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A STUDY ON IMAGE PROCESING WITH ANT COLONY OPTIMIZATION TECHNIQUE

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ABSTRACT

This study focuses on Ant Colony Optimization, a subfield of soft computing (ACO). To address a combinatorial optimization problem, ACO employs a method based on computational intelligence. It has been applied to routing, scheduling, sub-set, job, and classification challenges because of how straightforward and effective the method is. In this work, we will examine how Ant Colony Optimization can be applied to the field of image processing. In this study, we discuss how ACO is applied in several areas of image processing and how it is used to handle imprecise information and decision making in images. Edge detection, feature selection, edge linking, compression, and segmentation are some of the tasks that were analysed and addressed.

Keywords: Image, processing, system, edge, optimization.

INTRODUCTION

The biological foraging behaviour of certain species of ants serves as the inspiration for the optimization method known as ant colony optimization (ACO). To signal to other ants in the colony where food is and how to get there, workers lay pheromone trails in the soil. As time passes, so do pheromone trails. The longer it takes an ant to make the round trip, the more time the pheromones have to dissipate into thin air. Less-traveled, and hence more beneficial, routes are ploughed over with greater priority and speed. recovery from the loss of pheromones. Shorter distances maintain higher pheromone densities because more pheromone is being laid down at each step. Ants gradually adopt the shorter routes because of a positive feedback loop. This unplanned event served as motivation for enhancing the ACO metaheuristic. When Dorigo first proposed the ACO algorithm and ant programme (AS). In the interim, enhancements to AS have been developed. Ant colony structure is actually used by some very wealthy people (ACS). Since its inception, ACO has been used to solve a wide variety of optimization challenges.

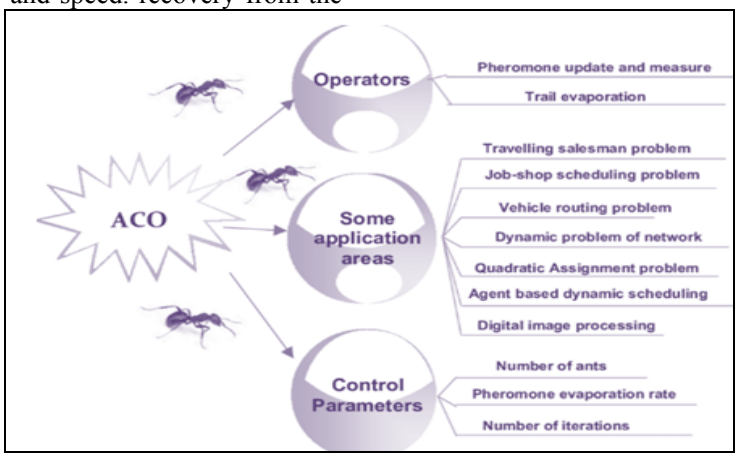

Figure 1: Framework of Ant Colony Optimization

Instead of trying to replicate the actions of real ants, ant algorithms are inspired by and modelled after their flexible and effective method of group communication. Synthetic ants can be viewed as communicating agents that have some characteristics with real ants but also include characteristics that have no natural analogues. In reality, it is the general characteristics that make them well-suited to solving problems, even if not optimally. Genuine foraging ants spend their entire lives moving back and forth between their colony and various food sources. It should therefore come as no surprise that the first problem solved using an ant algorithm, Ant System (AS), was the Travelling Salesman Problem (TSP), a well-known combinatorial issue in which the shortest route (path) that precisely visits each city of a certain set of cities, ending and starting at the same city, must be located.

CONCEPTUAL FRAMEWORK OF ANT COLONY OPTIMIZATION

Ant System: The goal of the travelling salesman issue is actually finding probably the shortest route

between a set of cities, completing and starting in the exact same city, going through all towns without visiting each community a few times. This particular issue is quite readily used to the thought of the Ant System due to the similarity of theirs in concepts: find probably the shortest path between 2 points in a graph. An AS algorithm thinks a sole ant colony with m man-made ants cooperating with one another. Before the algorithm begins to work each arc linking 2 various cities is provided a specific amount of pheromone τ0. This is normally an extremely little worth only adequate to make sure that the likelihood of each arc to be selected is actually distinct from zero. Furthermore, the ants are made. The algorithm has 2 primary phases, the building of the pheromone as well as the tour/solution update. Additional critical choices have to be made right before the ants are able to begin getting a solution, like defining the framework (representation) of the answer, or maybe the initial pheromone quantity to be awarded to each arc.

With iteration each ant is arbitrarily put into a city, out of the set of n cities. The city is going to be the kick off point of the tour which is to be built by the ant. A means to fix the TSP may be represented by a set of n consecutive cities. Thus, at each phase of the building the ant has to choose, with a certain probability, the subsequent city to travel to.

Ant Colony Principles: Ant Colony Optimization principles are actually based upon the organic behaviour of ants. In the everyday life of theirs, one of the chores ants have to perform is actually searching for food, in the vicinity of the nest of theirs. While walking in these kinds of a quest, the ants deposit a synthetic substance called pheromone of the ground. This's completed with 2 objectives. On the one hand, it enables ants to find the way of theirs back to the nest, like Gretel and Hansel of the fairytale. Additionally, on the additional hand, it allows for various other ants to learn the manner they've taken, so that the others are able to follow them. The curiosity is, simply because hundreds or perhaps thousands of ants have that behaviour, in case one might see the pheromone laid in the soil as a light type, the soil will be a big community with several of the arcs brighter compared to the others. Within the paths produced by those arcs would certainly be probably the shortest path between the nest and the food source. This particular behaviour may be viewed as a communication type between the ants. In case the road has a big concentration of pheromone, this's possibly because of its shorter length which helped ants to travel faster, resulting in a bigger selection of travels with the road thus with a lot more ants depositing pheromone on it. In addition, over time the pheromone evaporates and hence the focus of its reduces. The greater number of time it takes for the ant to go from the nest to the food supply and back again to the nest, the greater number of time the pheromones have to evaporate. This particular product is therefore used both on the good feedback, i.e. depositing of pheromone draws in some other ants to use the very same path that will improve the pheromone quantity, as well as on feedback that is negative, i.e. dissipating of the pheromone via evaporation leads to lower levels of pheromone hence discouraging different ants. Deneubourg et al (1990) and Goss et al (1989) carried out several encounters with genuine ants and they where in a position to show foraging ants are able to find probably the shortest path between the nest of theirs and several food supply, by the usage of a chemical substance called pheromone, they deposit while walking. When these experiments the authors proposed a stochastic design to explain what they'd noticed. It was the first task leading to an optimization algorithm depending on the foraging behaviour of ants. Several years later, Dorigo et al (1996) created the first foraging ants algorithm that had been known as Ant System which was first off proposed to resolve the travelling salesman condition.

Ant Colony System Algorithm: Various measures of an easy ant colony system algorithm are actually as follows.

A. Problem Graph Representation

Artificial ants can transition between states and settings with ease. Due to their typically discrete nature, the Continuous problems answered by the Ant Colony System algorithm can be represented by a graph with N nodes and R edges.

B. Ants allocation Initializing

A number of ants are actually positioned on the origin nodes. The amount of ants is usually defined based on trial and number and error of nodes of the region.

C. Ants option Distribution Rule

Ant's probabilistic switch between nodes may additionally be specified as node change rule as node transition rule.

D. Update Global Trail

When every ant has assembled an answer, at the conclusion of each cycle, the intensity of pheromone is actually up to date by a pheromone trail updating principle.

E. Stopping Procedure

To carry out this procedure, one must determine either the minimum number of cycles between two changes of the world's best strategies or the maximum number of cycles that can elapse before a change is made. The algorithm used by the Ant System has served as the basis for a wide variety of other ant algorithms, which have found use in a wide variety of exciting and fruitful contexts.

VARIOUS ASPECTS OF IMAGE PROCESSING

Edge Detection

One of the most telling characteristics of an image is its fast transition from high- to low-intensity regions, which often serves to convey crucial information about the subject at hand. In order to circumvent these restrictions, ACO-based systems can be implemented in parallel, making them suitable for use in distributed settings as well. In ACO-based edge detection approaches, a few "ants" are used to systematically explore the picture in search of interesting edges. An important pheromone matrix is formed as a result of this specific motion. Each pixel's edge information is encoded as a separate entry in the pheromone matrix. The key component to ant movement is variation in the intensity values of the image. This simple ACO-based technique was applied to successfully extract the image's edges. Some initial number of ants are scattered randomly around the picture. These ants increase the potency of their pheromones with each cycle. This approach employs a simple set of criteria to increase the concentrations of pheromones.

Edge Linking

Fake edges can be detected, actual edges can be missed, thin or thick lines can be produced, and noise can cause problems with both. These severed ties have been re-established through the use of an ACO-based strategy. The method is based on the observation that each pixel in an image is linked to its immediate neighbours. Pixels are assumed to be at the same distance from one another based on the original image's composition. Ants are placed on the identified boundary after using a conventional edge detection method. The search method is greatly complicated by the fact that an image is composed of many different endpoints. And since different ants may investigate the same area, it could lead to duplication of effort. The ants have been divided into several factions, each with a unique name, in order to confront this problem. An attempt by these ant colonies to repair the fractured edges. They broaden their search area to find compensable edges.

Feature Selection (FS)

Many areas of engineering and image processing face the challenge of choosing the right feature to represent an object or scene. Feature selection is used in the processing of pattern recognition, image recognition, and text recognition, which are all branches of image processing. In order to extract the features for the images, any typical feature extraction method can be used. The attributes could be global or local i.e. attributes could be of any single object of the image or even of the entire image. Shape, colour, consistency, contrast, cluster prominence, spatial correlations, etc. are all examples of attributes. The task that constitutes the key to further differentiation of images is the representation of the entire image using a feature vector, which is sufficient adequate to take the properties of its. Data processing and analysis are simplified as a result of the procedure's ability to reduce the dimensionality of feature space. To reduce computing complexity, a fundamental goal of feature selection in image processing is to eliminate irrelevant, unnecessary features. A comprehensive search is the best approach to this problem. The problem is that it requires analysing every potential subset of the whole set of features, which leads to exponential complexity and eliminates its usefulness in most real-world contexts.

Resolving the issue is unachievable due to the massive amount of research that applies thousands of subsets to individual datasets in pursuit of the optimal feature set. Therefore, selecting features is an NP-hard problem. ACO has been shown to be capable of solving NP-hard problems. Based on observations of ant behaviour, ACO compiles data from all over the world to find subsets of optimal solutions from all available features. The FS problems can be represented by a graph in which each feature is represented by a node and the graph can determine which features are more prominent overall. Filter methods and wrapper methods are two main categories into which feature section techniques can be placed. The criteria used to judge the effectiveness of each tactic is where the differences become most apparent. Wrapper strategies use a learning algorithm to direct the feature subset selection, whereas filter methods use statistical properties of information to make that choice.

Segmentation

The process of dividing a digital image into smaller parts, or segments, is known as image segmentation. The processing of the entire image can be made much more straightforward by breaking it down into smaller, more manageable pieces. Researchers have employed a multi-agent technique inspired by ant colonies to successfully divide an image into distinct clusters. Each image pixel is connected to its nearest cluster.

Incorporating Markov Random Field (MRF) and the AGO meta heuristic properties to segment a picture has significantly improved the performance of this particular technique. This algorithm employs a population of simple agents to create a candidate partition by a leisurely labelling in relation to contextual restrictions. The main problem with ACO-based algorithms is that the search activity in segmentation problems is highly subjective and requires a considerable number of calculations to converge on a good solution due to the continuously vanishing coefficients.

Still another ACO-based segmentation technique, this one inspired by a multistage choice algorithm, has been provided by Xiao et al. Through the use of this technique, precise outlines were obtained by locating the optimal route within a confined space. The arbitrary choice of clustering centres slows down the convergence

of these methods. The course-selection problem is both difficult and probabilistic in the standard ACO-based approach. An Author dealt with this issue using a fuzzy and soft method in conjunction with ACO. Every single picture element is treated as if it were an individual ant. In practise, the membership function of fuzzy sets is computed using heuristic and pheromone data on each cluster facility. Through the incorporation of spatial data, performance is improved even further.

Image Compression

The primary goal of image compression is removing the redundancies to be able to effectively use the transmission bandwidth as well as the storage area. A raw image contains Mbs of data, which is cut back by image compression methods. You will find 2 kinds of image compression methods - lossless compression as well as lossy compression.

Authors have effectively applied ACO for fractal image compression and also have accomplished decrease in computation time in comparison to standard techniques. To be able to decrease the encoding time an ant colony based fractal encoding algorithm has been recommended. The fractal encoding created by the ACO algorithm is wholly identical to that of the traditional full search. The main benefit attained will be the decrease in time. And so this particular algorithm is able to recognize the fractal image coding well. Authors have compared the overall performance of evolutionary methods as GA, ACO and PSO for fractal image compression and also have found the greater functionality of ACO with the various other strategies.

CONCLUSION

ACO has astounding potential in solving different image processing duties like edge detection, feature extraction, edge linking, segmentation as well as image compression. Details of different ACO algorithms towards solving these issues are talked about. Standard methods for solving these issues are also provided while showcasing the positive aspects of using ACO with these strategies. The present paper provides in depth analysis of ACO applied over image processing projects hence providing succeeding instructions of study. A number of other latest strategies as Cuckoo Search were utilized for optimization purposes. Potential study might concentrate on comparing ACO to these newest techniques. Moreover , search engine optimization given in66 may be evaluated by using ACO.

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