Artificial Intelligence – CSC 362
Assignment 5 Report
Sarah Groark

Overview

- Goal – optimization of multi-parameter functions (minimize combined equation with two functions below)
    - F = *a**f1 + *b**f2
        - NOTE: where a + b = 1

- Functions –

    [1] Cross Section Area

$$f_1(X) = 2x_2x_4 + x_3(x_1 - 2x_4)$$

    [2] Static Deflection

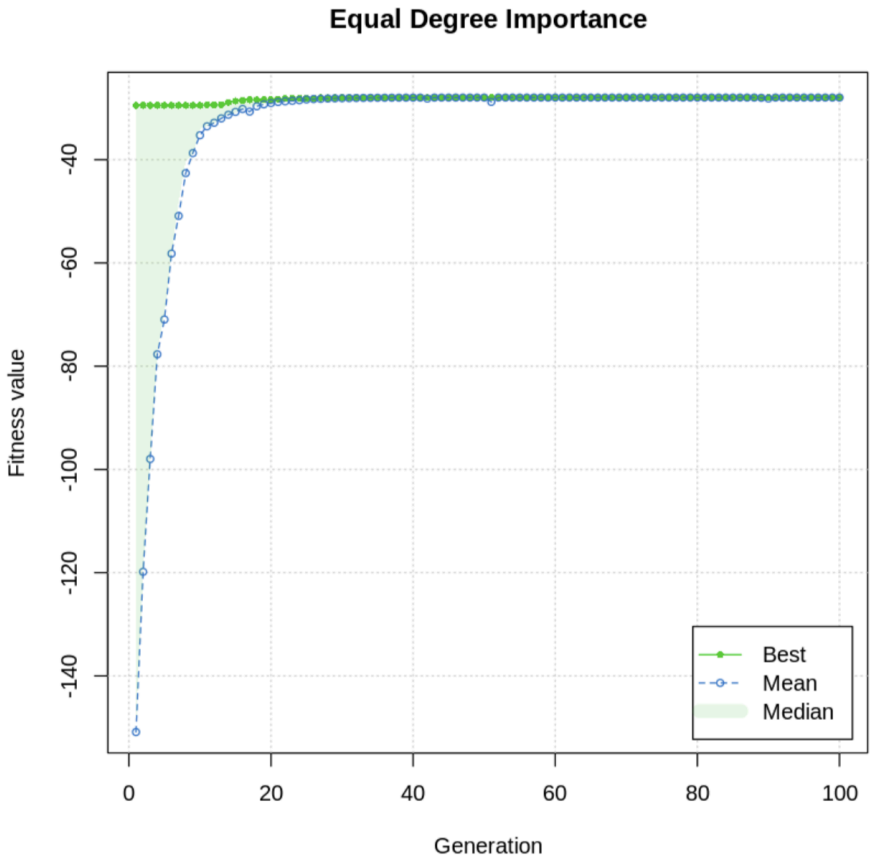
$$f_2(X) = \frac{60{,}000}{x_3(x_1 - 2x_4)^3 + 2x_2x_4\left[4x_4^2 + 3x_1(x_1 - 2x_4)\right]}$$

    - Side constraints:
        - $10 \leq x_1 \leq 80$
        - $10 \leq x_2 \leq 50$
        - $0.9 \leq x_3 \leq 5.0$
        - $0.9 \leq x_4 \leq 5.0$

- Population parameters –
    - numGenerations = 100
    - populationSize = 50
    - $P_c = 0.75$
    - $P_m = 0.001$

Conducted Experiments

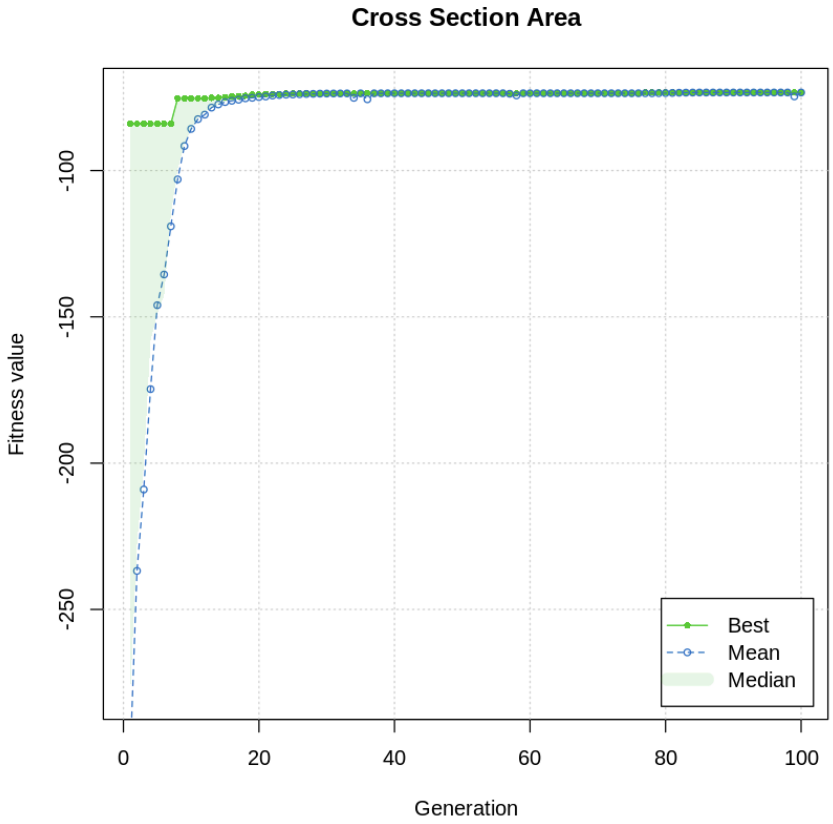
1. Weighted function – equal degree of importance (a = 0.5, b = 0.5)



The best obtained solution for this problem was assigned as the following:
$X_1 = 14.98798$
$X_2 = 10.12794$
$X_3 = 1.196612$
$X_4 = 2.185174$

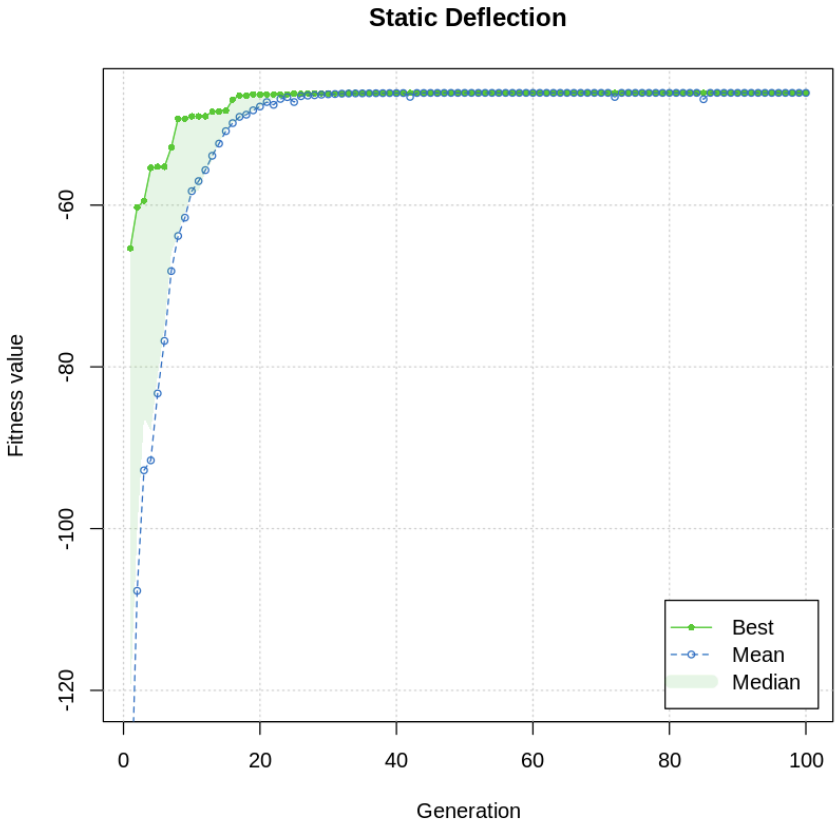
Since the optimization problem called for the minimization of the combined function (combining the two functions – static deflection and cross section area), the fitness values take on a negative value. The function begins to converge to a certain fitness value around generation 20. This fitness function value represents the combination of the four x-value solutions that would create the ideal parameters for the I-beam to structurally succeed. In this experiment, the static deflection and cross section area functions both weigh equal amounts in the combined fitness function.

2. Minimization of Cross Section Area (a = 1, b = 0)



In this experiment, the combined weighted function is minimized to only take into account the cross section area function. In these results, the fitness values converge to a lesser, more negative value than the equal weighted combined function. The cross section area function produces a larger negative result when minimizing the four parameters. Similarly, the mean fitness values converge near and around the 20th generation, while the best values begin converging closer towards the 15th generation. In this way, the four parameters are minimized to optimize the cross section area only, not taking into account the static deflection.

3. Minimization of Static Deflection (a = 0, b = 1)



In this experiment, the combined fitness function considers only the static deflection function. These particles' fitness values took longer to converge, with convergence beginning around generation 30, rather than 10 generations earlier, as seen with the above two experiments. This could be due to the slightly more complex nature of the static deflection function, but the minimization of this function ensures that the measurements of the I-beam will have a strong foundation. Additionally, the general fitness values fall somewhere between those of what the equal weight and cross section area functions produce.

Concluding Remarks

The genetic algorithm here proved to show convergence of values towards an optimum solution that would solve a very complex problem. The ability to combine two functions, with four different parameters, to minimize the ultimate fitness function, is very useful for industry to find

complex and accurate solutions to difficult problems. The small, almost undetectable changes in the x values as they converge toward the optimum solution shows the detail oriented approach taken by evaluating the generations' solutions one by one to determine the solution most likely to lead to utility.