

## Evolutionary Computation.

Use the function:

```
EC(M,L,generations,lb,ub,formula,mutrule,Delta, hardb)
```

**M:** Number of individuals

**L:** Number of traits

**Generations:** number of generations

**lb:** lower bound for trait value

**ub:** upper bound for trait value

**formula:** formula for fitness

1:  $50-x^2$

2:  $x_1^2 + x_2^2$

3:  $x^3$

4:  $\sin(x)$

5:  $x*\sin(x)$

6:  $x_1^2 + x_2^3$

7:  $x_1*\sin(x_2)$

8:  $(x_1-2)(x_2+5)$

9:  $x^2+\text{gauss}(0,.01x^2)$

10:  $x^2$

**mutrule:** mutation rule

1: Probability of  $.5 + \text{Delta}$ , and  $.5 - \text{Delta}$

2: Gaussian mutation operator

**Delta:** Value of change in trait, or SD in the Gaussian mutation operator

**hardb:** 1 for hard bounds in the trait; 2 for soft bounds

This function will print the fitness, the gene value for each individual, and the average, minimum and maximum fitness for the whole population.

At the end of the simulation, the average, minimum and maximum fitness by generation will be plotted.

Activities:

### 1. Simple Fitness Landscape (Section 1.3)

To run the simulation type:

```
EC(10, 1, 100, -100, 100, 1, 1, 1,1)
```

1.1 Are the number you obtained the same as the ones reported in the book? Why do you think that is the case?

1.2 What gene value would produce the highest fitness? Is that the same value as in your simulation? Why?

1.3 What happens if instead of a Delta of 1 you used a delta of .1? What about a Delta of 10? Explain the results

1.4 Now try the Gaussian mutation operator (`mutrule=2`). What happens to the fitness and gene values? Are they any different than in the previous simulations? Use `EC(10, 1, 100, -100, 100, 1, 2, 1,1)`

1.5 What happens if the bounds for the trait are not hard?

### 2. Two-dimensional geno/pheno-space (Section 1.4)

2.1 Consider the 4 possibilities outlined in page 15. What would the results of the simulations look like for each of the possibilities.

2.2 Run 10 simulations. Which one of the 4 scenarios occurred?

3. Do exercises 1 to 3 at the end of Chapter 1. Remember to run more than one simulation. For each of the fitness landscapes, make a prediction, write it down, and then run the simulations, and compare your predictions with the results of the simulations. For exercise 1 try hard bounds and soft bounds. For (3), compare formulas 9 and 10. Provide with a short description of the results (about 1 paragraph) for each simulation.

4. How would you make the EC model more biologically realistic?

5. Think of a way in which we can use an evolutionary model to explain how language evolves throughout time.