COSC 420/527: Biologically-Inspired Computation
Lab 4: Particle Swarm Optimization

Due: March 31, 11:59 PM

Introduction

In this lab, you will be investigating the effect of the parameters of particle swarm optimization on the performance of the algorithm for two classic optimization problems: the Rosenbrock function and the Booth function. The particle swarm optimization code we implemented has been expanded and provided to you to use for the lab, though you will need to update it to switch between Rosenbrock and Booth.

Experimental Setup

The parameters that we will be varying and studying the effect of are:

- Number of particles (default = 40)
- Inertia (default = 0.5)
- Cognition parameter (default = 1)
- Social parameter (default = 1)

Unlike the evolutionary algorithms lab, you will fix all but one of the parameters to their defaults and vary each one in isolation at a time to evaluate the effect on performance. These are the values you should examine for each parameter value (again, keeping all other parameters fixed to their default when you're varying them).

- Number of particles: 10 to 100, in increments of 10
- Inertia: 0.1 to 1, in increments of 0.1
- Cognition parameter: 0.1 to 4 in increments of 0.1
- Social parameter: 0.1 to 4 in increments of 0.1

Because random initialization impacts performance, you should run at least 20 tests for each parameter combination. The provided code prints the arguments used in evaluation, the number of epochs to convergence (which is capped at 1000), the solution that it converged to, and the fitness value of that solution. Note that it's possible that the algorithm will *NOT* converge to the actual solution in some cases. The correct solution for both problems is a fitness value of 0. If the values are sufficiently different (i.e., the fitness value is greater than 1e-10), then the algorithm has NOT converged to the actual solution.

CS 527 Credit

In addition to the above, you will evaluate how the cognition and social parameters varying ***together*** affect performance. You will evaluate all combinations of the cognition and social parameters (0.1 to 4 in increments of 0.1), with at least 20 different random initializations of each.

Report Write-Up

Your report write-up should include the following information:

Graphs

You will create a plot for each of the four parameters and each problem (eight total) where the x-axis is the parameter value and the y-axis is the number of epochs to convergence. You should not include the tests that did not converge to the correct solution in these plots. You should show a boxplot for each of the values. Additionally, you should plot a point for the mean convergence epochs for each parameter value and connect those with a line plot (see lecture notes for an example).

You will also create a plot for each parameter (up to eight, up to four for each problem) depicting the number of runs that did not converge to the correct solution. If every run converged for all parameter values, note that in your report and omit the figure. You may use a line plot, bar chart, or any other plot type of your choosing to depict these results.

CS 527: You will create up to four heatmaps indicating how the performance of the social and cognition parameters interact. The first set of two heatmaps will show the mean number of epochs to convergence for each combination of values (omitting those that did not converge to the correct solution) for each problem. If any of the runs did not converge for each problem, you will create a second heatmap showing the number of runs that did not converge to the correct value for each combination.

Discussion

- How big of an impact can parameter selection have on performance?
- Do there appear to be optimal values for each parameter? Are the "best" performing values (i.e., those that converge the fastest) the same for each problem?
- Why do some values perform better than others?
- **CS 527:** How do the social and cognition parameters interact with each other? Should one be set higher than the other? Should they be changed proportionally?

Submission

Grading

Undergraduate Grading Breakdown:

- **64 points total**: 16 points for each set of plots created for each parameter value (up to eight total plots for each parameter value).
- **36 points total**: 12 points for each discussion question.

Total: 100 points

For CS 420, if you complete the social/cognition parameter analysis, that will be an additional 15 points.

Graduate Grading Breakdown:

- **40 points total**: 10 points for each set of plots created for each parameter value (up to eight total plots for each parameter value) for the CS 420 portion of the project.
- **20 points total**: 10 points for each heatmap set.
- **40 points total**: 10 points for each discussion question.

Total: 100 points