Combinatorial Optimization

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Workdone during the current semester

- Literature survey on Quadratic bottleneck knapsack problem(QBKP).
- Implementing artificial bee colony based algorithm to solve QBKP.

Quadratic bottleneck knapsack problem (QBKP)

Let E $= \{1, 2, \ldots, n\}$ be a finite set and for each $(i, j) \in E \times E$, a cost q_{ij} and for each $j \in E$ a weight $w_j > 0$ are prescribed and $c \geq 0$ be a given capacity. Then QBKP can be formally defined as.

Minimize $\{\max q_{ij} : (i, j) \in S(X) \times S(X)\}$

Subject to $\sum_{j=1}^{n} w_j x_j \geq c$

$x_j = 0$ or 1 for j $= 1, \ldots, n$,

where $X = (x1, ..., xn)$. Also for QBKP we assume $q_{ij} \geq 0$ without loss of generality.

The QBKP problem can be formulated as, suppose we want to make a selection among n types of investments for a portfolio. Let q_{ij} be a measure of the combined risk for choosing both investments i and j, and let w_j be the expected return on investment j. Then the objective is to minimize the maximum risk, while the total expected return is not less than a prescribed threshold value c.

Ruonan Zhang, Abraham P.Punnen(2011) Quadratic bottleneck knapsack problems. Journal of heuristics;

Previous work on QBKP

- Semi greedy algorithm
- Approximate quadratic threshold heurisitc
- Cutting planes algorithm

ABC based algorithm to solve QBKP

- Initial solution
- employee bee phase
- onlooker bee phase

Initial solution

The initial solution is generated by selecting te first object randomly, then at each iteration an object which is having the maximum profit with already existing elements in the knapsack is selected and it is deleted from the unassigned list. This process is repeated until the capacity constraint is satisfied. Each newly generated solution is checked for uniqueness against the population of solutions generated so far and if it is unique then it is included, otherwise it is discarded.

Employee bee phase

In order to generate a neighboring solution for a particular solution i, first we create a copy i' of solution i and choose another solution j randomly. From solution i' we delete 3 objects randomly and add 3 objects chosen randomly from the random solution j.

If collision occurs then it is resolved by making the associated employed bee scout thereby eliminating one duplicate solution.

Onlooker bee phase

Binary tournament selection method is used for selecting a food source.

In the binary tournament selection two foodsources are selected randomly, and, the better of the two foodsources are selected with the probability p_{better} and worse of the two with the probability $1 - p_{better}$.

If the collision occurs while generating the neighboring solution for an onlooker then another solution is chosen randomly for copying objects from it.

2-phase heuristic

To Transform an infeasible solution into a feasible solution a 2-phase heuristic method is used.
In this method objects from the unassigned list are selected and added if their maximum profit value with the already existing elements in the knapsack is less than the maximum profit value of the objects available in the knapsack. This method is iterated until capacity constraint is satisfied.
During the second phase of this heuristic objects from the knapsack are deleted without voilating the capacity constraint.

Work to be done in the next semester

- Literature survey on plant propagation algorithm (PPA).

Conclusion

Hybrid artificial bee colony algorithm proved to be best approach for solving different np-hard combinatorial optimization problems.

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