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遗传算法求解函数优化问题的Matlab实现

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摘 要:利用Matlab优化工具箱,结合典型的一维和多维变量函数,在Matlab环境中有效地解决了用遗传算法求解函数优化问题、图形直观,性能优越,为遗传算法的实际应用开辟了新的渠道和途径.

关键词:遗传算法;函数优化;Matlab
中图分类号:TP301.6 **文献标识码**:A

遗传算法(Genetic Algorithms)是一种借鉴生物界自然选择和遗传机制的高度并行、随机、自适应的全局优化概率搜索算法.近30年来,遗传算法已广泛应用于函数优化、自动控制、机器学习、人工生命等领域.函数优化问题是遗传算法的经典应用领域,也是对遗传算法进行性能评价的常用算例.Matlab是一种开放式的软件,其功能强大、应用面广,特别是它的软件工具箱,是整个Matlab体系的基座,提供了体系中其他工具所需要的集成环境.它由一些对普通非线性函数求解最小化或最大化极值的函数和解决诸如线性规则等标准矩阵问题的函数组成,为科学理论研究和工程实际应用搭起了一座桥梁.

利用Matlab优化工具箱,结合典型的一维和多维变量函数,在Matlab环境中用遗传算法有效地实现了函数优化问题,并取得了优越的性能,为遗传算法的实际应用提供了新的思路和方法.

1 遗传算法求解函数优化的Matlab程序实现

函数优化问题根据解空间的维数可以分为一维空间的优化问题和多维空间的优化问题2大类,通过来自这2类的2个典型优化问题来说明用Matlab程序来实现遗传算法对函数的优化过程.

1.1 一维变量的函数优化问题

为了体现优化问题的普遍性,这里的优化对象选择一个多峰函数$f(x) = x + 10 * \sin(5x) + 7 * \cos(4x), x \in [0,9]$,并采用二进制编码,种群中的个体数目为10,染色体长度为20,交叉和变异概率分别为0.95和0.08.其Matlab的主程序源代码如下:

```
fplot('x + 10 * sin(5 * x) + 7 * cos(4 * x)',[0 9])
% create a random starting population of size 10.
initPop = initializega(10,[0 9],'ga1eval1');
hold on
plot (initPop(:,1),initPop(:,2),'b + ')
pause % Strike any key to continue to run the ga for one generation.
[x endPop] = ga([0 9],'ga1eval1',[],initPop,[1e-6 1 1],'maxGenTerm',1,…
'normGeomSelect',[0.08],['arithXover'],[2 0],'nonUnifMutation',[2 1 3]);
x %The best found
% plot the resulting the resulting population
plot (endPop(:,1),endPop(:,2),'ro')
pause % Strike any key to continue to run the ga for 25 generations
[x endPop] = ga([0 9],'ga1eval1',[],initPop,[1e-6 1 1],'maxGenTerm',25,…
'normGeomSelect',[0.08],['arithXover'],[2],'nonUnifMutation',[2 25 3]);
x %The best found,and plot the resulting the resulting population
pause % Strike any key to continue
figure(2)
fplot('x + 10 * sin(5 * x) + 7 * cos(4 * x)',[0 9])
hold on
```

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```
plot (endPop(:,1),endPop(:,2),'r*')
pause % Strike any key to continue
figure(3)
plot(trace(:,1),trace(:,3),'r-')
hold on
plot(trace(:,1),trace(:,2),'r-')
xlabel('Generation');ylabel('Fitness');
legend('solution','average');
% End
```

图 1 为目标函数的图形和初始化随机种群的个体分布图.经过一次遗传迭代后,寻优结果如图 2 所示,图中"o"表示经过一次迭代后的个体分布,此时最优解 $x = 2.897\ 9, 16.213\ 0$.

经过 25 次遗传迭代后,寻优结果如图 3 所示,图中"*"表示经过迭代后的最优结果,此时最优解 $x = 7.856\ 7, 24.855\ 4$. 迭代过程中迭代次数与函数值的变化如表 1 所示.图 4 则通过进化过程中种群平均值和解的变化绘出了遗传算法的寻优性能.

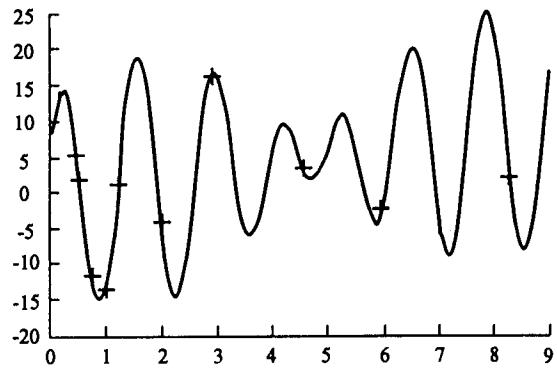

图 1　初始种群分布图

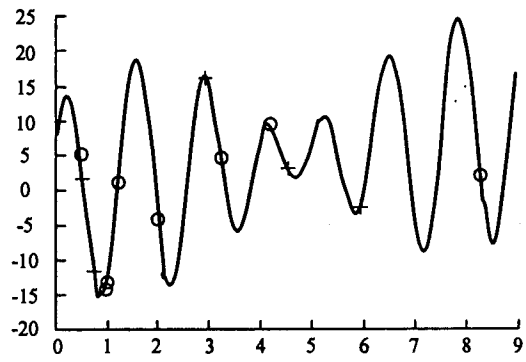

图 2　一次迭代后的寻优结果

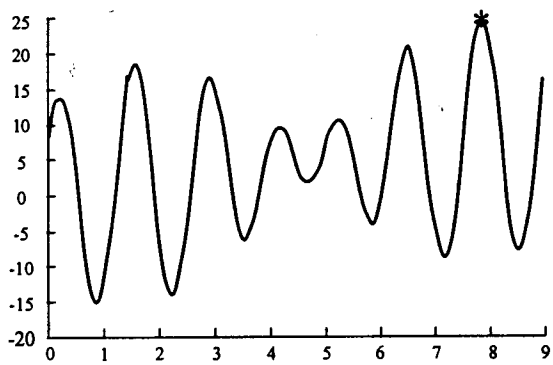

图 3　25 次迭代后的最优结果

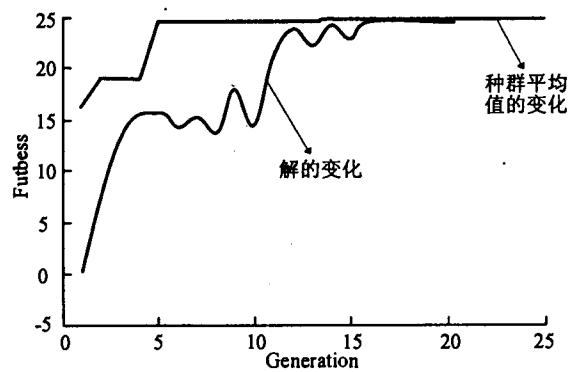

图 4　遗传算法的寻优性能

表 1　迭代次数与函数值的变化过程

迭代次数	1	2	5	14	17
函数值	16.212 973	18.851 287	24.480 041	24.839 363	24.853 845
迭代次数	19	22	23	25	
函数值	24.855 305	24.855 356	24.855 363	24.855 363	

1.2 多维变量的函数优化问题

Corana 函数是多维非凸函数,是多维变量函数优化问题的典型代表,它实质上是一个 n 维的抛物线,图 5 为二维 Corana 函数的示意图.以下为 Matlab 的主程序实现代码:

```
i=0;
a= -0.5:0.02:0.5;
for x=a
    i=i+1; j=0;
for y=a
    j=j+1;
    z(i,j)=coranaEval([x y]);
end
```

```
end
echo on
% Done!
plot(z(:,1)) % Plot a slice of the function in x, the range is [250.0-250.25]
pause % Strike any key to continue
clf
plot(z(1,:)) % Plot a slice of the function in y, the range is [0-250]
pause % Strike any key to continue
mesh(a,a,z);
view(30,60);
grid; % The deviation in y is 1000 times that of x.
pause %Strike any key to continue
% Minimize this function in 4 dimensions between [-10,000 10,000].
bounds = ones(4,1) * [-10 000 10 000];
% Begin optimize…
[x,endPop,bestSols,trace] = ga(bounds,'coranaMin');
% Done! The first return is the optimal [x1 x2 x3 x4 val]
x
% The performance of the ga during the run
plot(trace(:,1),trace(:,3),'b-')
hold on
plot(trace(:,1),trace(:,2),'r-')
xlabel('Generation'); ylabel('Fittness');
```

图6为遗传算法求解二维Corana函数的寻优性能,程序运行的最优解和所求极小值为:x = -33.784 7,0.171 6,-0.425 0,0.221 8,-182.489 6.

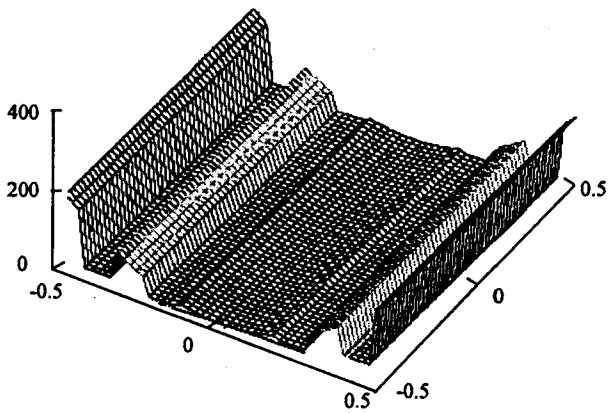

图5 二维Corana函数

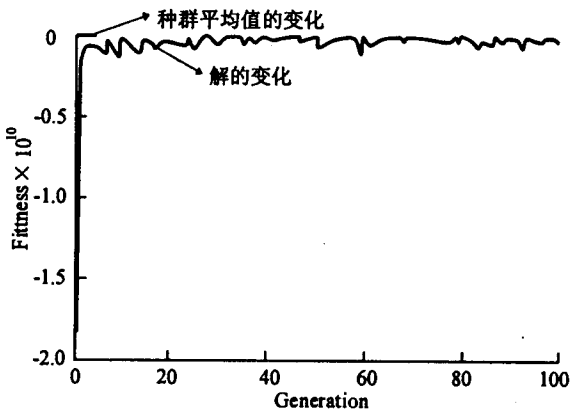

图6 遗传算法的寻优性能

2 实验结果分析

通过求解过程和实验结果可以看出,用遗传算法求解以上2种典型函数优化问题,无论是一维变量函数 $f(x) = x + 10 * \sin(5x) + 7 * \cos(4x)$,其中 $x \in [0,9]$,还是多维Corana函数,它们均能在Matlab环境中有效地收敛到全局最优值,而且收敛速度快,结果直观.

3 小结

Matlab作为一个功能强大的软件和工具,目前已广泛应用于众多工程领域.笔者利用Matlab优化工具箱,有效地实现了用遗传算法求解一维和多维变量的函数优化问题,实验结果直观,性能良好,也为遗传算法的实际应用与实验模拟提供了一条新思路.

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Design of the Burnable Gas Detector System Based on CAN Bus

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Abstract: By using distributed system, a new burnable gas detector system based on CAN bus is designed. Hardware circuit of the measure-control unit and software system are mainly discussed. The practice shows that the system is accurate and reliable.

Key words: CAN bus; burnable gas; detector system

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Realization of Function Optimization with Genetic Algorithm in Matlab

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Abstract: By using the Matlab optimization toolbox, one-dimension and multi-demension variable function optimization is realized effectively with genetic algorithm(GA). Visual results and excellent performance can be obtained. A new method for the actual application of GA is established.

Key words: genetic algorithm; function optimization; Matlab

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Optimization Design of Line Illumination and Its Implementation and Simulation Based on MALTAB

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Abstract: Discretization is used to discretize line source to point source; and reflecting concave to a series of points on a volute curve so as to solve the surface area problem formed with a combination of the straight light and the reflected light on the measuring screen 25 meters away. Meanwhile the simulation based on Matlab is also achieved. The result of the simulation accords with the theoretical result. This example deals with the application of the discretization thoughts in mathematical modeling and the advantage of Matlab implementation and its simulation.

Key words: mathematical modeling; discretization; simulation