BioComputation

Worksheet 3: Simple Genetic Algorithm with Real Variables

You should now have a working generational GA which uses a binary encoding, tournament selection, single-point crossover and bit-wise mutation. Whilst in theory anything can be represented by a binary encoding, it is typically not the most efficient way to do things. Instead, having genes that are real numbers (floats) is far more powerful.

Alter your individuals and their initialisation process so that their genes are reals in the range [0.0,1.0]. The very simple counting ones fitness function wherein the fitness of an individual is equal to the number of '1's in its array of genes (genome) is easily extended to the sum of the real-valued genes:

```
fitness=0;
for( i=0; i<N; i++ ) {
        fitness = fitness + ind.gene[i];
}
```

The selection and crossover processes do not need to be changed to work with reals but mutation does. Since you can't sensibly "flip" a real, another way to mutate them is to simply add or remove a small random number from a defined range [0.0,MUTSTEP]:

```
for( i=0; i<P; i++) {
    for( j=0; j<N; j++ ) {
        if( random() < MUTRATE ) {
            alter = rand_range(0,MUTSTEP);
            if( random()%2 )  offspring[i].gene[j] = offspring[i].gene[j]+alter;
            else offspring[i].gene[j] = offspring[i].gene[j]-alter;
        }
    }
}
```

Again, once you are happy this is working, attempt to maximise the best fitness (max = N) achieved by your GA over fifty generations for a fifty-gene genome in a population of fifty individuals. That is, explore the effects of altering the probability of mutation events occurring and the size of the alterations made when it happens. Population and tournament size can be varied too. Remember this is a stochastic algorithm so results should be averaged over (preferably) ten separate runs (different random seeds) for a true estimate of utility.

Next try a minimisation function:

$$f(x) = 10n + \sum_{i=1}^{n} x_i^2 - 10.\cos(2\pi.x_i) \qquad \text{Where } -5.12 \leq x_i \leq 5.12, \text{ and use } n=10, 20$$