Dolores and all [13] in 'bio inspired algorithm for searching relationship in social network' given concept of 'food node'. Food node is kind of high centrality node (node with lot of friend).there is high probability of ant's to choose high centrality user node during search between source node to destination node. Approach suggests deposit Food on nodes and gives sense of smell to ants. Odor of food node is diffused in environment there is high probability ant will visit on food nodes.

5.1.1 Diffusion of Food Odor-

It may sure 'Odor' diffusion in limited area. Dolores defines mathematically expression to represent evaporation rate of food smell [13].

$$O(n_i) = O(n_j) - k*W_{ij} \text{ ……..(6)}$$

O(n) denote food order on node(either i or j) 'W' is weight on corresponding edge and k is evaporation factor.

(5.1.2)Path Search Phase-

Tabu list use to prevent repetition of visited node. Selection of valid node in based on equation(7) .n_i is set of actual node, node R is visible node after tabu list applied, n_j are indexed node through node R, τ is pheromone value between adjacent vertices[13].

$$P(n_i,n_j) = \tau ij / \sum k = \text{nodeR}(\tau ij)) \text{ …….(7)}$$

5.2 Predict Stock Market Movement onTwitter

Salah and all[18] in 'Ant colony based approach to predict stock market movement from mood collected on twitter' define prediction model which maps the relationship between input attribute (measure public mode states on twitter) and output (attribute present movement of stock market). Data set 'D' are define in following way D={ (x_1,y_1) ,(x_2,y_2),.....(x_n,y_n)} for 'n' data sample , where $X \in R^d$ is observation vector of d measurable mood state attributes and $y_i \in C$ is predicted direction of stock market. Objective of method is deployed in three principles that is 'decomposition of experts', 'reuse expertise chunks', 'adaptation of expertise chunks'. Probability is computed on the basis of conditional probability distribution of the original instance attribute coming for k^{th} BC.

5.3 Recommendation Trust Model for E-Commerce-

Zhang wei [20] in 'A novel trust model based on recommendation for E-commerce', zhang developed computational trust and reputation model based on recommendation in online service oriented environment. Trust path is calculated based on ant colony optimization. Two user can exchange information based on test scenario (TS).user i,j,k exchange information based on test scenario T ,user i.j,k exchange item $I_{i.j}$ and $I_{j,k}$ based on test scenario T(i.j) and T(j,k),and similarities of test scenario is gives as[20].

5.4 Dynamic social network from sensory data Feed-

Md Abdur Rahman , Abdulmotaleb El Saddik and wail Gueaieb in [18] 'Building dynamic social network from sensory data feed' developed frame work that bridge body sensor network(BSN) and social network by mapping a sub group of member's of social network with sensory data feed. A open stack is created and any sensor data push from BSN in stack and direct forward to interested subgroup of social network [18].

SNA (social network analysis) SNA data sets take place with three major steps:

(1)Find all possible routes between services and create graph. Forward ants' looks for possible service connect to user and back ward ant reinforce it.

(2) Using SNA ants try to discover resource associated with any user over the web.

(3) At the end matrix is created which points to each ego connect to space.

Paper present frame work for connecting social network to sensory network and also explore web 2.0 to web 3.0.

5.5 Mining Community in Social Networking with Ant Colony Optimization-

Zhang Nan and Wang Zhe [27] proposed clustering base an algorithm (CIACA) [cluster base improved ant colony algorithm],related to community mining in dynamic social network .CIACA combine local pheromone with global pheromone and utilize heuristic function to adjust cluster function dynamically, assisted by decay coefficient of dynamic network model .in order to improve clustering accuracy and convergence rate in the process of ant migration, a structure tightness between nodes based clustering centers method is proposed ,which can provides us initial clustering centers with certain clustering precision and high diversity. In addition random number and specific parameter are used in the ant transaction probability, which strengthens the search stochastic properties of CIACA effectively.

5.6 Articulation User Selection

Shashvat and all in 'pheromone base swarm approach detecting articulation user node in social network' [21] present novel approach to detect articulation user which is base on ant colony optimization, Communities in social

network are deployed in user nodes with connecting people, it may seem that there is some user which is common among many communities .these user node is a kind of 'social articulation points (SAP)' which is like a bridge between communities,

Next section is summarize work of ant colony optimization in some other field like machine learning ,computer networking, sub set, assignment problem .ant colony optimization also give solution of classical problem such as traveling sales person, graph color , job sequencing, quadratic assignment, problem of data mining, remote sensing, bio informatics, image processing.

Table2:- Summarize work of Ant colony optimization

Problem Type	Problem Name	Reference
Assignment	Sequential ordering, Quadratic assignment Graph coloring University course timetabling	Gambardella & Dorigo (1997, 2000) Maniezzo, Colorni, &Dorigo (1994) Stutzle (1997b) Maniezzo&Colorni (1999) Maniezzo (1999) Stutzle&Hoos (2000) Graph coloring Costa & Hertz (1997) Socha, Knowles, &Sampels (2002) Socha,,Sampels, &Manfrin (2003
Subset		
	Connection less routing	
	Connection – oriented routing optical routing	Schoonderwoerd, Holland, Bruten, & Rothkrantz (1996) Schoonderwoerd, Holland, &Bruten (1997) White, Pagurek, &Oppacher (1998) Di Caro & Dorigo (1998d) Bonabeau, Henavy, Gue´rin, Snyers, Kuntz, (1998) Di Caro and Dorigo (1997.1998)
Machine Learning		
	Classification rules Bayesian networks Fuzzy system	Heusse , Snyers,Guerin,and Kuntz(1998) Parpinelli Lopes and Freitas(2002)
Routing		
	Traveling salesman Vehicle routing	De Campos ,Gamez and Puerta (2002) Casillias Cordon and Herrera(2000) Dario, Manifesto, &Colorni (1991a,b,1996)
	Connection less Routing	Dorigo(1992) Gambardella,and Dorigo (1995) Dorigo& Gambardella
Network Routing	Connection-oriented routing	Schoonderwoerd, Holland, Bruten, & Rothkrantz (1996) Schoonderwoerd, Holland, &Bruten (1997) White, Pagurek, &Oppacher (1998) Di Caro & Dorigo (1998d) Bonabeau, Henavy, Gue´rin, Snyers, Kuntz, (1998) Di Caro and Dorigo (1997.1998) Heusse , Snyers,Guerin and Kuntz(1998)

6. CONCLUSION

This paper is all about survey of ant colony optimization.ant Meta heuristic help tool to solve combinational problem, hence social network is growing field with ant colony optimization. Ant Meta heuristic can solve social issue such as trust in social network, influence in social network and social graph issue. At last table summaries some other field related to Aco

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