Genetic Algorithms (ATHENS course): Takehome project report

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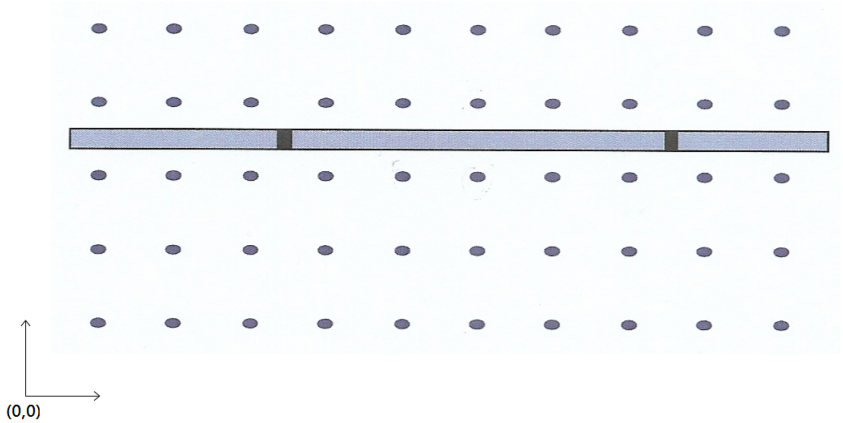

Figure 1: Graphical representation of the town with the 50 possible locations. Each dot represents a possible building site for the fire unit. The rectangle in the center of the image is the river with the two bridges at $(3.5, 3.5)$ and $(8.5, 8.5)$

1 Introduction

The assignment describes the problem a fire department would have if they want to select the best location for placing a fire unit. There are 50 locations suitable and those are spaced out evenly on a grid as shown in figure 1. The river in the center of the town has two bridges. These bridges should be taken into account when calculating the weight each point gets according to the objective function. The objective function models the response time to all these locations according to the distance. In the next section we will look at this function in more detail.

2 Objective function

The objective function for this particular problem is defined as the summed distance to each of the possible building sites. The euclidean distance is being used and the bridges are taken into account. The euclidean distance is proffered over an other distance (e.g. hamming distance) since we have no further information about the layout of the town. The symbolic notation of the objective function is the following:

$$f((a,b)) = \Sigma_{x \in i, y \in j}(x-a)^2 + (y-b)^2$$
$$\text{with } i = 1, \ldots, 10 \text{ and } j = 1, \ldots, 5$$

The Matlab implementation of the objective function f can be found in listing 1 on page 8.

In figure 2 you can find a graphical representation of the objective function f. The choice to represent the function in a mesh grid is intentional. Because creating a mesh grid isn't as calculation intensive as a more precise representation, a rough idea can quickly be formed of the function being researched.

In this case it is clear that there seems to be a minimum in the region between 2 and 4 in both the x and y direction. With this in mind we can easily evaluate the algorithms we wrote for the problem.

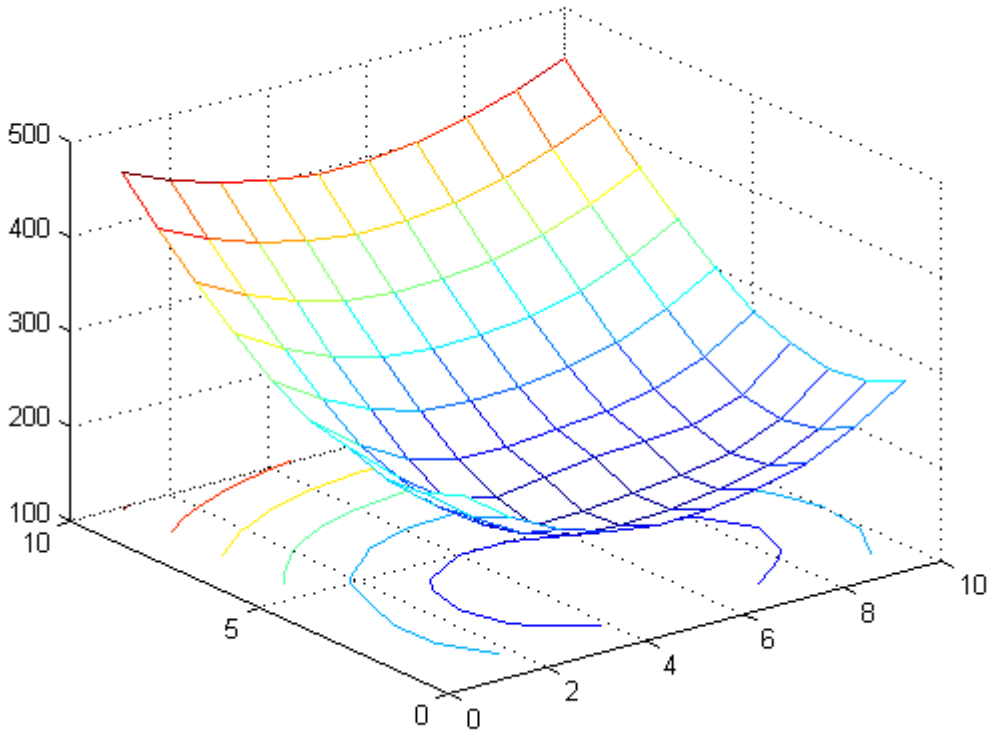

Figure 2: A mesh visualization of the objective function. A grid of 10 on 10 is used starting in point (0,0). Under the mesh the contour plot is visible.

3 Search space specification

Since only a finite amount of possible locations is given the search space is clearly discrete. The (two-dimensional) points were defined in the previous section as the combination of all the elements from i for the first dimension with every element of j for the second dimension.

4 Genetic Algorithm

For the genetic algorithm we take a two dimensional coordinate as chromosome. Initially the population is randomly generated with each coordinate picked from a uniform distribution between 1 and 10. In this algorithm as much parents will survive as the amount of children they create. The parents are selected in order of their respective weights (lowest is best for this problem). To give more chances to reproduce to better parents an exponential distribution is used depending on the amount of parents selected. Randomly the first or second gene is selected from one parent and combined with the other gene of another parent. After combining the two genes on each of the genes there is a small chance of mutation (either positive or negative unit). This new combinations gives us the children which form, in addition to the parents and survivors, the new generation.

4.1 code

```
function [ Generation ] = ga(PopSize , BreedSize, SurvivorSize, MutChance,
    Iterations)
%GA Runs the genetic algorithm with the given parameters.

Population = randi(10,PopSize,2)
Generation = zeros(PopSize, 3);

for i=1:PopSize
    Generation(i,:) = [Population(i,:) weight(Population(i,:))];
end

for k=1:Iterations
fprintf('Iteration %d \n__________\n',k)
SortedGeneration = sortrows(Generation,-3);
fprintf('Current best (%d,%d) with weight=%d\n',SortedGeneration(end,1),
    SortedGeneration(end,2),SortedGeneration(end,3))

%Select (BreedSize lowest) Parents.
Parents = SortedGeneration(end-BreedSize:end,:)
Survivors = SortedGeneration(end-(BreedSize+SurvivorSize):end-BreedSize,:)

%Breed to create BreedSize Children
Children = zeros(BreedSize,3);
for j=1:BreedSize
    %Select random numbers from an exponential distribution depending on the
        breedsize.
    exprnd1 = exprnd(BreedSize/5);
    exprnd2 = exprnd(BreedSize/5);

    %Failsafe to not select a parent out of the bounds.
    if exprnd1 > BreedSize
```

```
29          exprnd1 = BreedSize;
30      end
31      if exprnd2 > BreedSize
32          exprnd2 = BreedSize;
33      end
34
35      %Ceil to make up for 1-based counting of matlab.
36      parentselector1 = ceil(exprnd1);
37      parentselector2 = ceil(exprnd2);
38
39      %Failsafe to be sure two different parents are picked.
40      if parentselector1==parentselector2
41          if parentselector1 > 1
42              parentselector1=parentselector1-1;
43          else
44              parentselector1=parentselector1+1;
45          end
46      end
47
48      %Select the first/second gene of the first/second parent to keep.
49      geneselector1 = randi(2);
50      geneselector2 = mod(geneselector1, 2) +1;
51
52      % Mutations
53      MutMod1 = 0;
54      MutMod2 = 0;
55      if rand(1)<MutChance
56          MutMod1 = (-1)^randi(2);
57      end
58      if rand(1)<MutChance
59          MutMod2 = (-1)^randi(2);
60      end
61
62      %Generate the new child.
63      Gene1 = Parents(parentselector1,geneselector1)+MutMod1;
64      Gene2 = Parents(parentselector2,geneselector2)+MutMod2;
65      Children(j,geneselector1) = Gene1;
66      Children(j,geneselector2) = Gene2;
67      Children(j,3) = weight([Children(j,1) Children(j,2)]);
68  end
69  Children
70  Generation = [Parents ; Survivors ; Children];
71
72  end
73
74  end
```

4.2 results

After plenty of experimentation the following following parameters seemed well suited.

Population size = 35 The amount of chromosomes being used.

Breed size = 15 The amount of children being created each iteration and also the amount of parents.

Survivor size = 5 The amount of chromosomes that survive without being used as parent.

Mutation Chance= 0.01 The chance any gene of a child has to become mutated (either one unit added or subtracted).

Amount of iterations=50 The amount of iterations that will be performed.

Utilizing this parameters nearly always resulted in convergence to the (4,3) optimum across the entire population. The extensive output of the Matlab program run with these parameters can be found in the appendix.

4.3 conclusion

The optimum (4,3) of the problem appears rapidly in the generated generations. In the attached output we find the optimum already in the 10th generation (see page 18). It does however take many more generations till the entire population has converged to the optimal point.

5 Particle Swarm Optimization

For the PSO algorithm we start by selecting an amount of points randomly. Again discrete points are the only once considered since any solution can only consist of integers. A couple of additional matrices are initialised: The personal bests, the global best and the velocities. Next the algorithm takes a particle and calculates it's according velocity for the two dimensions according to the formula below.

$$v_{i,d} \leftarrow \omega v_{i,d} + \phi_p r_p(p_{i,d} - x_{i,d}) + \phi_g r_g(g_d - x_{i,d})$$

- $v_{i,d}$ the velocity for particle i in dimension d.
- ω a PSO variable for this we chose 1.
- ϕ_p another PSO variable for this we chose 1.
- ϕ_g another PSO variable for this we chose 1.
- $p_{i,d}$ the coordinate of the personal best of particle i in dimension d.
- $x_{i,d}$ the coordinate of the particle i in dimension d.
- g_d the coordinate of the global best particle in dimension d.
- r_g a random number between 0 and 1 picked for each particle individually each iteration.
- r_p a second random number between 0 and 1 picked for each particle individually each iteration.

When the velocities are calculated they are added to the current location of the particle to calculate the next location. At this step the result is rounded so only integer coordinates remain. After calculating the new position some checks are executed to see whether improvement has been made. Both the global and personal bests are updated if the current weight is better than any previous weight. The same weight function f is used for PSO as we used for the GA. This process continues as long as indicated with the `iterations` parameter and this for every particle every iteration.

5.1 code

```
function [ g p particles ] = pso( nb_particles, iterations )
%PSO Summary of this function goes here
%   Detailed explanation goes here
particles = [randi(10,nb_particles,1) randi(5,nb_particles,1)]

p = particles;

particlesWeight = zeros(nb_particles, 3);

for i=1:nb_particles
    particlesWeight(i,:) = [particles(i,:) weight(particles(i,:))];
end

particlesSortedWeight = sortrows(particlesWeight,-3);
g = particlesSortedWeight(1,1:2);
omega = 1;
phi_p = 1;
phi_g = 1;

velocities= [(randi(20,nb_particles,1)-10) (randi(10,nb_particles,1)-5)];

for k=1:iterations
    fprintf('Iteration %d \n__________\n',k)
    for i=1:nb_particles
        r_p = rand(1);
        r_g = rand(1);
        velocities(i,1) = omega*velocities(i,1)+phi_p*r_p*(p(i,1)-particles(i
            ,1))+phi_g*r_g*(g(1,1)-particles(i,1));
        velocities(i,2) = omega*velocities(i,2)+phi_p*r_p*(p(i,2)-particles(i
            ,2))+phi_g*r_g*(g(1,2)-particles(i,2));
        particles(i,:) = round(particles(i,:) + velocities(i,:));

        fprintf('Particle %d : (%d,%d) \n',i,particles(i,1),particles(i,2))

        if weight(particles(i,:))< weight(p(i,:))
                p(i,:) = particles(i,:);
                fprintf('New Personal Best for %d: (%d,%d) with weight=%d \n',i
                    ,p(i,1),p(i,2),weight(p(i,:)))
            if weight(particles(i,:))< weight(g)
                g = particles(i,1:2);
                fprintf('New Global Best (%d,%d) with f(g)=%d \n',g(1),g(2),
                    weight(g))
            end
        end
    end
end
```

5.2 results

After extensive experimentation we found that using the following parameters resulted in finding the optimal point after only 10 iterations.

Amount of particles = 20 The amount of chromosomes being used.

Amount of iterations= 10 The amount of iterations that will be performed.

This seemed quite consistently the case. The swarm does not however converge to the optimal point. But it is a well known fact that this is very hard to achieve and it's beyond the scope of this assignment.

5.3 conclusion

With this amount of variables that we can freely chose it is very hard to find consistent trends. Thus evaluating PSO with a given set of variables compared to another set is difficult. It is however notable that with a relatively low amount (compared to GA) of both particles and iterations the optimum is found. An important remark is however that for each particle there are a lot more calculations to be done compared to an element of the population in the GA.

A Utility functions

Listing 1: Matlab implementation for the objective function. The input parameter V is the vector representing the point for which the weight function f is calculated.

```
function [ W ] = weight( V )
%WEIGHT Summary of this function goes here
%   Detailed explanation goes here
W = 0;
loc = locations;
for i=1:length(loc)
    W = W + minDist(V,loc(i,:));
end

end
```

Listing 2: Function that calculates the matrix holding the weights of the points generated from combining the X and Y matrices for the first and the second coordinate respectively.

```
function [ W ] = meshweight( X,Y )
l1 = length(X);
l2 = length(X(:,1));
W = zeros(l1,l2);
for i=1:l1
    for j=1:l2
        W(i,j) = weight([X(i,j),Y(i,j)]);
    end
end
end
```

Listing 3: Utility function that calculates the minimal euclidean distance between two given vectors taking the bridges into account.

```
function [ Dist ] = minDist( P1, P2 )
% Calculates the shortest distance
```

```
Bridge1 = [3.5 3.5];
Bridge2 = [8.5 3.5];

if (P1(2) < 3.5 && P2(2) < 3.5) || (P1(2) > 3.5 && P2(2) > 3.5)
    Dist = norm(P1 - P2);
else
    Dist = min(norm( P1- Bridge1 )+ norm(Bridge1 -P2), norm(P1 - Bridge2)+norm(
        Bridge2 - P2));
end

end
```

Listing 4: Utility function that generates the possible locations for use in verious functions.

```
function [ V ] = locations( )

V = zeros(50,2);

for i=1:10
    for j=1:5
        V(5*(i-1)+j, :) = [i j];
    end
end

end
```

B Matlab output

Listing 5: Output of GA matlab program run for 20 particles and 10 iterations

```
>> lastgeneration = ga(35,15,5,0.01,50)

Population =

     7     3
     1     3
     7     4
     5     7
     9     1
     6     2
    10     6
     6     4
    10     2
     4     7
     8    10
    10     4
     3     5
     4    10
     9     1
     3     6
     5     7
     8     6
     5     6
```

```
     9     1
     3     3
     8     1
     3    10
     4     8
     1    10
     5     7
     7     3
     8     9
     4     1
     7    10
     4     6
     3     7
     6     3
     7     9
     4     4

Iteration 1
-----------
Current best (6,3) with weight=1.725229e+002

Parents =

    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    4.0000    6.0000  234.1724
    5.0000    6.0000  229.5562
    3.0000    5.0000  214.7243
    8.0000    1.0000  214.3457
    4.0000    1.0000  197.5657
    7.0000    4.0000  196.6674
    6.0000    4.0000  193.2794
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229


Survivors =

    1.0000    3.0000  258.8336
   10.0000    4.0000  258.1768
   10.0000    2.0000  254.4226
    8.0000    6.0000  249.5507
    3.0000    6.0000  248.5757
    9.0000    1.0000  238.4096


Children =

    9.0000    6.0000  270.2957
    9.0000    1.0000  238.4096
```

```
    9.0000    1.0000  238.4096
    6.0000    1.0000  192.2433
    5.0000    1.0000  190.9277
    9.0000    3.0000  208.7871
    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    7.0000    5.0000  209.3910
    9.0000    1.0000  238.4096
    9.0000    6.0000  270.2957
    9.0000    1.0000  238.4096

Iteration 2
-----------
Current best (6,3) with weight=1.725229e+002

Parents =

    5.0000    6.0000  229.5562
    3.0000    5.0000  214.7243
    8.0000    1.0000  214.3457
    7.0000    5.0000  209.3910
    9.0000    3.0000  208.7871
    4.0000    1.0000  197.5657
    7.0000    4.0000  196.6674
    6.0000    4.0000  193.2794
    6.0000    1.0000  192.2433
    5.0000    1.0000  190.9277
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229


Survivors =

    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    9.0000    1.0000  238.4096
    4.0000    6.0000  234.1724
    5.0000    6.0000  229.5562


Children =

    5.0000    5.0000  200.3717
    3.0000    6.0000  248.5757
    6.0000    5.0000  204.2584
    3.0000    1.0000  214.1816
    5.0000    1.0000  190.9277
```

```
    8.0000    5.0000  218.5068
    3.0000    6.0000  248.5757
    9.0000    6.0000  270.2957
    3.0000    6.0000  248.5757
    8.0000    5.0000  218.5068
    9.0000    5.0000  238.9097
    5.0000    1.0000  190.9277
    3.0000    6.0000  248.5757
    6.0000    6.0000  231.5297
    7.0000    3.0000  178.2436

Iteration 3
-----------
Current best (6,3) with weight=1.725229e+002

Parents =

    6.0000    5.0000  204.2584
    5.0000    5.0000  200.3717
    4.0000    1.0000  197.5657
    7.0000    4.0000  196.6674
    6.0000    4.0000  193.2794
    6.0000    1.0000  192.2433
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229


Survivors =

    3.0000    5.0000  214.7243
    8.0000    1.0000  214.3457
    3.0000    1.0000  214.1816
    7.0000    5.0000  209.3910
    9.0000    3.0000  208.7871
    6.0000    5.0000  204.2584


Children =

    6.0000    5.0000  204.2584
    6.0000    5.0000  204.2584
    7.0000    5.0000  209.3910
    5.0000    1.0000  190.9277
    4.0000    5.0000  201.1111
    5.0000    1.0000  190.9277
    7.0000    5.0000  209.3910
    5.0000    5.0000  200.3717
```

```
    6.0000    1.0000  192.2433
    4.0000    5.0000  201.1111
    4.0000    1.0000  197.5657
    5.0000    4.0000  186.8445
    5.0000    5.0000  200.3717
    6.0000    1.0000  192.2433
    5.0000    4.0000  186.8445

Iteration 4
-----------
Current best (6,3) with weight=1.725229e+002

Parents =

    6.0000    1.0000  192.2433
    6.0000    1.0000  192.2433
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229


Survivors =

    4.0000    1.0000  197.5657
    4.0000    1.0000  197.5657
    7.0000    4.0000  196.6674
    6.0000    4.0000  193.2794
    6.0000    1.0000  192.2433
    6.0000    1.0000  192.2433


Children =

    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    3.0000    1.0000  214.1816
    6.0000    1.0000  192.2433
    6.0000    1.0000  192.2433
    6.0000    1.0000  192.2433
    5.0000    4.0000  186.8445
    6.0000    1.0000  192.2433
    6.0000    1.0000  192.2433
    6.0000         0  223.4078
    6.0000    1.0000  192.2433
```

```
    5.0000    1.0000  190.9277
    7.0000    1.0000  199.5111
    6.0000    1.0000  192.2433
    5.0000    1.0000  190.9277

Iteration 5
-----------
Current best (6,3) with weight=1.725229e+002

Parents =

    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229


Survivors =

    6.0000    1.0000  192.2433
    6.0000    1.0000  192.2433
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277


Children =

    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    6.0000    1.0000  192.2433
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
```

```
    5.0000    4.0000  186.8445

Iteration 6
-----------
Current best (6,3) with weight=1.725229e+002

Parents =

    5.0000    1.0000  190.9277
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229


Survivors =

    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277


Children =

    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    1.0000  190.9277
    5.0000    4.0000  186.8445
    3.0000    1.0000  214.1816
    3.0000    1.0000  214.1816
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445

Iteration 7
```

```
-----------
Current best (5,3) with weight=1.685228e+002

Parents =

    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228


Survivors =

    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445


Children =

    5.0000    3.0000  168.5228
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    4.0000    4.0000  179.1698
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445

Iteration 8
-----------
Current best (5,3) with weight=1.685228e+002
```

```
Parents =

    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228


Survivors =

    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445


Children =

    6.0000    4.0000  193.2794
    7.0000    4.0000  196.6674
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    3.0000  168.5228
    5.0000    4.0000  186.8445
    5.0000    3.0000  168.5228
    5.0000    4.0000  186.8445
    5.0000    3.0000  168.5228
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    6.0000    4.0000  193.2794
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445

Iteration 9
-----------
Current best (5,3) with weight=1.685228e+002

Parents =

    5.0000    4.0000  186.8445
```

```
    5.0000    4.0000  186.8445
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228


Survivors =

    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445


Children =

    4.0000    3.0000  167.3930
    5.0000    4.0000  186.8445
    7.0000    4.0000  196.6674
    5.0000    4.0000  186.8445
    4.0000    4.0000  179.1698
    5.0000    3.0000  168.5228
    3.0000    4.0000  190.3247
    5.0000    4.0000  186.8445
    4.0000    3.0000  167.3930
    5.0000    4.0000  186.8445
    5.0000    4.0000  186.8445
    3.0000    4.0000  190.3247
    3.0000    4.0000  190.3247
    6.0000    3.0000  172.5229
    4.0000    4.0000  179.1698

Iteration 10
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    4.0000  179.1698
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
    7.0000    3.0000  178.2436
```

```
    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229
    6.0000    3.0000  172.5229
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    5.0000    4.0000  186.8445
    3.0000    3.0000  181.9945
    4.0000    4.0000  179.1698
    4.0000    4.0000  179.1698
    4.0000    4.0000  179.1698
    4.0000    4.0000  179.1698


Children =

    7.0000    3.0000  178.2436
    6.0000    2.0000  174.1430
    7.0000    3.0000  178.2436
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    7.0000    4.0000  196.6674
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    6.0000    3.0000  172.5229
    4.0000    3.0000  167.3930
    5.0000    4.0000  186.8445
    4.0000    3.0000  167.3930
    7.0000    4.0000  196.6674
    4.0000    3.0000  167.3930
    6.0000    3.0000  172.5229

Iteration 11
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    6.0000    2.0000  174.1430
    6.0000    3.0000  172.5229
    6.0000    3.0000  172.5229
    6.0000    3.0000  172.5229
    6.0000    3.0000  172.5229
    5.0000    2.0000  171.7524


Children =

    5.0000    2.0000  171.7524
    5.0000    2.0000  171.7524
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228
    5.0000    2.0000  171.7524
    5.0000    3.0000  168.5228

Iteration 12
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228


Children =

    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    4.0000  186.8445

Iteration 13
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228


Children =

    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228

Iteration 14
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
Survivors =

    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930


Children =

    4.0000    2.0000  175.9902
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 15
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 16
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 17
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 18
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 19
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 20
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 21
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 22
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 23
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 24
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
Iteration 25
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 26
-----------
Current best (4,3) with weight=1.673930e+002
```

```
Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 27
-----------
Current best (4,3) with weight=1.673930e+002

Parents =
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 28
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 29
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 30
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 31
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 32
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 33
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 34
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 35
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 36
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    5.0000    3.0000  168.5228
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 37
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 38
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    4.0000  179.1698
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 39
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    2.0000  175.9902
    4.0000    3.0000  167.3930
    3.0000    3.0000  181.9945
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 40
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 41
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 42
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    3.0000    3.0000  181.9945
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
Iteration 43
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 44
-----------
```

```
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 45
-----------
Current best (4,3) with weight=1.673930e+002

Parents =
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 46
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 47
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 48
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 49
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930

Iteration 50
-----------
Current best (4,3) with weight=1.673930e+002

Parents =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Survivors =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


Children =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930


lastgeneration =

    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

```
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
    4.0000    3.0000  167.3930
```

Listing 6: Output of PSO matlab program run for 20 particles and 10 iterations

```
>> [g_best p_best particles] = pso(20,10)

particles =

     6     1
     3     5
     9     3
     6     1
     9     1
     6     3
     6     2
     8     5
     7     2
     7     3
    10     5
     3     4
     4     1
     8     4
     5     2
     4     5
     5     2
     3     4
     6     5
     2     1

Iteration 1
-----------
Particle 1 : (7,1)
Particle 2 : (12,7)
Particle 3 : (17,7)
Particle 4 : (9,2)
Particle 5 : (14,0)
Particle 6 : (1,3)
Particle 7 : (5,5)
Particle 8 : (19,6)
```

```
Particle 9 : (3,2)
Particle 10 : (5,5)
Particle 11 : (2,6)
Particle 12 : (5,6)
Particle 13 : (18,9)
Particle 14 : (17,10)
Particle 15 : (6,5)
Particle 16 : (1,9)
Particle 17 : (6,-1)
Particle 18 : (19,9)
Particle 19 : (12,1)
Particle 20 : (1,0)
Iteration 2
-----------
Particle 1 : (9,3)
Particle 2 : (14,7)
Particle 3 : (18,9)
Particle 4 : (11,3)
Particle 5 : (17,0)
Particle 6 : (-3,3)
Particle 7 : (6,6)
Particle 8 : (16,6)
Particle 9 : (4,4)
New Personal Best for 9: (4,4) with weight=1.791698e+002
New Global Best (4,4) with f(g)=1.791698e+002
Particle 10 : (2,5)
Particle 11 : (-3,5)
Particle 12 : (5,6)
Particle 13 : (11,7)
Particle 14 : (13,9)
Particle 15 : (4,6)
Particle 16 : (3,6)
Particle 17 : (5,2)
Particle 18 : (27,11)
Particle 19 : (10,0)
Particle 20 : (1,1)
Iteration 3
-----------
Particle 1 : (8,4)
Particle 2 : (4,4)
New Personal Best for 2: (4,4) with weight=1.791698e+002
Particle 3 : (3,2)
New Personal Best for 3: (3,2) with weight=1.922959e+002
Particle 4 : (10,4)
Particle 5 : (9,3)
New Personal Best for 5: (9,3) with weight=2.087871e+002
Particle 6 : (6,3)
Particle 7 : (7,5)
Particle 8 : (-1,3)
Particle 9 : (5,6)
Particle 10 : (3,4)
Particle 11 : (5,4)
New Personal Best for 11: (5,4) with weight=1.868445e+002
Particle 12 : (4,4)
New Personal Best for 12: (4,4) with weight=1.791698e+002
```

```
Particle 13 : (1,4)
Particle 14 : (-2,0)
Particle 15 : (3,2)
Particle 16 : (5,2)
New Personal Best for 16: (5,2) with weight=1.717524e+002
New Global Best (5,2) with f(g)=1.717524e+002
Particle 17 : (4,5)
Particle 18 : (22,8)
Particle 19 : (3,2)
New Personal Best for 19: (3,2) with weight=1.922959e+002
Particle 20 : (2,2)
New Personal Best for 20: (2,2) with weight=2.220413e+002
Iteration 4
-----------
Particle 1 : (5,3)
New Personal Best for 1: (5,3) with weight=1.685228e+002
New Global Best (5,3) with f(g)=1.685228e+002
Particle 2 : (-6,1)
Particle 3 : (-11,-4)
Particle 4 : (3,2)
Particle 5 : (-2,6)
Particle 6 : (14,3)
Particle 7 : (6,1)
Particle 8 : (-13,1)
Particle 9 : (6,7)
Particle 10 : (6,2)
New Personal Best for 10: (6,2) with weight=1.741430e+002
Particle 11 : (13,3)
Particle 12 : (3,1)
Particle 13 : (-5,-2)
Particle 14 : (-15,-9)
Particle 15 : (4,-1)
Particle 16 : (7,-1)
Particle 17 : (3,6)
Particle 18 : (-1,2)
Particle 19 : (-2,5)
Particle 20 : (5,3)
New Personal Best for 20: (5,3) with weight=1.685228e+002
Iteration 5
-----------
Particle 1 : (2,2)
Particle 2 : (-7,0)
Particle 3 : (-11,-4)
Particle 4 : (-2,0)
Particle 5 : (-4,6)
Particle 6 : (12,3)
Particle 7 : (4,-2)
Particle 8 : (-4,2)
Particle 9 : (6,5)
Particle 10 : (9,0)
Particle 11 : (11,2)
Particle 12 : (4,0)
Particle 13 : (0,-3)
Particle 14 : (-15,-10)
Particle 15 : (7,0)
```

```
Particle 16 : (8,-2)
Particle 17 : (5,2)
Particle 18 : (-17,-2)
Particle 19 : (-1,6)
Particle 20 : (8,4)
Iteration 6
-----------
Particle 1 : (3,3)
Particle 2 : (-4,0)
Particle 3 : (-5,-2)
Particle 4 : (1,-1)
Particle 5 : (6,3)
New Personal Best for 5: (6,3) with weight=1.725229e+002
Particle 6 : (0,3)
Particle 7 : (2,-4)
Particle 8 : (15,5)
Particle 9 : (5,2)
New Personal Best for 9: (5,2) with weight=1.717524e+002
Particle 10 : (9,1)
Particle 11 : (5,2)
New Personal Best for 11: (5,2) with weight=1.717524e+002
Particle 12 : (5,3)
New Personal Best for 12: (5,3) with weight=1.685228e+002
Particle 13 : (11,2)
Particle 14 : (20,11)
Particle 15 : (8,3)
Particle 16 : (6,1)
Particle 17 : (7,-2)
Particle 18 : (-25,-4)
Particle 19 : (8,1)
Particle 20 : (9,5)
Iteration 7
-----------
Particle 1 : (5,4)
Particle 2 : (4,2)
New Personal Best for 2: (4,2) with weight=1.759902e+002
Particle 3 : (5,2)
New Personal Best for 3: (5,2) with weight=1.717524e+002
Particle 4 : (10,3)
Particle 5 : (16,0)
Particle 6 : (-3,3)
Particle 7 : (2,-3)
Particle 8 : (22,7)
Particle 9 : (4,-1)
Particle 10 : (5,4)
Particle 11 : (-1,2)
Particle 12 : (6,6)
Particle 13 : (18,6)
Particle 14 : (30,18)
Particle 15 : (7,6)
Particle 16 : (3,6)
Particle 17 : (8,-3)
Particle 18 : (-23,-4)
Particle 19 : (10,-2)
Particle 20 : (6,4)
```

```
Iteration 8
-----------
Particle 1 : (7,3)
Particle 2 : (12,4)
Particle 3 : (15,7)
Particle 4 : (14,6)
Particle 5 : (22,-2)
Particle 6 : (2,3)
Particle 7 : (6,5)
Particle 8 : (8,5)
Particle 9 : (4,1)
Particle 10 : (1,5)
Particle 11 : (2,3)
Particle 12 : (5,4)
Particle 13 : (19,9)
Particle 14 : (25,16)
Particle 15 : (5,8)
Particle 16 : (2,8)
Particle 17 : (4,4)
Particle 18 : (14,6)
Particle 19 : (7,-1)
Particle 20 : (2,2)
Iteration 9
-----------
Particle 1 : (6,2)
Particle 2 : (11,4)
Particle 3 : (21,11)
Particle 4 : (6,4)
Particle 5 : (8,2)
Particle 6 : (8,3)
Particle 7 : (10,10)
Particle 8 : (-7,2)
Particle 9 : (6,5)
Particle 10 : (3,3)
Particle 11 : (9,4)
Particle 12 : (4,0)
Particle 13 : (4,4)
New Personal Best for 13: (4,4) with weight=1.791698e+002
Particle 14 : (9,7)
Particle 15 : (3,3)
Particle 16 : (3,5)
Particle 17 : (1,11)
Particle 18 : (40,13)
Particle 19 : (-2,6)
Particle 20 : (3,2)
Iteration 10
-----------
Particle 1 : (4,2)
Particle 2 : (4,3)
New Personal Best for 2: (4,3) with weight=1.673930e+002
New Global Best (4,3) with f(g)=1.673930e+002
Particle 3 : (11,6)
Particle 4 : (-2,-1)
Particle 5 : (-10,7)
Particle 6 : (11,3)
```

```
Particle 7 : (8,6)
Particle 8 : (-3,2)
Particle 9 : (6,7)
Particle 10 : (6,1)
Particle 11 : (11,3)
Particle 12 : (4,1)
Particle 13 : (-11,-2)
Particle 14 : (-9,-5)
Particle 15 : (2,-2)
Particle 16 : (6,0)
Particle 17 : (1,10)
Particle 18 : (6,5)
Particle 19 : (-3,8)
Particle 20 : (5,2)

g_best =

     4     3


p_best =

     5     3
     4     3
     5     2
     6     1
     6     3
     6     3
     6     2
     8     5
     5     2
     6     2
     5     2
     5     3
     4     4
     8     4
     5     2
     5     2
     5     2
     3     4
     3     2
     5     3


particles =

     4     2
     4     3
    11     6
    -2    -1
   -10     7
    11     3
     8     6
    -3     2
     6     7
```

6	1
11	3
4	1
−11	−2
−9	−5
2	−2
6	0
1	10
6	5
−3	8
5	2