Tutorial on Genetic Algorithm

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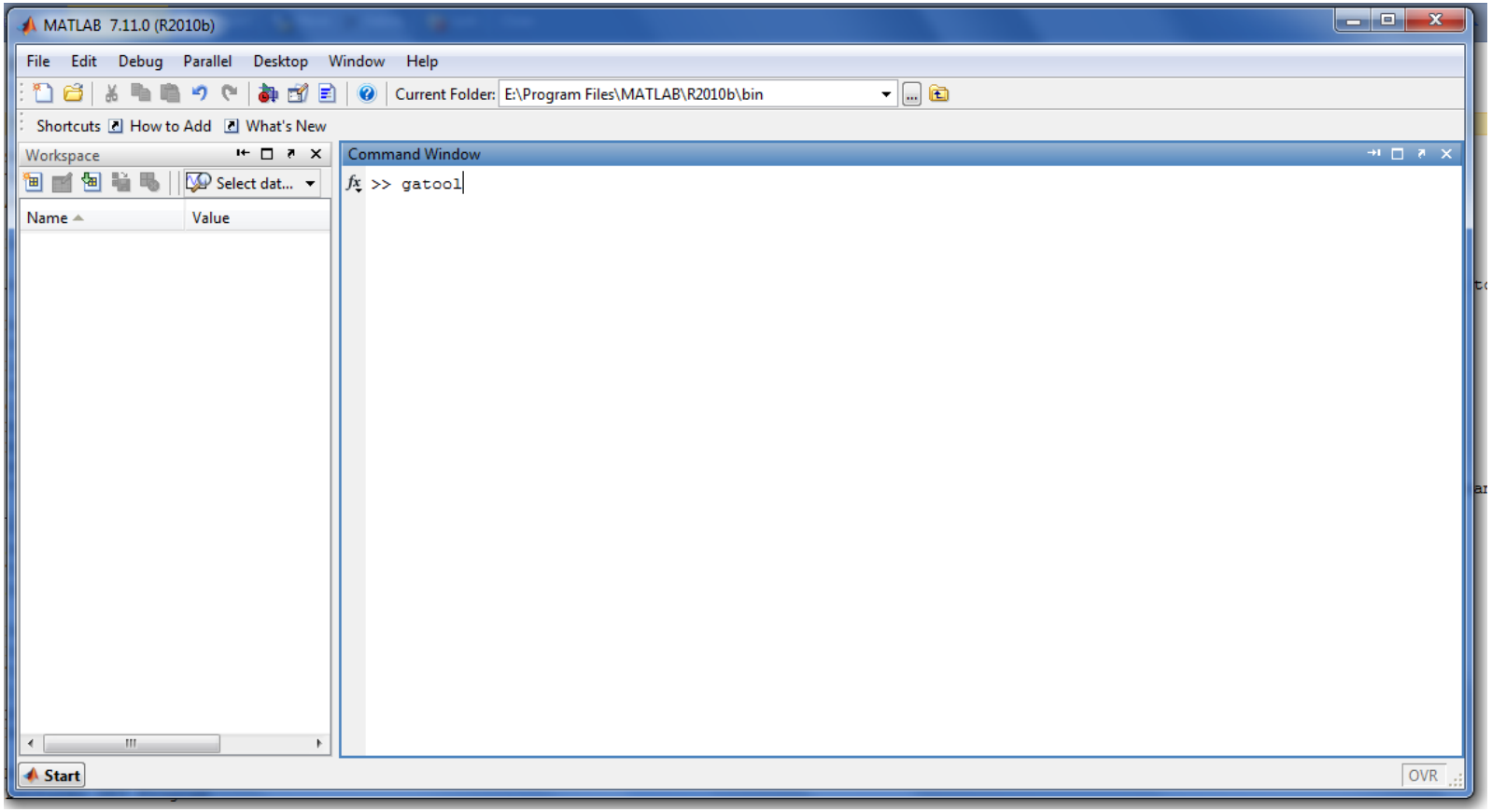
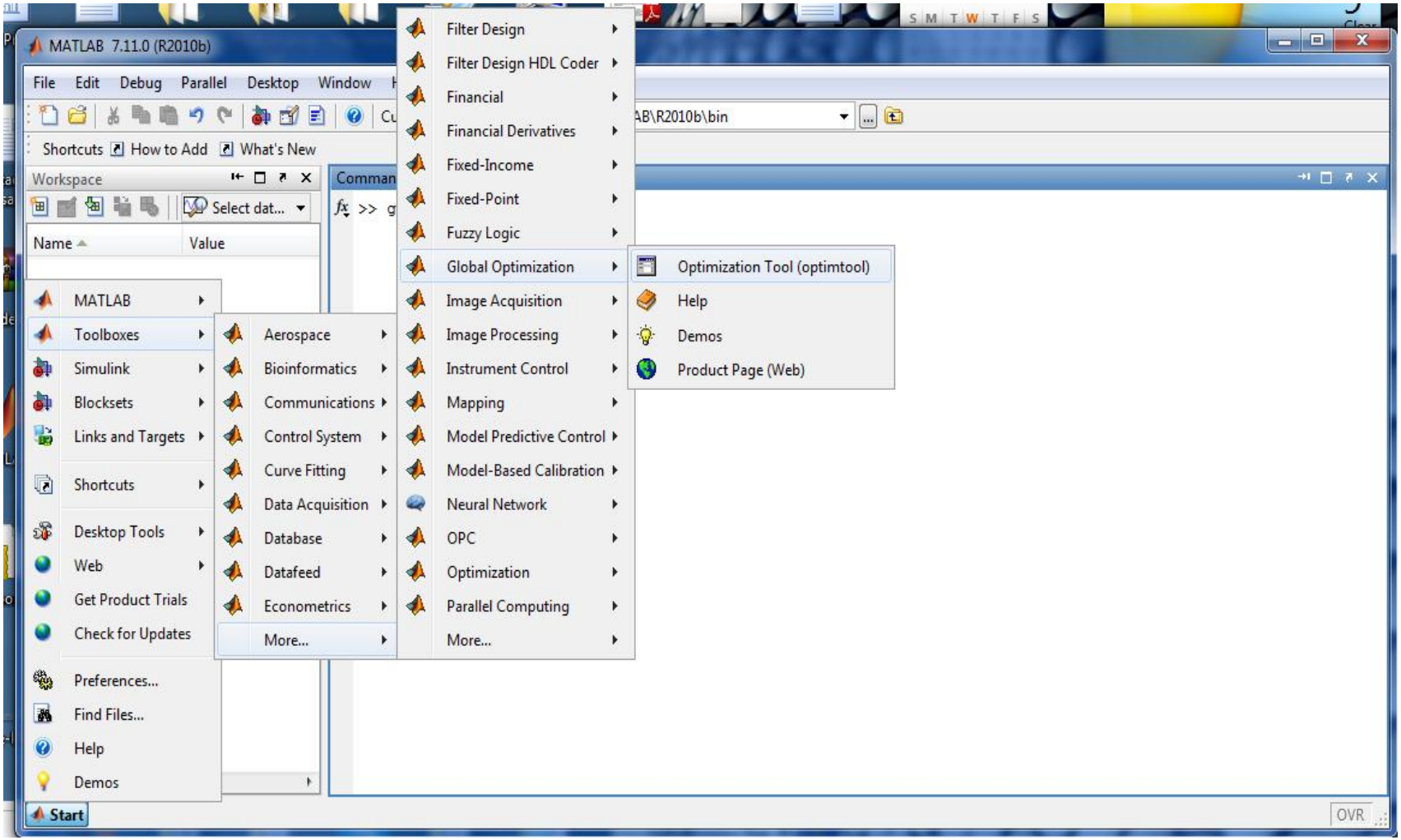
Electrical Engineering Department,

- Type in “gatool” in the command window



- OR


MATLAB 7.11.0 (R2010b)
File Edit Debug Parallel Desktop Window
Shortcuts How to Add What's New
Workspace
Name Value
MATLAB
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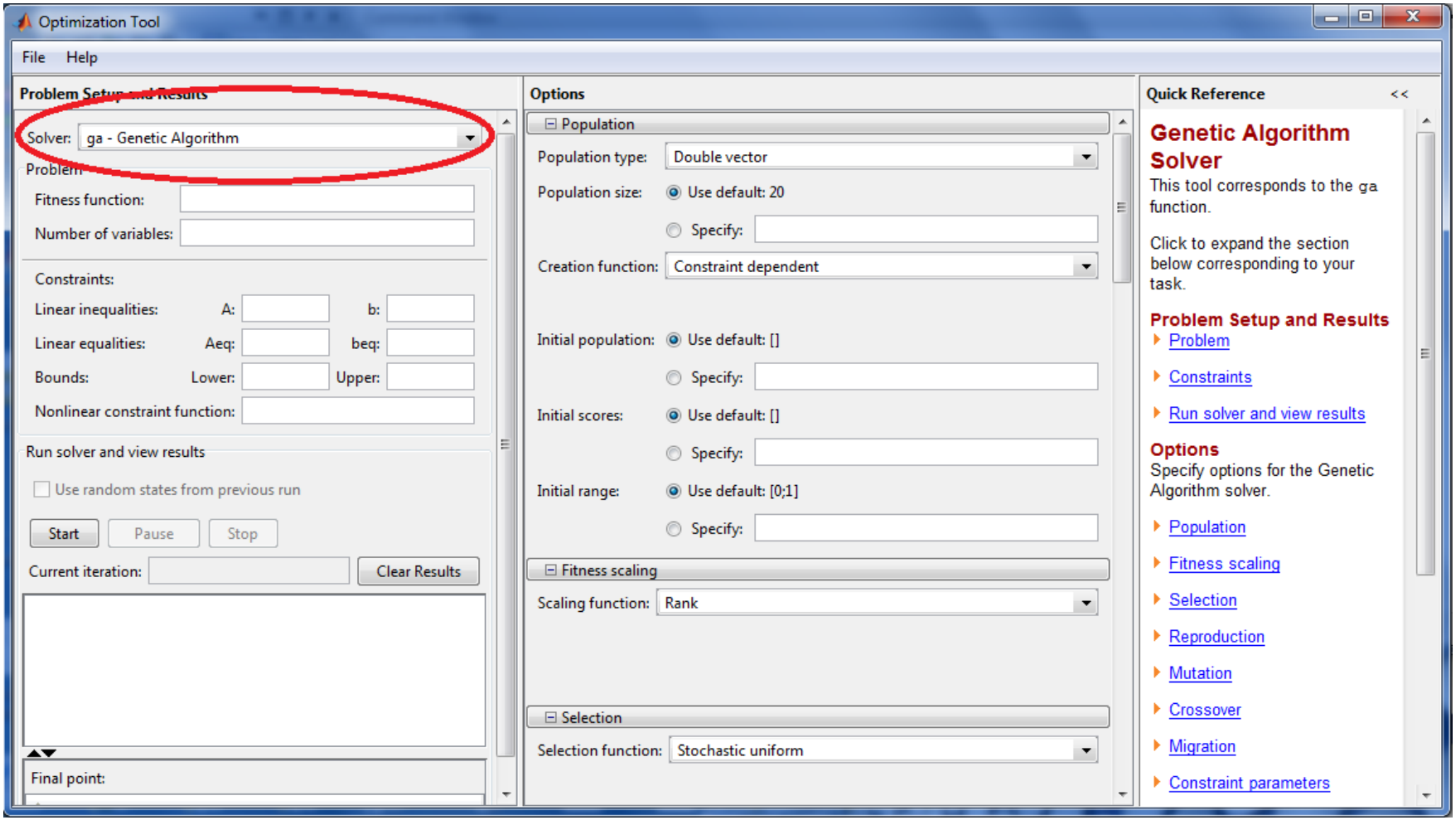
Simulink
Blocksets
Links and Targets
Shortcuts
Desktop Tools
Web
Get Product Trials
Check for Updates
Preferences...
Find Files...
Help
Demos
Start
Aerospace
Bioinformatics
Communications
Control System
Curve Fitting
Data Acquisition
Database
Datafeed
Econometrics
More...
Filter Design
Filter Design HDL Coder
Financial
Financial Derivatives
Fixed-Income
Fixed-Point
Fuzzy Logic
Global Optimization
Image Acquisition
Image Processing
Instrument Control
Mapping
Model Predictive Control
Model-Based Calibration
Neural Network
OPC
Optimization
Parallel Computing
More...
Optimization Tool (optimtool)
Help
Demos
Product Page (Web)
OVR


Optimization Tool
File Help
Problem Setup and Results
Solver: ga - Genetic Algorithm
Problem
Fitness function:
Number of variables:
Constraints:
Linear inequalities: A: b:
Linear equalities: Aeq: beq:
Bounds: Lower: Upper:
Nonlinear constraint function:
Run solver and view results
Use random states from previous run
Start Pause Stop
Current iteration:
Clear Results
Final point:
Options
Population
Population type: Double vector
Population size: Use default: 20
Specify:
Creation function: Constraint dependent
Initial population: Use default: []
Specify:
Initial scores: Use default: []
Specify:
Initial range: Use default: [0;1]
Specify:
Fitness scaling
Scaling function: Rank
Selection
Selection function: Stochastic uniform
Quick Reference
Genetic Algorithm Solver
This tool corresponds to the ga function.
Click to expand the section below corresponding to your task.
Problem Setup and Results
Problem
Constraints
Run solver and view results
Options
Specify options for the Genetic Algorithm solver.
Population
Fitness scaling
Selection
Reproduction
Mutation
Crossover
Migration
Constraint parameters

Example 1 : Ackley Function

- $$f(x,y) = \frac{1}{20}\left\{-20 \times e\left[-0.2\sqrt{\frac{1}{2}(x^2+y^2)}\right] - e\left[\frac{1}{2}(\cos(cx)+\cos(cy))\right] + 20 + e + 5.7\right\}$$

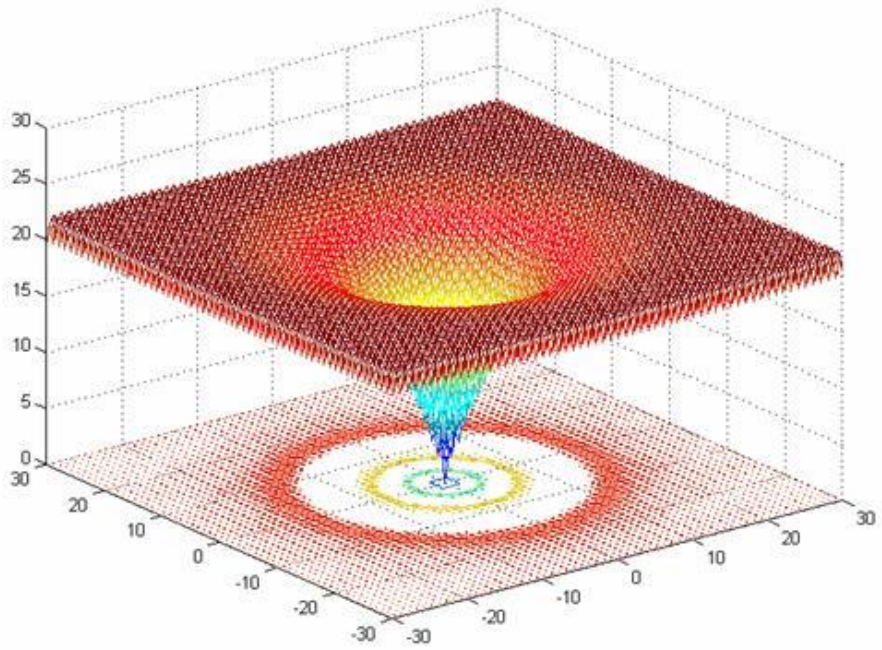
  - Number of variables: can be '*n*' variables.
  - Search domain: $-15 \leq x_i \leq 30,\ i = 1, 2, \ldots, n.$
  - Number of local minima: several local minima.
  - The global minimum: $\mathbf{x}^* = (0, \ldots, 0), f(\mathbf{x}^*) = 0.$

Ackley Function

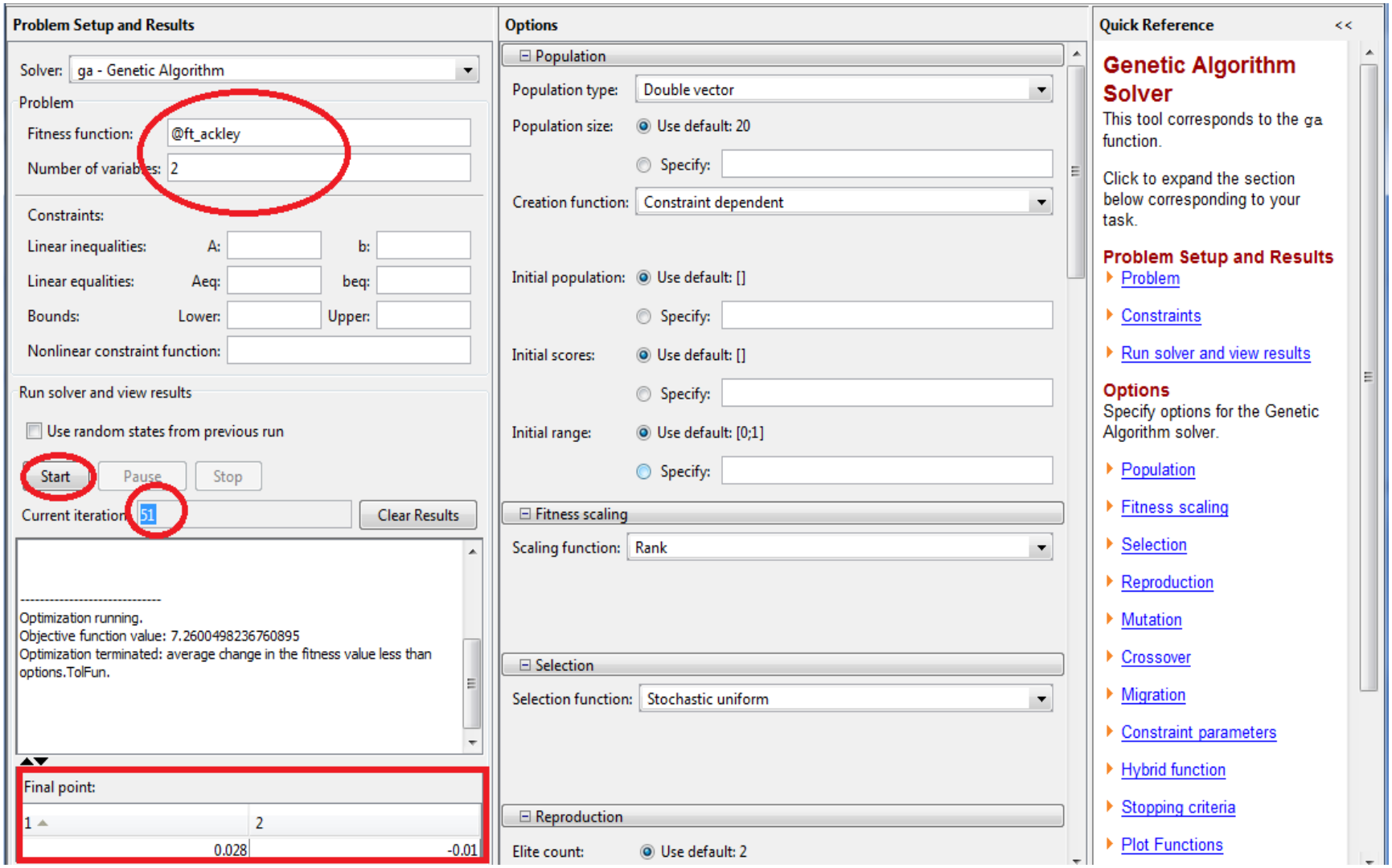
Function graph: for $n = 2$.

MATLAB CODE :

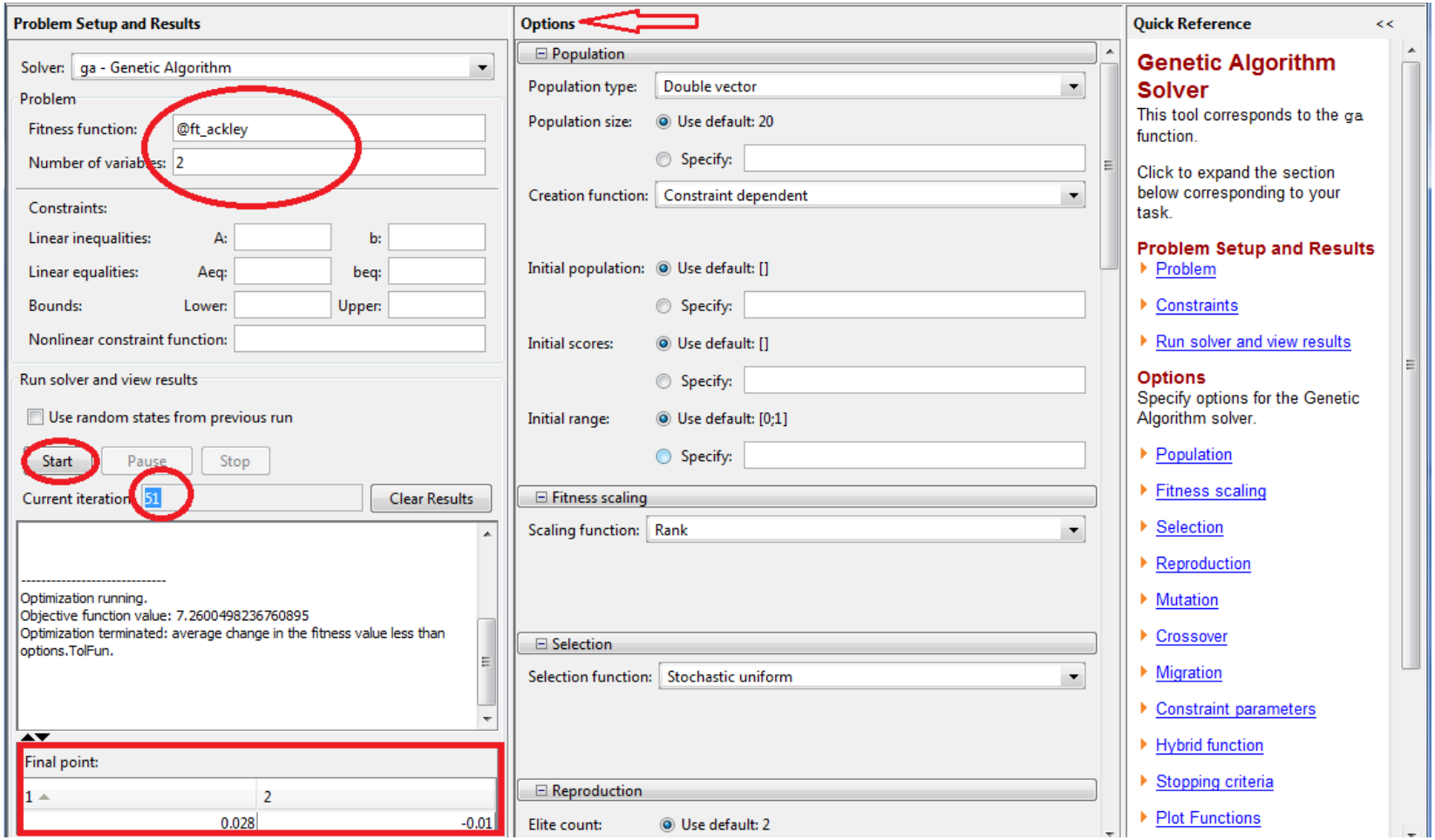
```
function z = ft_ackley(in)
 a =   20; b =  0.2; c = 2*pi; d =  5.7; f =  0.8;
n =    2;
x= in(:,1); y= in(:,2);
z = (1/f)*( -a*exp(-b*sqrt((1/n)*(x.^2+y.^2))) - exp((1/n)*(cos(c*x) + cos(c*y))) + a + exp(1) + d);
```



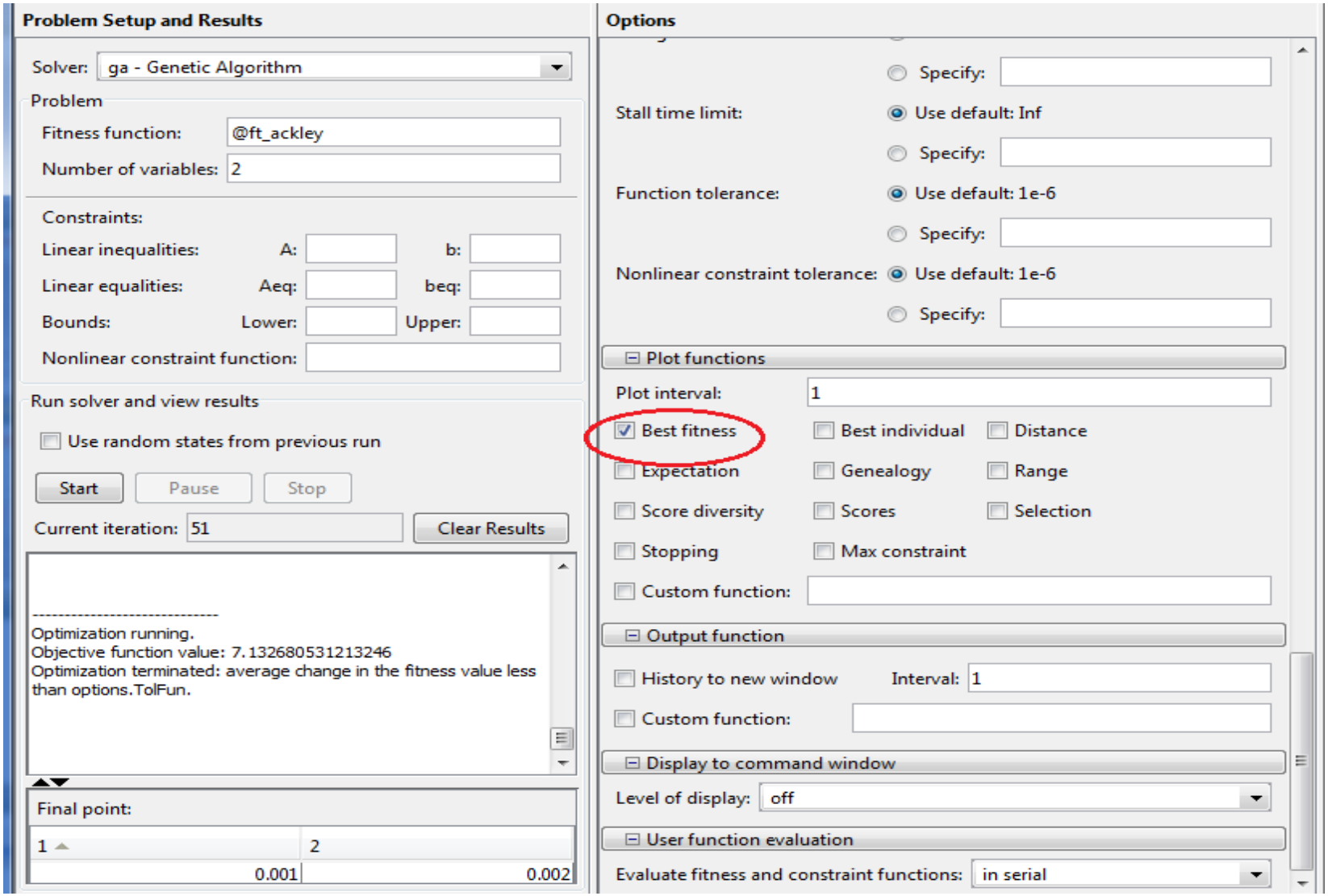
Using the gatool

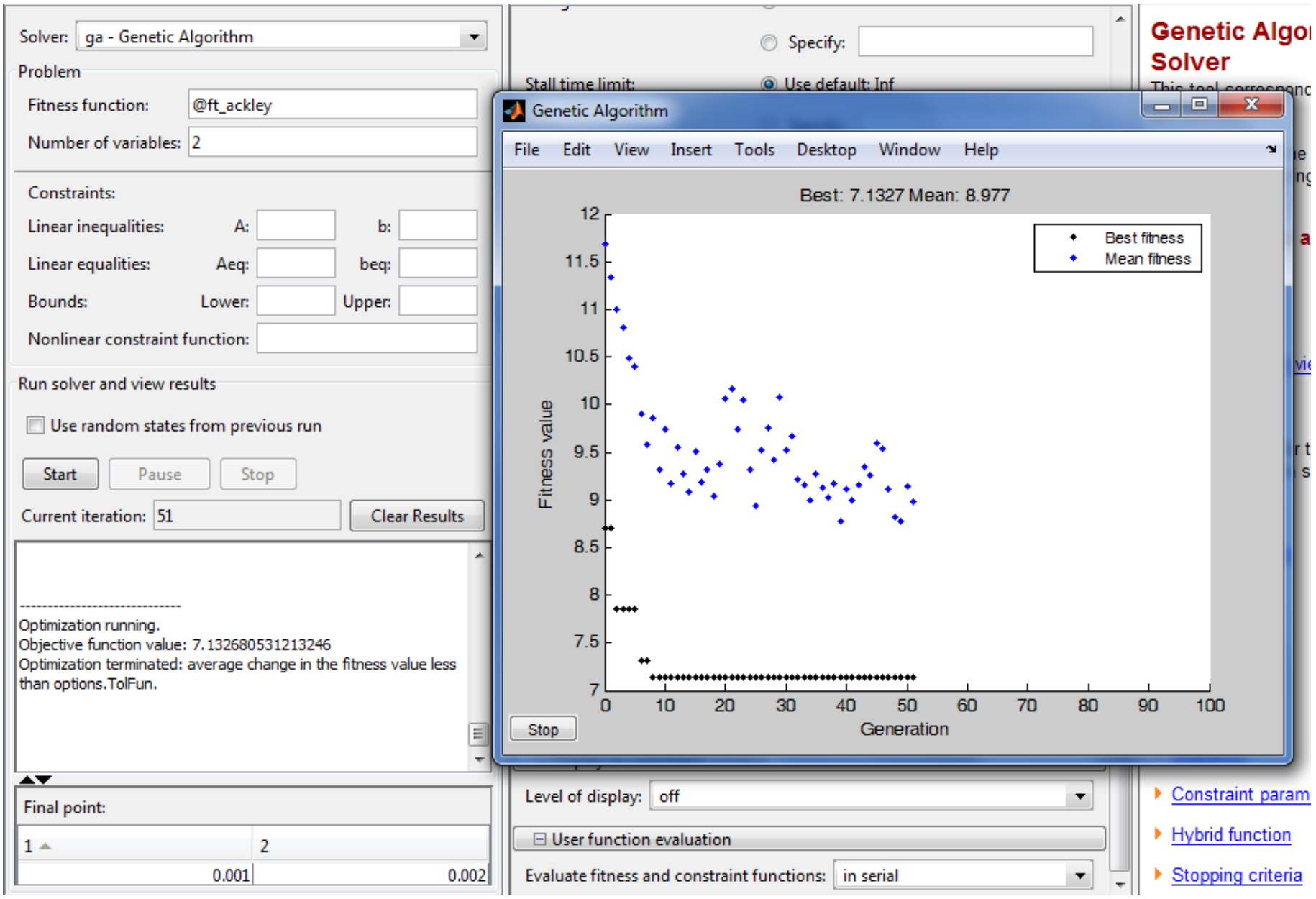


You can customize your solution by manipulating the "Option Menu"



For example plotting the fitness function




Solver: ga - Genetic Algorithm
Problem
Fitness function: @ft_ackley
Number of variables: 2
Constraints:
Linear inequalities: A: b:
Linear equalities: Aeq: beq:
Bounds: Lower: Upper:
Nonlinear constraint function:
Run solver and view results
Use random states from previous run
Start
Pause
Stop
Current iteration: 51
Clear Results
Optimization running.
Objective function value: 7.132680531213246
Optimization terminated: average change in the fitness value less than options.TolFun.
Final point:
1
2
0.001
0.002
Specify:
Stall time limit:
Use default: Inf
Genetic Algorithm
File Edit View Insert Tools Desktop Window Help
Best: 7.1327 Mean: 8.977
Best fitness
Mean fitness
Fitness value
Generation
Stop
Level of display: off
User function evaluation
Evaluate fitness and constraint functions: in serial
Genetic Algo
Solver
Constraint param
Hybrid function
Stopping criteria

Example 2: Rastrigin's Function

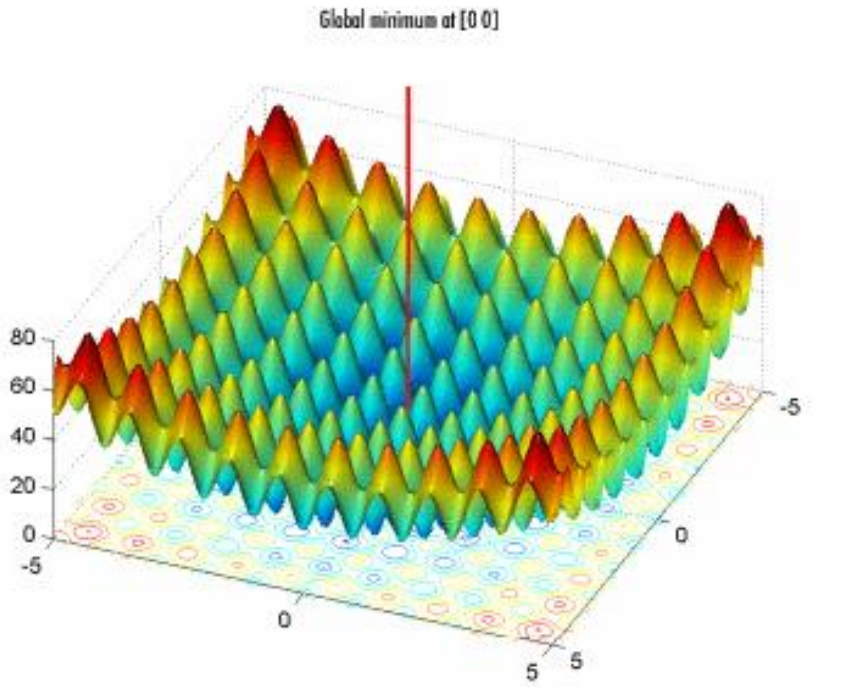
- $Ras(x) = 20 + x_1^2 + x_2^2 - 10(cos2\pi x_1 + cos2\pi x_2)$

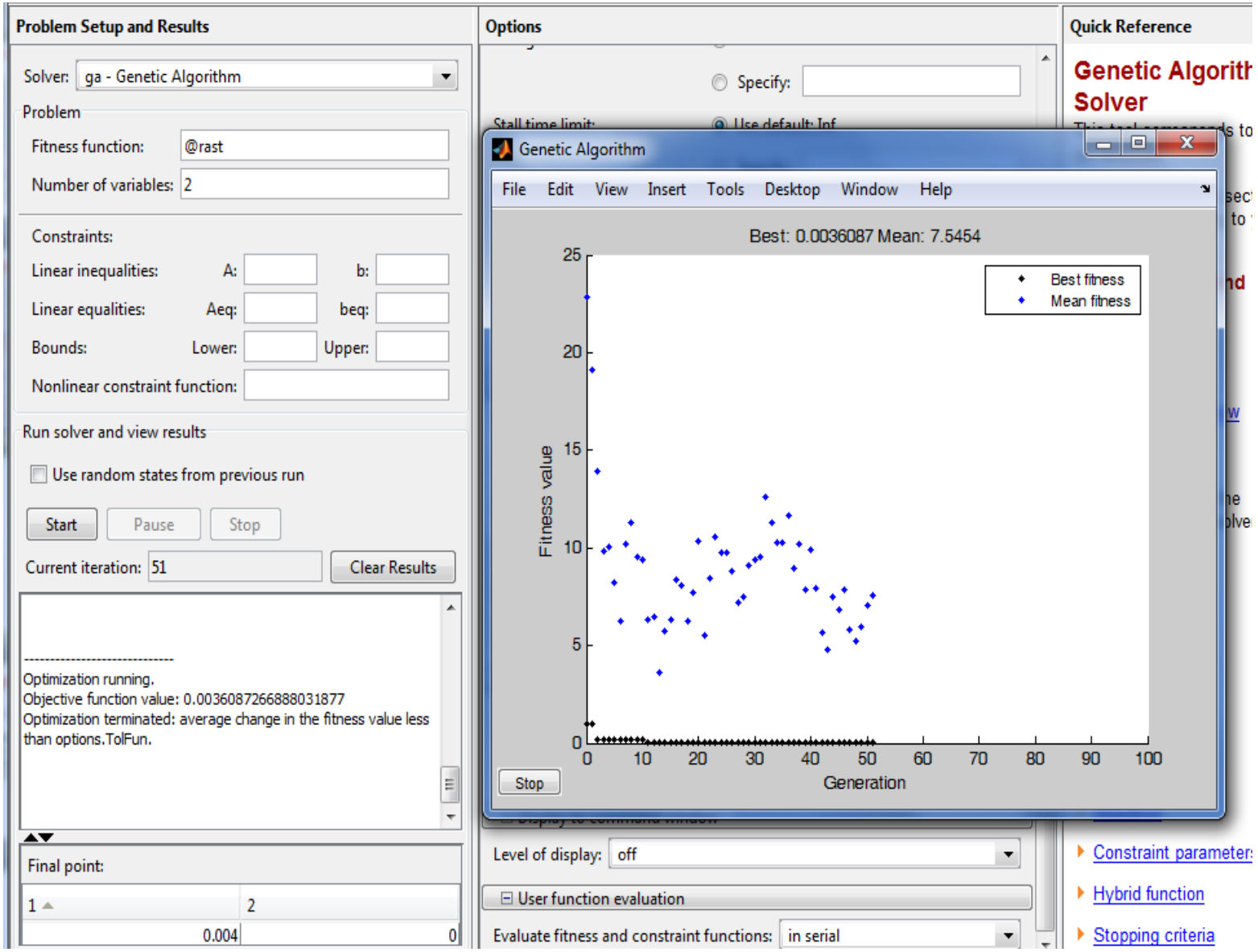
- Number of variables: n variables.
- Search domain: $-5.12 \leq x_i \leq 5.12,\ i = 1, 2, \ldots, n.$
- Number of local minima: several local minima.
- The global minima: $x^* = (0, \ldots, 0), f(x^*) = 0.$

- **MATLAB Code:**

```
function y = rast(x)
% The default value of n = 2.
n = 2;
s = 0;
for j = 1:n
    s = s+(x(j)^2-10*cos(2*pi*x(j)));
end
y = 10*n+s;
```

Function graph for n = 2




Problem Setup and Results
Solver: ga - Genetic Algorithm
Problem
Fitness function: @rast
Number of variables: 2
Constraints:
Linear inequalities: A: b:
Linear equalities: Aeq: beq:
Bounds: Lower: Upper:
Nonlinear constraint function:
Run solver and view results
Use random states from previous run
Start
Pause
Stop
Current iteration: 51
Clear Results
Optimization running.
Objective function value: 0.0036087266888031877
Optimization terminated: average change in the fitness value less than options.TolFun.
Final point:
1
2
0.004
0
Options
Specify:
Use default: Inf
Genetic Algorithm
File Edit View Insert Tools Desktop Window Help
Best: 0.0036087 Mean: 7.5454
Best fitness
Mean fitness
Fitness value
Generation
Stop
Level of display: off
User function evaluation
Evaluate fitness and constraint functions: in serial
Quick Reference
Genetic Algorith
Solver
Constraint parameters
Hybrid function
Stopping criteria

Example 3: Sum Squares Function

- $$f(x) = \sum_{i=1}^{n} x_i^2$$

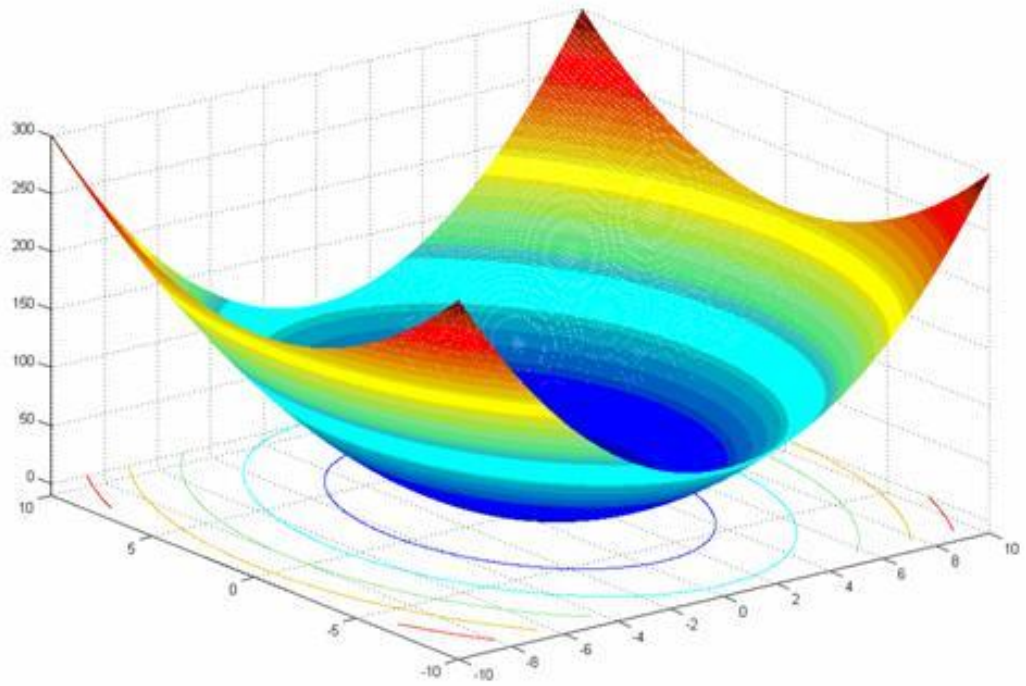
- Number of variables = ‘n’ variables
- Number of local minima: no local minimum except the global one.
- The global minima: $x^* = (0, \ldots, 0)$, $f(x^*) = 0$.

- Matlab Code:

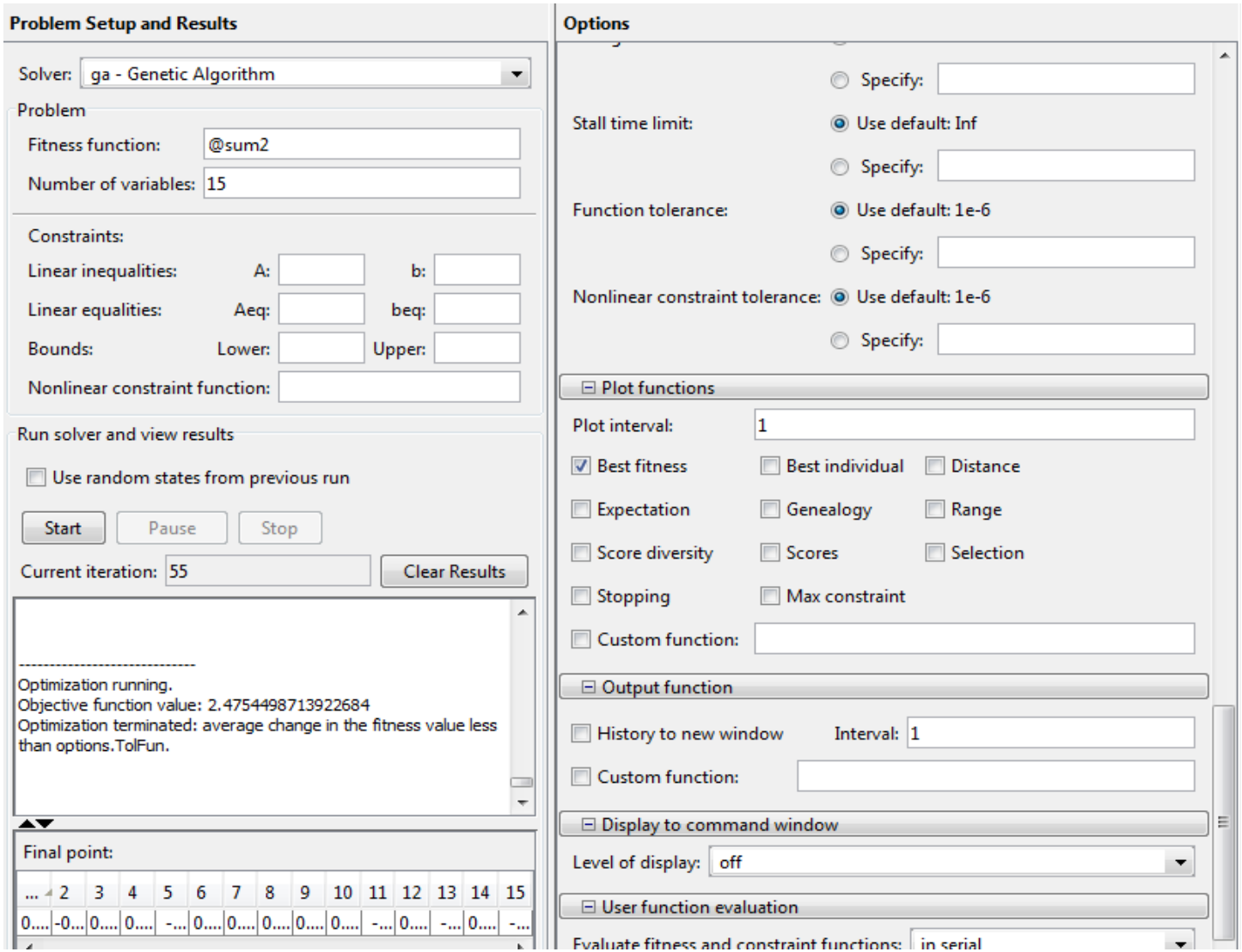
```
function y = sum2(x)
% The default value of n = 15.
n = 15;
s = 0;
for j = 1:n
   s=s+j*x(j)^2;
end

y = s;
```

Function Graph for n =15



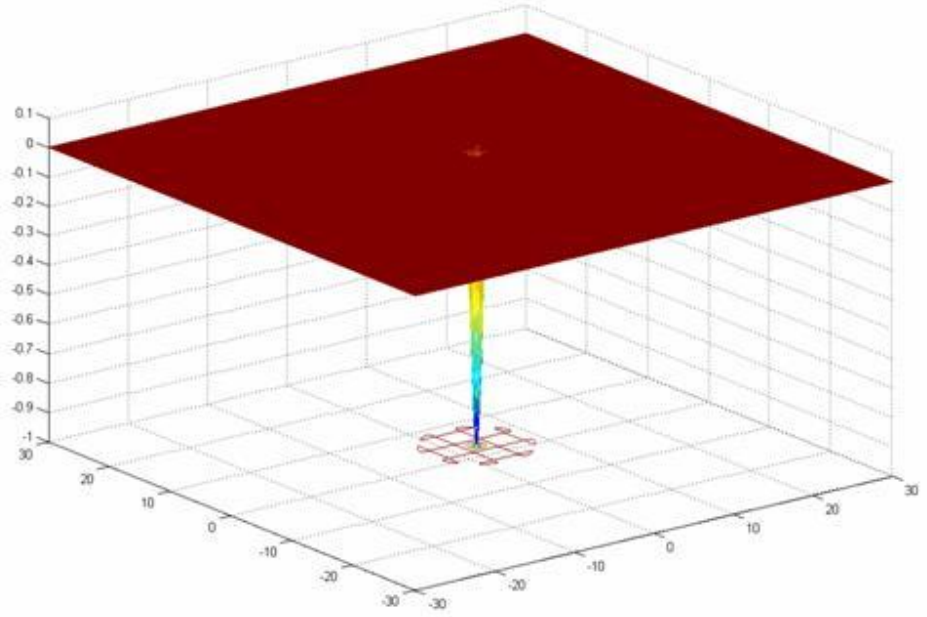
Best Fitness:



Example 4: Easom Function:

- $f(x) = -cosx_1 cosx_2 \exp(-(x_1 - \pi)^2 - (x_2 - \pi)^2$
- Number of variables: $n = 2$.
- Number of local minima: several local minima.
- The global minima: $x^* = (\pi, \pi), f(x^*) = -1$.

- **Matlab Code:**
- function y = easom(x)
- % Easom function
- %The number of variables n = 2.
- y = -cos(x(1))*cos(x(2))*exp(-(x(1)-pi)^2-(x(2)-pi)^2);



Best Fitness