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Implementation of Genetic algorithms in Mathematica® language

Introduction

In this paper I would like to describe my way and experiences with implementation of Genetic Algorithms(GA) in program Mathematica. I implemented GA in order to find a optimal solution of NP-hard or other large complex problem(in many dimensions). In our Department of Electroenergetics i used this package on several problems with enough-good results.

What is optimization?

There are many methods, how to find some exact solution for this problem

```
minimize    F(x)

subject to  gi(x)  = 0      for i = 1, ..., m1      where m1 >= 0
            hj(x) >= 0      for j = m1+1, ..., m    where m >= m1
```

There only depends on characteristics of multidimensional function $F(x)$ (x is a vector of variables). If this function is terrible, we sometimes can't find exact solution. If we need only suitable or enough-good solution, we can choose algorithm like GA.

What is Genetic Algorithms?

Genetic algorithms (GAs) are search procedures that use the mechanics of natural selection and natural genetics. The genetic algorithm, first developed by John H. Holland in the 1960's, allows computers to solve difficult problems. It uses evolutionary techniques, based on function optimization and artificial intelligence, to develop a solution. The basic operation of a genetic algorithm is simple. First a population of possible solutions to a problem are developed. Next, the better solutions are recombined with each other to form some new solutions. Finally the new solutions are used to replace the poorer of the original solutions and the process is repeated.

Algorithm does not need to know everything about solved problem, but converge to good solutions. And this is why I implemented GA.

What is Mathematica?

The creator of program Mathematica declare: “*A System for Doing Mathematics by Computer*”. This is a bombastic thesis, but if you know everything, what know this system, you can call ownself mathematician. More I will write only facts. Mathematica has very powerfull, functional oriented language. For internal representation of individuals was voted array of chromosomes.

Practical Implementation

First of all we need load file with algorithm into FrontEnd Kernel(Math Kernel). There is body of all procedures, e.g. operator of mutation, operator of selection etc.

```
<< genetic.m
```

Now we can implement our problem like this.

```
VectorOfVariables = {{x, 0.0, 3.5, 16}, {y, 0.0, 3.5, 16}, {z, 0, 3, 16}};  
Fitness[{x_, y_, z_}] := -(Cos[x] + Sin[y] + Cos[z]);
```

```
numberOfIndividuals = 80;  
probabilityOfMutation = 0.01;  
probabilityOfCrossing = 0.85;  
useGrayCode = True;  
useRoulette = True;  
debugMode = False;
```

```
Population = Initialization[numberOfIndividuals];
```

```
OptimizationLoop[20];
```

My package I used in geometric optimization(size and angle of rotation) of square radiating heaters in any room. Requirement was best equal distribution of heat fluxes from any number of heaters.

Conclusion

Result of my work is ready for use, universal Mathematica package, which optimize any accurately specified problem. Problem can be selected from any area of science. This is also my own proof of functionality of GA.

If you are interested in this problems or you like to try solve your very hard optimization problem, you can contact author (via e-mail).