Local Search Algorithm by using microRNA-list

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I. Introduction

PROBLEM solving strategies inspired by nature has been a primary focus in AI field for a number of years. These are utilized not only for understanding how nature works but for finding better techniques to solve problems. For example, Evolutionary Algorihms (EAs) have been widely used in the field of optimization. In fact, the use of evolutionary algorithms is generally well suited for optimization problems.

In this project, we introduce a optimization algorithms by using microRNA(abbr. miRNA)s-pieces-list to improve the efficiency of exploration of search space. The algorithm extends a general local search approachs to guide searching direction and avoid searching regions likely having unfavourable solutions. In our approach the techinique of escaping from unattractive area will be implemented by miRNAs-pieces-list. We end the report by demonstrating that miRNAs-pieces-list can be applied to Maximumcut(abbr. Max-cut) problem with promising results.

II. Background

A. microRNAs

microRNA provide crucial inspiration for devising new appoach. A microRNA is a small non-coding RNA molecule (ca. 22 nucleotides) found in plants and animals, which functions in transcriptional and post-transcriptional regulation of gene expression. Encoded by eukaryotic nuclear DNA, miRNAs function via base-pairing with complementary sequences within mRNA molecules, usually resulting in gene silencing via translational repression or target degradation. miRNAs are well conserved in eukaryotic organisms and are thought to be a vital and evolutionarily ancient component of genetic regulation. Combinatorial regulation is a feature of miRNA regulation. A given miRNA may have multiple different mRNA targets, and a given target might similarly be targeted by multiple miRNAs. miRNA research has revealed multiple roles in negative regulation (transcript degradation and sequestering, translational suppression) and possible involvement in positive regulation (transcriptional and translational activation). By affecting gene regulation, miRNAs are likely to be involved in most biological processes Selbach et al. and Baek et al. indicated that a single miRNA may repress the production of hundreds of proteins, but that this repression often is relatively mild (less than 2-fold).[1]

B. Maximumcut

We show importance of this novel approach as solving Maximumcut(abbr. Max-cut) problem. For a graph, a Max-cut is a cut whose size is at least the size of any other cut. The problem of finding a Max-cut in a graph is known as the max-cut problem. The problem can be stated simply as follows. One wants a subset S of the vertex set such that the number of edges between S and the complementary subset is as large as possible.[2]We define this number as fitness value of subset S and S'.

III. Model

A. Local search algorithm

We use typical local search algorithm which is steepest hill climbing to optimize a target fitness function $f(x)$, where x is a solution vector of binaray values that indicate whether a particular element belong to subset S or S'. This is an iterative algorithm that attempts to find a better solution x by incrementally changing a single element in solution x. Where subset S and S' are given, fitness gain is defined as that which is gap between fitness value of given subsets and fitness value of changed subsets by moving an element from one subset to another. All possible change are compared and the change causing biggest fitness gain is accepted. This incremental change is made to the new solution, repeating until no further improvements can be found. x is then said to be locally optimal.

This algorithm is good for finding a local optimum, a solution that cannot be improved by considering a neighbouring configuration, but it is not guaranteed to find the best possible solution, which is the global optimum, out of all possible solutions in the search space. The characteristic that only local optima are guaranteed can be cured by using multi-starts (repeated local search), or more complex schemes such as EAs.

B. miRNAs-pieces-list

The key role of miRNA is to restrict the funtions of certain genes to prevent to generate genetically vulnerable feature. Like miRNA in nature, we would like to use miRNAs-pieces-list to handle the abilities of avoiding disadvantage .

we use local search algorithm to reach to local optimum, then add the local optimum solution to miRNAs-pieces-list and set escaping count(EC) to 1 which determine how futher next target solution will be from the local optimum solution. The local optimum is called as miRNA-piece. EC imprement is occured by revisitation a miRNA-piece that already has been uploaded to miRNAs-pieces-list so that search agent escape from locally wide attractor, the miRNA-piece. We assist miRNAs-pieces-list is approximately in apposition with particular set of miRNAs because Schema of a miRNA is shared by multiple miRNA-pieces.

IV. Experiments

Experiment was conducted under Intel i5-3337U processor, 1.80GHz $\times 4$. we generate an instance randomly having 750 vertecies and non-weighted edges which means all weight of edges are equal and non zero. Only one instance is used in this project. haha. Each trial is repeated ? times and averaged. Each time the system are iterated ? steps of local search to try to find best solution.

A. Local search vs. Local search+miRNAs-pieces-list

local search decribed in subsection 3.A is compared with same scheme but using miRNAs-pieces-list

to check whether this kind of scheme works well or not. so we set the experiment evironment like this.

when the agent meet local optima former strategy doesnt do anything(just restart repeatedly) but record best fitness score to find best solution so far, whereas later one works slightly different like when the same situation is happened it check miRNAs-pieces-list whether uploaded and then if it does the system increase ec and escape from that local area using ec. how to eacape is quite easy. just perturbing the current solution. that s all.

B. Inheritance of miRNAs-pieces-list

now we will compare two different starategy which are noraml miRNAs-pieces-list local search decribed above and miRNAs-pieces-list with inheritance local search. the later searching scheme has also simple difference. when the system meet terminate condition former one do nothing and when it restarts former one has empty list but later one recieve previous list like inheritance.

V. Result and Discussion

the results of first experiment is like this. It means like that statistically. This is implied sth like sth. blabla.

the results of second experiment is like this. It means like that statistically. This is implied sth like sth. blabla.

Through this study we show it is helpful for solving Max-cut problem to use mechanism from nature .

We assume miRNAs-pieces-list is emcompassed by schema of miRNAs but couldn't prove it but we remain this for future work.

References

[1] http://en.wikipedia.org/wiki/MicroRNA
[2] http://en.wikipedia.org/wiki/Maximum_cut