Application of Nature Inspired Algorithms for Decision Making of Small Businessmen

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Abstract

The main aim of this paper is to present a decent optimal demand forecasting technique for the cause of survival and development of small entrepreneurs of daily Indian rural markets using nature inspired genetic algorithms. The paper tries to explore the various existing parameters of the targeted groups and analyze the same using Special Pareto Evolutionary Algorithm (SPEA) to present an optimized and effective technique for a better decision making in the prevalent uncertain environment. The 0-1 Knapsack problem is used as solution of the SPEA algorithm, methods and procedures for finding the minimal spanning tree in graphs and diagraphs, domination parameters problems.

Keywords - *Nature Inspired Algorithms, SPEA Algorithms, Dynamic Programming, Shortest path Problem*

I. INTRODUCTION

The local businessmen dealing with vegetables, milk and fish on a daily basis usage of Indian markets in every parts of India face hard survival though they fulfill an integral part of diet for lower or upper middle class communities of rural India. In spite of having high end demand of their items, they often mooed down by various challenges with very few survival strategies. These challenges are mainly because of reasons like lack of an organized infrastructure, small working capital, and other basic challenges of the daily essential fundamental needs and the debts of this small entrepreneur involved along with the apathy of the Government in this sector. Hence, there is a strong need for these small rural businessmen in terms of an effective demand prediction technique. This study thrives for using an optimal model using an effective optimization model. The researcher studies the possibility of fitting one such nature inspired evolutionary genetic algorithms in this environment which is SPEA algorithms.

II. PRELIMINARIES

A. Definition of the Existing system

Let us analyse the primal problems associated with a common hutwalas, which include a daily fund based on its only available resources, which he or she needs to invest productively on purchasing the basic lot of a group of items depending on several parameters, discussed bellow that would yield a maximum profit .The parameters here symbolizes the constraints which induces an optimal search for the given problem. The common parameter includes:

- Available cash / Daily Investment scheduled for the day
- The available display area, which itself is limited and minimal and needs to be effectively addressed.
- Seasonal and maximum demand of the customer along with special focus for festive and other specific demands
- Lot size depending on the last two days business on a certain type and the available purchase power of the region. Normally they maintain two lot sizes (5-Kg/10-Kg per type)
- Possibility of taking risks.

B. Exploring suitable technology for the model

The solving of this real life problem is identifying a mathematical model or function that best suits the constraints/data collected during the experiment associated with this dynamic problem environment, during the operation process of the experiment. Thus if we can specify three elements of the problem: a model of phenomenon of distinguished decision variables, an objective function i.e a quality criterion, and limitation of each of this can be strictly formed as an optimization problem. This approach should involve risk analysis, safety and reliability as this caters to a very vital resource of the element concerned in the system (hutwalas) whose entire existence depends on the day's success.

In this paper , first we discuss the various optimization methods for selection of the problem and thereby defining it environment then use the graphical methods for presenting a solution model ,which can act as a reliable , safe ,risk free , and accurate for the business man with least wastage and each part worth for the day's capital.

C. Review of multi criterion optimization methods

As we are aware the problem of optimization are broadly of two types:

- Single criterion
- Multi criterion

The problem defined above falls in the category of multi criterion category and we pick up the method of the Goal Programming methods. As we also are aware, these methods represent general approaches for optimization i.e. deterministic, non deterministic, heuristic, evolutionary or genetic, so in this paper we tend to fit an evolutionary or a genetic approach which involves the successive revisions at each stage before specifying an optimal lot. A general operation of genetic or evolutionary algorithm is based on the following steps:

1. Initialization
2. Calculate fitness
3. Selection /Recombination/Mutation (parents and children)
4. Finished

III. METHODOLOGIES

In this paper we try to utilize the power of the Strength Pareto Evolutionary Algorithm (SPEA).

A. SPEA algorithm

This algorithm as discussed is a multiple objective evolutionary algorithm from the evolutionary computational approach. The objective of this algorithm is to locate a front of non dominated solutions an ideally a set of Pareto optimal solutions. This is achieved by using an evolutionary process to explore the search space, and a selection procedure that uses the combination of degree to which a candidate solution dominates over its counterpart in the solution space and an estimation of the Pareto front as an assigned fitness[Clever Algorithm: Nature Inspired Programming Recipes, By Jason Brownlee].

Here we assume that the problem is a maximization of the profit problem where in we first assume the parameters, mentioned above, which are considered to be the decision vectors for the problem and stored at the set X. Mathematically the Pareto optimal is picking up of the parameters and then identifying the dominance of one over the other in terms of decision making. Let's say two factors T and t of two parents ready for mutations.

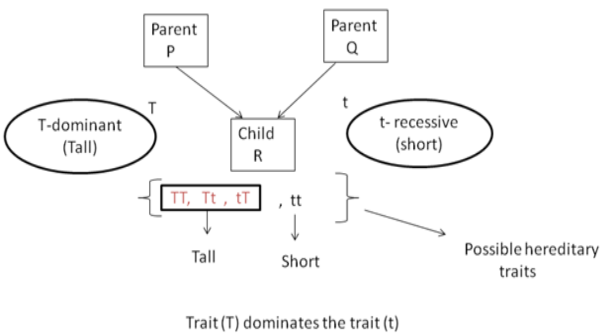

Fig1: Genetic Evolution, implication of dominance of one parameter over the other

Thus, from the above figure we can say that from the possible heredity set of child T dominates t or T, similarly in our case if we consider the available working capital (say x) allotted for the day ,and the maximum variety possible for the day items(y) ,then clearly x will dominate y. It is clear from the context that the parameter y is left out or covered by the parameter x. Hence using this process we eliminate the vectors of the parameter set X.

Thus the definition of the given problem is:

Maximise: Profit + Variety

Subject to

X: {capital, variety, display-area, Lot-size} // weight vectors set

Y: {reliability, fitness to the environment, safe} //quality vector set

B. Analysing and posing effective algorithm for the given problem

Knapsack [0\1] strategy using Branch and Bound greedy approach: This approach is solution chosen for this problem because the problem falls under the category of Dynamic Programming, greedy approach, with features of branch and bound feature, backtracking (for improvisation) etc.

C. Knapsack [0, 1] strategy

Let us assume a set of '**n**' items, which has a expected profit '$\mathbf{p_i}$ '(if sold) associated with each item collected in a profit set P and a weight $\mathbf{w_i}$, calculated on several factors as discussed W. Let us assume a Knapsack size of M kg on the basis of the ratio of the available display area, max profit, variety and the category of items. For the sake of calculation let us take n = 4 a P = {1,2,5,6} in rupees and weight W = {2,3,4,5} , Let M = 8 Kg. Now ideally visiting the market for variety he finds the common items taken by his competitors are the 4 items. If he includes all the items i.e. 2+3+4+5 = 14 Kg, which is more than the Knapsack size of 8 Kg. Thus he requires taking an optimized decision on the weights to exclude certain items yet max profit and max variety, and also the floor area. In the process it will satisfy the qualified variable set Y as discussed in the problem above. This requires configuring another set which would be the solution of the problem. This set will be having a value 0/1 for each item as not included/included. Thus here for each four items we will have 2^4 solutions =16 solutions as:-

{0,0,0,0} – all the four items not included --------- not possible

(1,0,0,0} – item 1 only included

…

…

{1,0,0,1} – item 1 and item 4 included

…

…

{1,0,1,1} – item1,item 3 and item-4 included

…..

{1,1,1,1} – all items include (which is not possible for this case as $\sum_1^n$ > M)

Now, we have to analyse all the 16 solutions to get an optimized solution, but for a generalized case if we take this algorithm to a broader solution with n items, we require to analyse $\mathbf{2^n}$ solutions to analyse and hence a complexity of **O (2^n)** order, which is complicated .Hence this problem has every attributes to be considered as a dynamic optimization problem with a candidate solution of branch and bound technique as exhibited.

Let us configure the solution set S = {P,W} as follows:

P = {1,2,5,6} , W = {2,3,4,5}

S^0 = {0,0}----→ no items included ,as P=0 and W=0.

$S^{0/1}$ = {1,2} --- -> add 0 + p_i, 0 + w_i ,include the first object i.e. (p_1,w_1) is added

S^1 = {(0,0),(1,2)}→ implies cost for no items included and cost for first item included.

$S^{1/1}$ = {(0+2,0+3),(1+2,2+3)}= {(2,3),(3,5)}→ add (2,3) to the ordered pairs

S^2 = {(0,0),(1,2),(2,3),(3,5)} -> implies cost when no items are included, first item is included,2nd item is included and both 1st and 2nd item is included.

$S^{2/1}$ = {(0+5,0+4),(1+5,2+4),(2+5,3+4),(3+5,5+4)}

= {(5,4),(6,6),(7,7)(8,9)}→ add (5,4) to the ordered pairs.

S^3 = {(0,0),(1,2),(2,3),(3,5),(5,4),(6,6),(7,7),(8,9)}-> Here (8,9) implies profit is 8 and weight is 9kg,whichis exceeding M, so this tuple is excluded from S^3.

Thus S^3 = {(0,0),(1,2),(2,3),(3,5),(5,4),(6,6),(7,7)}

Note we revise S^3 as we observe that the pattern from the tuple (3,5) and (5,4) that on increase of profit from 3 to 5, weight decreases from 5 to 4 which is not true as per the natural phenomenon so we discard the tuple (3,5) which is known as dominance rule.

Thus , S^3 = {(0,0),(1,2),(2,3), (5,4),(6,6),(7,7)}.

Now, we prepare the $S^{3/1}$, by adding the last (p_4,w_4) i.e. (6,5) to $S^3$and form $S^{3/1}$

S^4 = {(0,0),(1,2),(2,3), (5,4),(6,5),(7,7),(8,8)}.--> Final Selection generating all possibilities of pattern of selection. The time taken by this algorithm is almost 2^n.

Now we take simultaneously the sequence of decision for solving the optimization problem

TABLE I. **Decision Table for decision making for the inclusion/exclusion of items**

Ordered Pair	Analysis/Interpretation	Decision
(8,8) highest pair	€ S^4 but not € S3, S^4→4th item	Include 4th item (P=6) ,x_4 =1
(8-6,8-5)=(2,3) Here (6,5) which is substracted from the highest pair is actually the (p_i, w_i) for the 4th item	€ S^3 and also € S^2,S^3→3rd item,i.e this is not bcoz of the third item. Now (2,3) € S^2 but not to S_1, S^2-> 2nd item	Do not include 3rd item Decision variable,x_3=0 So, Include 2nd item (p=2) , Decision variable ,x_2 =1
Now the (p_i, w_i) pair for the second item is (2,3) , so (2-2,3-3)=(0,0)	Now (0,0) € S^1 and € S^0	So 1st item is not included Thus the decision matrix is : (0,1,0,1), Weight = 0+3+5+0= 8 Kg Profit = 2 +6= 8

IV. ALGORITHM AND RESULTS

Shop Mix Finder (Daily Investment Limit, Shop Area, items Available)
Problem type: NP Hard

Algorithm Category: Special Pareto Evolutionary Algorithm/Nature Inspired Algorithms

Procedure:

1. Design an outlay for the day.
2. Calculate the Expected Profit.
3. Calculate the weight of the associated items, by ranking them on the basis of certain heuristics, involving previous day /experience of the sale.
4. Find all possible optimal strategies for the problem using set method of SPEA algorithm.
5. Investigate and find the dominance of one strategy over the other using dominance principle.
6. Find optimal strategy.
7. Calculate the Profit and find out the variance from the expected profit and best-fit on various quality factors.
8. Update the heuristic function of weight, and readjust accordingly and generate a new iteration of

Step-3 and continue.

Complexity : O (2^n)

Output: Item –Matrix {cauliflower, potato-A, potato-B, beans, tomato, green chilly}

Selection Matrix {1, 1, 1, 0, 0, 1}

Thus, the above strategy provides a risk free strategy of selection of items which finds an effective mix that can efficiently fill up the display area and have a minimum loss and guarantee a minimum return, as the weights which determine the selection are more from the environment and are therefore more realistic and efficient mix of the demand and working capital is made.

V. LIMITATIONS

Depends on the blind search, and hence can encounter many plateaus, before finding a static and more confident optimal strategy .But more success encountered will instill confidence on the business man and he tries upgrading his heuristic functions and thus the weights and the dominance functions. The researcher has used only one such SPEA algorithm - namely Knapsack (0, 1), but felt other such algorithm like Travelling salesman or Prim's algorithm can also be tried for the design of effective solutions for such scenarios.

VI. CONCLUSIONS

In this study it was found that the nature inspired algorithms are much more suited for these unorganized environments. It has enough potential for creating a mark in case of small scale enterprises, where the uncertainty of demand has a certain common parameters and can be very well be defined by the multi criterion characteristics of dynamic problem. It needs an effective optimization method, which SPEA methods discussed above presents a more informed results which can evolve to be the best solution in the present dynamic world.

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