A HYBRID OF ANT COLONY OPTIMIZATION ALGORITHM AND SIMULATED ANNEALING FOR CLASSIFICATION RULES

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Abstrak

Pengoptimuman koloni semut (ACO) adalah pendekatan metaheuristik yang diilhamkan daripada tingkah laku semulajadi semut dan boleh digunakan untuk menyelesaikan pelbagai masalah pengoptimuman kombinatorik. Masalah penginduksian petua klasifikasi telah diselesaikan dengan algoritma *Ant-miner*, satu varian ACO, yang diketengahkan oleh Parpinelli dalam tahun 2001. Kajian lepas menunjukkan bahawa ACO adalah teknik mesin pembelajaran yang berkesan untuk menjana petua klasifikasi. Walau bagaimanapun, *Ant-miner* kurang pemfokusan terhadap kelas kerana petua untuk kelas diberi selepas petua dibina. Terdapat juga kes di mana *Ant-miner* tidak dapat mencari sebarang penyelesaian optima bagi sesetengah set data. Oleh itu, tesis ini mencadangkan dua algoritma varian hibrid ACO dengan simulasi penyepuhlindapan (SA) untuk menyelesaikan masalah induksi petua pengelasan. Algorithm pertama menggunakan SA untuk mengoptimumkan penemuan peraturan oleh setiap semut. Set data tanda aras dari pelbagai bidang telah digunakan untuk menguji algoritma yang dicadangkan. Keputusan eksperimen yang diperolehi daripada algoritma yang dicadangkan ini adalah setanding dengan keputusan *Ant-miner* dan beberapa algorithma induksi petua terkenal yang lain dari segi ketepatan petua, dan menunjukkan keputusan lebih baik dari segi saiz petua. Algoritma kedua pula menggunakan SA untuk mengoptimumkan pemilihan istilah semasa pembinaan petua. Algoritma ini juga menetapkan kelas sebelum pembinaan setiap petua. Penetapan awal kelas membolehkan penggunaan fungsi heuristik dan fungsi kecergasan yang lebih mudah. Keputusan eksperimen algoritma kedua adalah lebih baik berbanding dengan algoritma lain yang diuji, dari segi ketepatan ramalan. Kejayaan dalam menghibridkan algoritma ACO dan SA telah membawa kepada peningkatan keupayaan pembelajaran ACO untuk pengelasan. Oleh itu, model klasifikasi dengan kebolehan ramalan yang lebih tinggi untuk pelbagai bidang boleh dijana.

Kata Kunci: Pengoptimuman koloni semut, Simulasi penyepuhlindapan, *Ant-miner*, Penginduksian petua

Abstract

Ant colony optimization (ACO) is a metaheuristic approach inspired from the behaviour of natural ants and can be used to solve a variety of combinatorial optimization problems. Classification rule induction is one of the problems solved by the Ant-miner algorithm, a variant of ACO, which was initiated by Parpinelli in 2001. Previous studies have shown that ACO is a promising machine learning technique to generate classification rules. However, the Ant-miner is less class focused since the rule's class is assigned after the rule was constructed. There is also the case where the Ant-miner cannot find any optimal solution for some data sets. Thus, this thesis proposed two variants of hybrid ACO with simulated annealing (SA) algorithm for solving problem of classification rule induction. In the first proposed algorithm, SA is used to optimize the rule's discovery activity by an ant. Benchmark data sets from various fields were used to test the proposed algorithms. Experimental results obtained from this proposed algorithm are comparable to the results of the Ant-miner and other well-known rule induction algorithms in terms of rule accuracy, but are better in terms of rule simplicity. The second proposed algorithm uses SA to optimize the terms selection while constructing a rule. The algorithm fixes the class before rule's construction. Since the algorithm fixed the class before each rule's construction, a much simpler heuristic and fitness function is proposed. Experimental results obtained from the proposed algorithm are much higher than other compared algorithms, in terms of predictive accuracy. The successful work on hybridization of ACO and SA algorithms has led to the improved learning ability of ACO for classification. Thus, a higher predictive power classification model for various fields could be generated.

Keywords: Ant colony optimization, Simulated annealing, Ant-miner, Rule induction

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List of Abbreviations

ACO	Ant colony optimization
AD	Air defense
ANN	Artificial neural network
ASA	Adaptive simulated annealing
C2	Command and control
DFR	Distribution feeder reconfiguration
DGs	Distributed generators
GA	Genetic algorithm
IIR	Infinite-impulse-response
IR	Information retrieval
ML	Maximum likelihood
MMAS	Max-Min ant system
MSER DFE	Minimum symbol-error-rate decision feedback equalizer
ODP	DMOZ Open Directory Project
PSO	Particle swarm optimization
SA	Simulated annealing
SAM	Surface to air missile
STWTSDS	Single machine total weighted tardiness with sequence-dependent setups
TAP	Target assignment problem
TS	Tabu search
TSP	Travelling salesman problem
Web->KB	CMU World Wide Knowledge Base

The contents of the thesis is for internal user only

CHAPTER ONE
INTRODUCTION

The tremendous growth in computing power and storage capacity, the availability of increased access to data from Web navigation and intranets, the explosive growth in data collection, the storing of the data in data warehouses, and the competitive pressure to increase market share in globalized economy stimulated the development of data mining. Data mining acts as a tool to extract or yield important information from raw data.

Classification is a data mining task of finding the common properties among different objects and classifying the objects into classes. Figure 1.1 depicts the general framework of classification task. The classification model contains a set of classification rules. The classification model categorizes new unseen example data, by predicting a class label for the example. One way of presenting the classification model is by representing the information as a set of IF-THEN rules (classification rules).

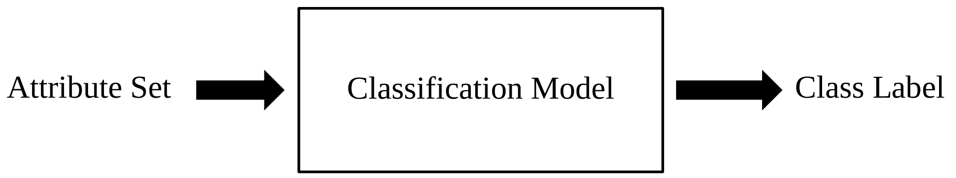

Figure 1.1: Classification Task General Framework

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