The Application of Hybrid Genetic Algorithms Model in Solving Product Optimization Problem

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Abstract—**We introduce basic theory of genetic algorithms in this paper, Build one hybrid genetic algorithms model base on genetic algorithms in solving product optimization problem. And we realize the model by software. The disposal result of real data tells us that the model has good practicability and accuracy to the problem of product optimization problem.**

Keywords-genetic algorithms; hybrid genetic algorithms; product optimization; fitness function

I. INTRODUCTION

The final aim of every manufacturer is to realize the maximal benefit how to use resource fully under the condition of limit resource. We can solve this problem by genetic or developmental algorithms, but there is bug if we use single algorithms. We combine the two algorithms to build hybrid genetic algorithms in this paper, and solve the product optimization problem very good.

II. GENETIC ALGORITHMS DESCRIPTION

A. Brief of genetic algorithms

The genetic algorithms are one self-fit global probability search algorithms that genetic and evolution procedure of biology is simulated in the environment. It is provided earliest by Holland professor of university of American Mizhian，and origin from the research of nature and manpower self-fit system in 1960 years. [1] De Jong carry out a lot pure number function optimize compute experiment base on genetic algorithms in 1970 years. [2] Goldberg form basic framework by sum up and base on a serial research work in 1980 years. [3]

B. Basic term of genetic algorithms

The genetic algorithms are one new search and optimize algorithms that simulate genetic choice and natural eliminate through selection or contest's biology evolutionism base on Darwin's theory. The theory of Darwin thinks that every species more and more fit environment during the development procedure. Every basic character is inherited by next era, but net era is not equal to father era. The character is saved if it fits environment, and this is the theory of survival of the fittest. The genetic theory of Mendel thinks that genetic code encapsulation in every cell, and is included in the chromosome by the form of gene. The position of every gene controls has special place and control some special property, the position of gene named gene seat in the chromosome. Every unit has definite fit to the environment. The gene across and variation can produce next era better. The fit of species to the environment continues improve in nature by nature choice. We can get conclusion that breed of biology provides the chance to appear good character, nature choice saves the good character. The species is better by this method. The idiographic method is copy, across and variation. The genetic algorithms realize optimization procedure by simulating the three methods.

The genetic algorithms express the solution of the problem as chromosome. We build chromosome group by many feasible solutions. We put them in the condition of problem environment, choose chromosome of fit environment to copy according to the rule of survival of the fittest, produce new era chromosome colony by across and variation operator. We get optimization by converge the unit of fittest environment after continue evolution of every era. The operation of genetic algorithms is going on in the problem environment, the environment is fit function.

C. Evaluation step of genetic algorithms

The three basic terms of genetic algorithms, code, genetic operator and fit function.

(1)Code. Among genetic algorithms, we first should change research space into expression space, which operation is called code. The adverse operation is called decode. The spaces of expression space are called individual or chromosome. Individual usually is expressed by string, each bit of string is called gene. Many individuals constitute a population to be used by genetic algorithms.

(2)Genetic operator. Superior wined and inferior washed out process is called genetic operator during evolution. The genetic algorithms mainly include three genetic operations: copy, across and variation.

(i)Copy is that forming new generation by exchanging and variation from father's good individuals with high fit.

(ii)Across is a genetic exchange process between two chromosomes.

(iii) Variation is gene's random change process of a chromosome.

The process of （ii） and （iii） can produce ideal chromosomes.

(3)Fit function. Among genetic algorithms, define a match function to measure a chromosome's extend. This is fit function. It is not confined by continuum and differentiability.

D. Evaluation step of genetic algorithms

We express the problem into chromosome first and build chromosome group. We put them in the condition, choose chromosome of fit environment to copy according to the rule of survival of the fittest, and produce new era chromosome colony by across and variation operator. We get optimization by converge the unit of fittest environment after continue evolution of every era.

The four ready works must be finished first if we want to use genetic algorithms to solve the problem.

(1)We ensure express scheme, that is how to express every point of problem space into binary string of sure length.

(2)We ensure the measurement if fit, that is how to compute fit value of every sure length character string.

(3)We ensure parameter and variable, that is scale M of colony, max era N, copy probability P_r, across probability P_c, variation probability P_m and so on.

(4)We ensure the method of produce the result and the rule of stop run.

We can execute genetic algorithms after finishing ready work. The main step of genetic algorithms as follows.

(1)We produce initial colony random by one character string group that confirm length.

(2)We execute step （i） and （ii） until satisfy stop rule.

(i)Compute fit value of every unit in the colony

(ii)Produce next era colony by copy, across and variation operator

(3)We name the execute result of genetic algorithms that two best unit strings of every era. The result can be expressed one solution (approximate solution).

The basic genetic algorithms as follows picture 1. Variable k is current era number, and m is colony scale.
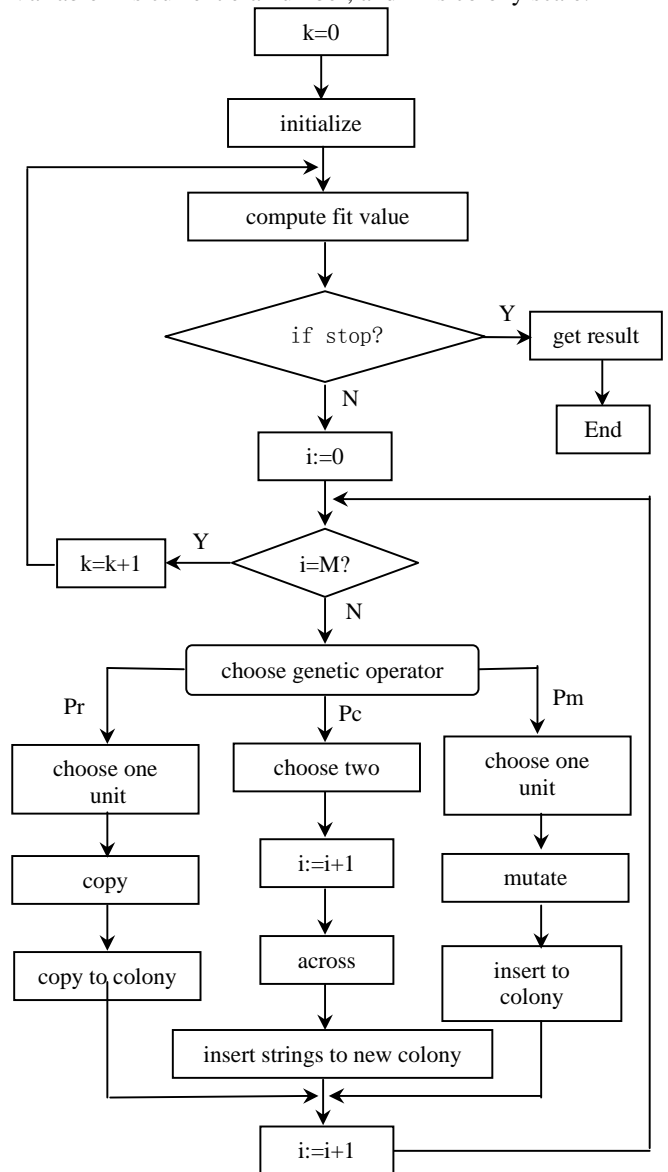

Figure 1 basic genetic algorithms framework

III. APPLICATION IN SOLVING PRODUCT OPTIMIZATION PROBLEM

A. Bring forward problem

Some factory can produce fifty products, and the material of every product as table 1. The unit of material is M, the unit of profit is YUAN.

Table 1 product use material and profit

product	1	2	3	4	5	6	7	8
material	253	245	243	239	238	237	236	235
profit	200	200	240	240	225	225	235	235

product	9	10	11	12	13	14	15	16
material	234	232	231	230	229	228	227	226
profit	110	140	160	180	150	130	170	180
product	17	18	19	20	21	22	23	24
material	224	217	213	207	203	201	195	194
profit	190	230	220	280	210	205	195	190
product	25	26	27	28	29	30	31	32
material	191	188	187	177	175	171	169	168
profit	180	170	160	140	175	185	160	160
product	33	34	35	36	37	38	39	40
material	166	164	161	160	158	150	149	147
profit	165	170	190	160	140	150	130	120
product	41	42	43	44	45	46	47	48
material	141	140	139	136	135	132	128	126
profit	110	140	135	145	155	160	165	125
product	49	50						
material	122	120						
profit	125	120						

The total number of material is five thousands meter. The request of manufacturer is to realize the maximal benefit how to use resource fully under the condition of limit resource.

B. Abstract math model

We can abstract the problem into bag problem wide, math model as follows.

$$
\begin{cases}
\max \sum_{i=1}^{50} P_i X_i \\
s.t. \sum_{i=1}^{50} R_i X_i \le 5000 \qquad (4\text{-}1) \\
X_i \in \{0,1\}, 1 \le i \le n.
\end{cases}
$$

thereinto, $P=(P_1,P_2,\cdots,P_{50})$ is profit vector, $X=(X_1,X_2,\cdots,X_{50})$ is integer set. If X_i is 1 then produce the product. If X_i is 0 then not produce the product. $R=(R_1,R_2,\cdots,R_{50})$ is material vector.

C. Build and solve procedure of hybrid genetic algorithms

The solving method of bag problem is some heuristic algorithms mainly (such as greedy algorithms[4]), we also can use genetic algorithms to solve the problem. We need search 2^n points if we use enumerate method aim at bag problem of n goods. We can get approximate optimization result by greedy algorithms, and can not sure get optimization. Simple genetic algorithms can't get good result by genetic algorithms if the scale of the problem is big, and even get worse result than greedy algorithms under many conditions. The reason of the problem is that search space is too big. So we combine heuristic algorithms with greedy algorithms by importing the decode procedure of genetic algorithms, and build one hybrid genetic algorithms.[5]

The composing of hybrid genetic algorithms as follows:

(1)Chromosome code method, we use binary to code vector X random. It express that we produce the product if X_i is 1, and express that we not produce if X_i is 0.

(2)Combine of greedy algorithms and decode procedure, above chromosome code method is intuitionistic, but we can't sure get feasible result for that they not satisfy restrict condition aim at random code string, or across and variance unit, that is the code method produce many invalid chromosomes. We can use the idea of greedy algorithms to load the goods that Pi/Ri is big and xi is 1 aim at these chromosome code strings. We change xi into 0 of chromosome code string aim at the goods that should be loaded and should not be loaded in fact. We can produce new and good quality chromosome code string, and they should satisfy restrict condition.

(3)Fit function

$$
f = \begin{cases}
\sum_{i=1}^{50} P_i X_i & (\sum_{i=1}^{50} R_i X_i \le 5000) \\
0 & (\sum_{i=1}^{50} R_i X_i > 5000)
\end{cases}
$$

(4)Genetic operator, across operation use across operator, variation operation use variation operator, choice operation use choice operator.

We use advanced program language to implement the hybrid genetic algorithms model in this paper, parameter set and run result as follows Figure 2.
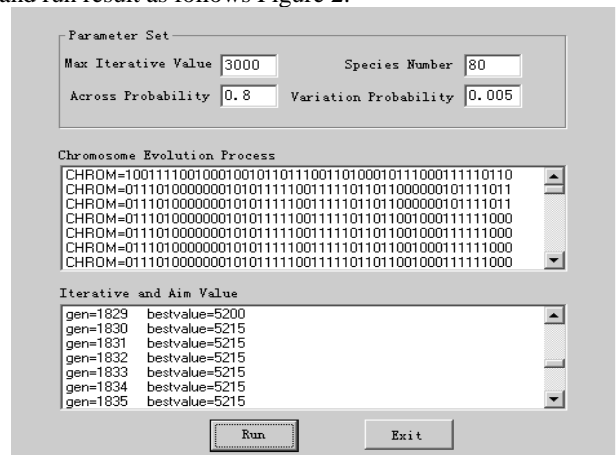

Figure 2 hybrid genetic algorithms parameter and run result

We can get conclusion from picture 2 that the value of chromosome and aim function does not change after iterating 1830. The value of chromosome is how to produce, and the value of aim function is maximal economic benefit.

IV. TAG

We build one hybrid genetic algorithms model base on genetic algorithms aim at one product optimization problem,

and realize the model by software. The disposal result of real data tells us that the model is right and has good practicability and accuracy to the problem of product optimization problem. The model has some spread value.

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