Application of Job Shop Based on Immune Genetic Algorithm

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Abstract. Job Shop scheduling problem,as an important part of computer integrated manufacturing system engineering, is a classic NP-hard combinatorial optimization problem and has vital effect on production management and control system. In this paper, base on biological immune system's antigen recognition, maintaining the diversity of antibodies and other features, a proposed improved genetic algorithm-the immune genetic algorithm is put forward, the algorithm will introduce the thinking of biological systems immune to the genetic algorithm, namely in use of first immune knowledge it structures inspection operator. By vaccination and immune selection, it not only retains the best individual groups but also ensures the diversity of individuals, thus avoiding the premature convergence of evolutionary search and improving convergence speed, meantime, an improved immune genetic algorithm, and adopting timely dynamic vaccination and the shut down criteria are given. Simulation results show that the algorithm is effective.

Keywords: Genetic Algorithm, immune, job shop, NP-hard, hypermutation.

1 Introduction

The job shop scheduling problem (JSP), may be described as follows: given n jobs, each composed of several operations that must be processed on m machines. Each operation uses one of the m machines for a fixed duration. Each machine can process at most one operation at a time and once an operation initiates processing on a given machine it must complete processing on that machine without interruption.

The operations of a given job have to be processed in a given order. The problem consists in finding a schedule of the operations on the machines, taking into account the precedence constraints that minimize the make span (Cmax), that is, the finish time of the last operation completed in the schedule[1].

2 Genetic Algorithm Optimization Strategy

The foregoing model can be used find optimal values of several model parameters (design variables).Obviously an object function must be defined which determines the

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quality of a certain set of design values. In genetic optimization the object function is often called the fitness function. Here the focus in on finding the distribution of stress near holes. Genetic algorithms are the best choice to solve such problems.

"A Genetic Algorithm (GA) is a programming technique that mimics biological evolution as a problem-solving strategy." It is based on Darwinian's principle of evolution and survival of fittest to optimize a population of candidate solutions towards a predefined fitness. [2]

GA uses an evolution and natural selection that uses a chromosome-like data structure and evolve the chromosomes using selection, recombination, and mutation operators. The process usually begins with randomly generated population of chromosomes, which represent all possible solution of a problem that are considered candidate solutions. Different positions of each chromosome are encoded as bits, characters or numbers. These positions could be referred to as genes. An evaluation function is used to calculate the goodness of each chromosome according to the desired solution; this function is known as "Fitness Function". During evaluation, two basic operators, crossover and mutation, are used to simulate the natural reproduction and mutation of species. The Selection of chromosomes for survival and combination is biased towards the fittest chromosomes. [2][3]

A GA generally has four components. A population of individuals represents a possible solution. A fitness function which is an evaluation function by which we can tell if an individual is a good solution or not. A selection function decides how to pick good individuals from the current population for creating the next generation. Genetic operators such as crossover and mutation which explore new regions of search space while keeping some of the current information at the same time [4].

The following is a typical GA procedure:

```
Begin
 Initialize population;
 Evaluate population members;
 While termination condition not satisfied do
 Begin
  Select parents from current population;
  Apply genetic operators to selected parents;
  Evaluate offspring;
  Set offspring equal to current population;
 End
End
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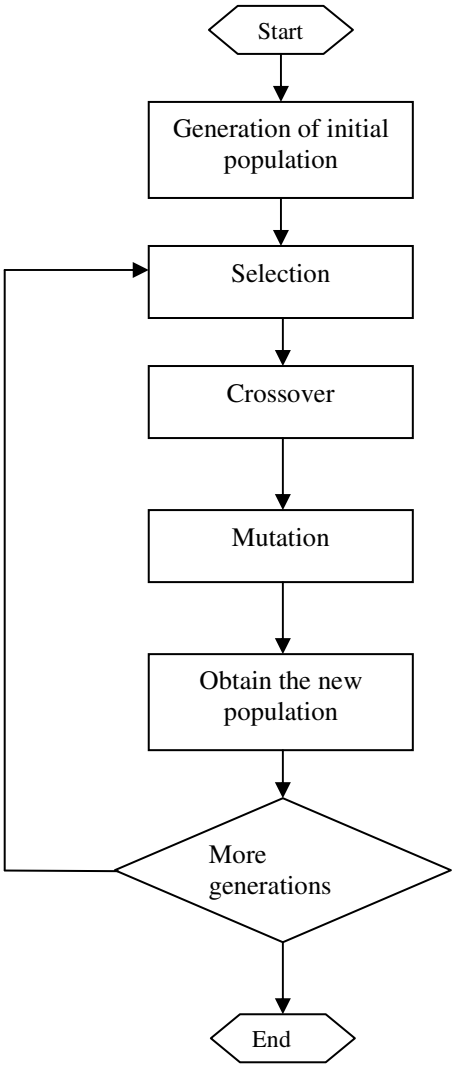

Fig. 1. Scheme of classical genetic algorithm

3 Immune System

The Biological information processing system can be divided into: brain systems, genetic and immune systems. People in practice the three major information systems through the simulation of biological research has been based on the three information processing system of the three intelligent algorithms that simulate brain systems based on artificial neural networks, genetic system based on simulation and simulation-based

genetic algorithm the immune system, artificial immune algorithm. In these three algorithms, artificial neural networks and genetic algorithms have been extensively studied so far, and was applied to various fields. However, the immune system structure based on artificial immune algorithm, due to the complexity of the immune system, the method difficult to design more complex, so the other two algorithms did not get equal attention, so at home and abroad and the application of research results is relatively small .Meanwhile, the three intelligent algorithms, genetic algorithms and artificial immune algorithm and relatively similar in both their genetic algorithm, mutation, crossover, belonged to the evolutionary algorithm, similarity is relatively large. Both have their own advantages and disadvantages. Such as the genetic algorithm is faster to maintain their individual diversity through crossover and mutation operators to achieve, but proved such a diversity of populations evolving with significantly reduced, the convergence of the algorithm easy to fall into local minimum during optimal solution and local search-based crossover operation ability, which is the genetic algorithm needs to be overcome. The use of artificial immune algorithm crossover and mutation operators to maintain the diversity of individual solutions, and the solution by increasing the concentration of antibodies and inhibition of regulatory mechanisms to promote the production of antibody solution, thus increasing the diversity of solutions of antibody selection, to further ensure the algorithm can converge to the global optimal solution, but the calculation is relatively slow. [5]

Artificial immune algorithm began in the 20th century, late 90s, now the research has just started. The idea comes from the biological immune system, which the immune system by simulating the learning, memory and other functions for pattern recognition and search optimization. Artificial immune algorithm will correspond to the antigen and antibody optimization objective function and feasible solutions. The affinity of the antibodies and antigens as a feasible solution to the matching degree with the objective function: the affinity between antibodies to ensure the diversity of feasible solutions, by calculating the expected survival rate of antibodies to promote optimum antibody of heredity and variation, with the memory cell unit After saving merit similar to the feasible solutions to curb continue to produce feasible solutions and accelerate the search to the global optimal solution, the same time, when similar problems recur, can quickly adapt to produce the optimum solution of the problem or even optimal solution.[5]

4 Algorithm Design

SGA prematurely and low search efficiency in the latter part of the problem, many improvements have been proposed operator method, in which the immune genetic algorithm is proposed based on biological immune mechanism An improved genetic algorithm that the actual objective function corresponds to solving the problem for the antigen, and antibodies corresponding to the solution of the problem. Biological immune system to antigens invading the body through the life of cell division and differentiation, automatically produce antibodies to protect against, a process known as immune response. In the immune response, some antibody preserved as memory cells invaded again when the same antigen, memory cells are activated and rapidly

produce a large number of antibodies, so again, faster response more strongly than the initial response, reflecting the memory function. Also, antibody mutual promotion between antibodies and inhibition, in order to maintain the diversity of antibodies and immune balance, this balance is based on the concentration of the mechanism, that is, the higher the concentration of antibodies, the more restrained; lower the concentration the more affected by promotion, reflects the self-regulation. On the basis of the existing genetic algorithm, the paper said the introduction of information entropy between the affinity and antibody concentration, so that it can more effectively express affinity between antibody and concentration, and using a new evaluation indicators - polymer affinity, can effectively ensure the diversity of antibody group, On the basis of the existing genetic algorithm, the paper said the introduction of information entropy between the affinity and antibody concentration, so that it can more effectively express affinity between antibody and concentration, and using a new evaluation indicators - polymer affinity, can effectively ensure the diversity of antibody group.[6]

The basic algorithm steps described below

Step 1: Initialize the population, population size N set

Step 2: If the primary response, the function within the parameters of the range of all randomly generated antibodies.

Step3: For each antibody, the algorithm to calculate the fitness value.

Step4: Genetic algorithms

Step5: The antibody affinity group H, and set affinity antibody population threshold H0 if H<H0, Into the next generation of optimization operations, into Step 3; if H> H0, P is a randomly generated antibodies, antibody at this time scale is N + P, to maintain the antibodies diversity.

Step6: Determine whether the termination condition, if not, the next generation of group optimization, into Step 3; stable or if they meet the concentration of antibodies to the conditions at the end of algebra, the output the optimal solution.

5 Conclusion

Shop scheduling problem is that many experts now the focus of attention, genetic algorithm is used to solve the optimization problem of job shop scheduling algorithm, this paper, genetic algorithm optimization to improve the efficiency of in-depth and meticulous research, an improved immune genetic algorithm and the algorithm is applied to the workshop to solve scheduling problems.

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