Examen Parcial Algoritmos Genéticos

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1 Problem 1

1.1 Part 1

Individuals are represented by their genotype which is a codification. In genetic algorithms the genotype are strings consisting of binary digits. The phenotype is generated by interpreting the genotype , and then it is evaluated using a fitness function. During the simulation many genotypes are generated by combining individuals and mutating them. The ones that remain are the ones that have the highest fitness values.

In Karl Sims' work the phenotype is a 3D structure consisted of blocks that together represent the body of an individual. The genotype is a directed graph that represents the 3D structure. The nodes represent body parts and the edges connect them with other nodes or connect to themselves using recursivity. When they are connected to the same child multiple times , it means that duplicate instances are being created.

Each node represents one part of the body , it contains information such as dimensions and join-type. Dimensions determine the physical shape and join-type which are the constraints of motion between the node part and its parent for instance: rigid , revolute, twist, universal, bend-twist, twist-bend or spherical.There are other parameters such us Joint-limits and recursive limit, also local neurons and connections other nodes. Connections also have information such as position , orientation , scale and reflection.

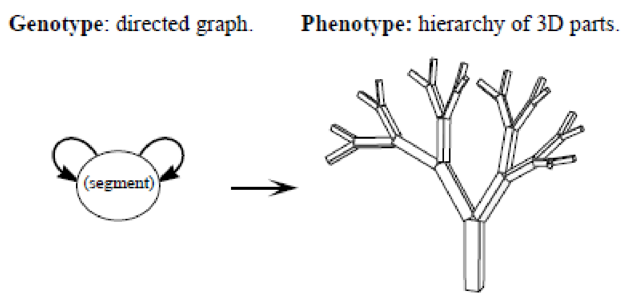

Fig. 1. Genotype and Phenotype

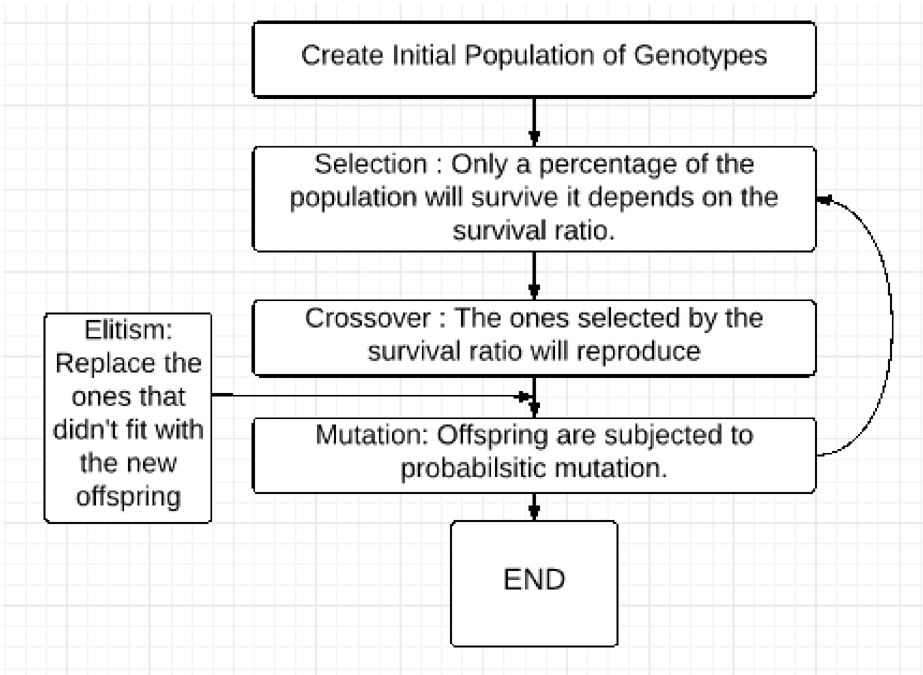

Fig. 2. Part2 Flow Diagram

2 Problem 3

2.1 Part1

Uses of Genetic Algorithms in Environmental Science.
The aim of using Genetic Algorithms is to optimize , in Environmental Sciences there is a lot of modeling and simulation that needs to be optimized to find optimal solutions to problems.

- GA were used to estimate parameters to calibrate a water quality model(Mulligan and Brown in 1998). Non linear regression was used to search for parameters that minimized the error when trying to find the best fit model to the data. Genetic Algorithms were useful because they provided information about the search space that allowed the researchers to develop confidence regions and parameter correlations.

- IA and GA were used in managing groundwater supplies. Researches combined GAs with neural network to simulate annealing techniques . GAs allowed them to fit parameters of a model to optimize pumping locations of underground water.

– GAs are also used in astrophysics when modeling the rotation curves of galaxies, extracting pulsation periods of Doppler velocities in spectral lines, and optimizing a model of hydrodynamic wind.

2.2 Part 2

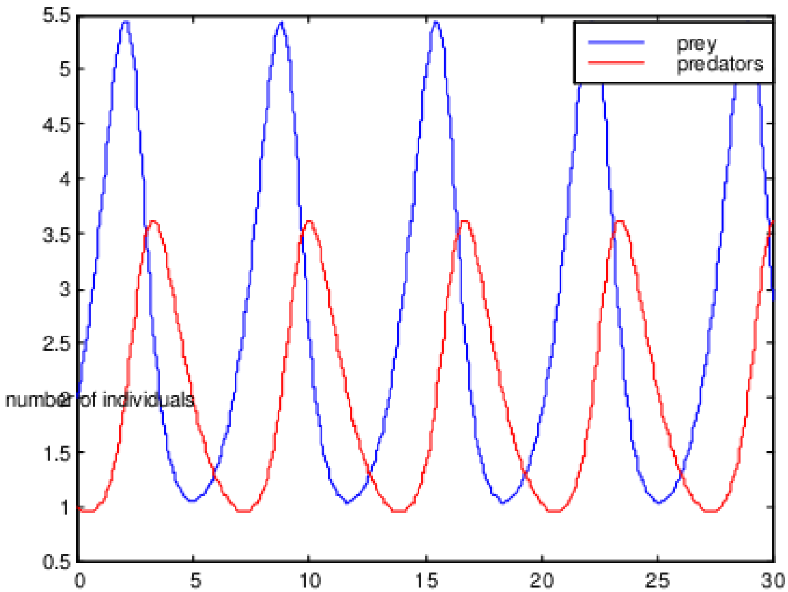

Fig. 3. Solution 1

The figure above represents the variation of individuals of prey and predators over time solving the system using Runge Kutta's method.

$$\frac{dx}{dt} = ax - bxy$$
$$\frac{dy}{dt} = -cy + dxy$$

Fig. 4. Predator-Prey Model

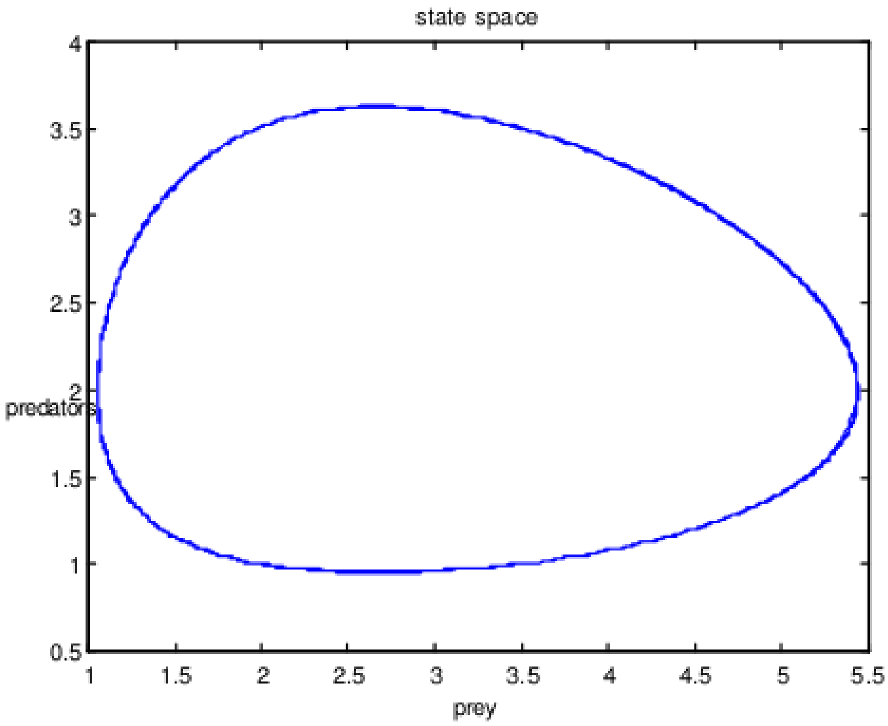

Fig. 5. This figure represents the interaction of predator and prey , in other words is the solution of X(t) vs Y(t) in the Lotka-Volterra equations.

2.3 Part 3

Genetic Algorithms are used to minimize the least square error between the model and the data .

The nonlinear model is : $S_t = Ns^T s + Ls + C$.

So our fitness funcion is the least squeare error funcion.

$$obj(\mathbf{p}) = \sum_{j=1}^{k} |\mathbf{y}(t_j; \mathbf{p}) - \mathbf{y_j}|^2,$$

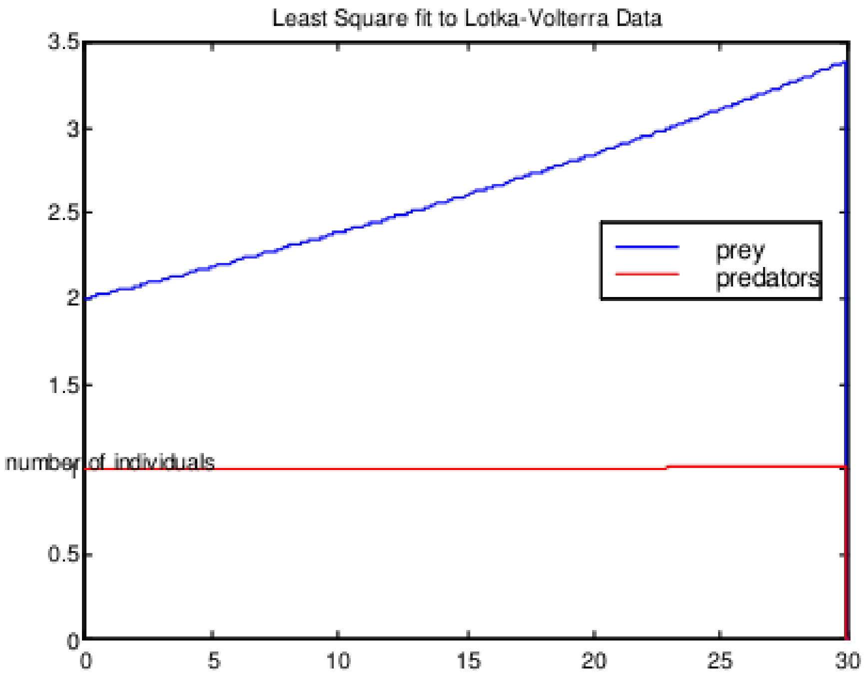

Fig. 6. This figure represents an scenario with no predators , the density of preys grow at a rate a which is the prey birth rate. This is the result of the least squares fit to the linear model $S_t = Ls + C$.

2.4 Problem 2

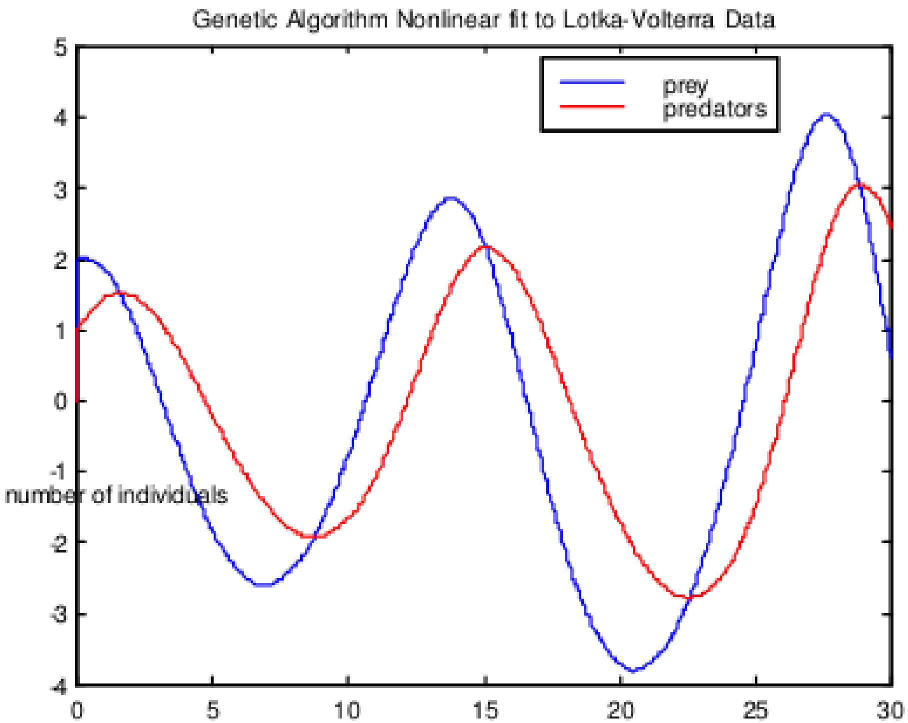

Fig. 7. After using GA to minimize the least square error to fit the data and the model we have the solution with GA.

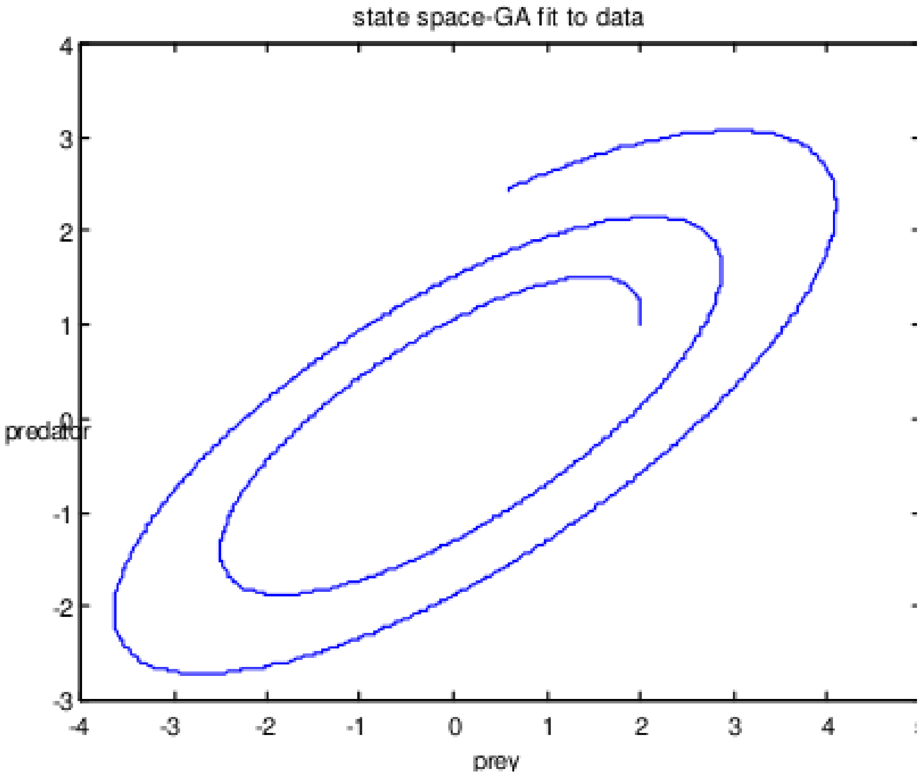

Fig. 8. This figure shows the relation between prey and predator using the nonlinear model fitted by the Genetic Algorithm

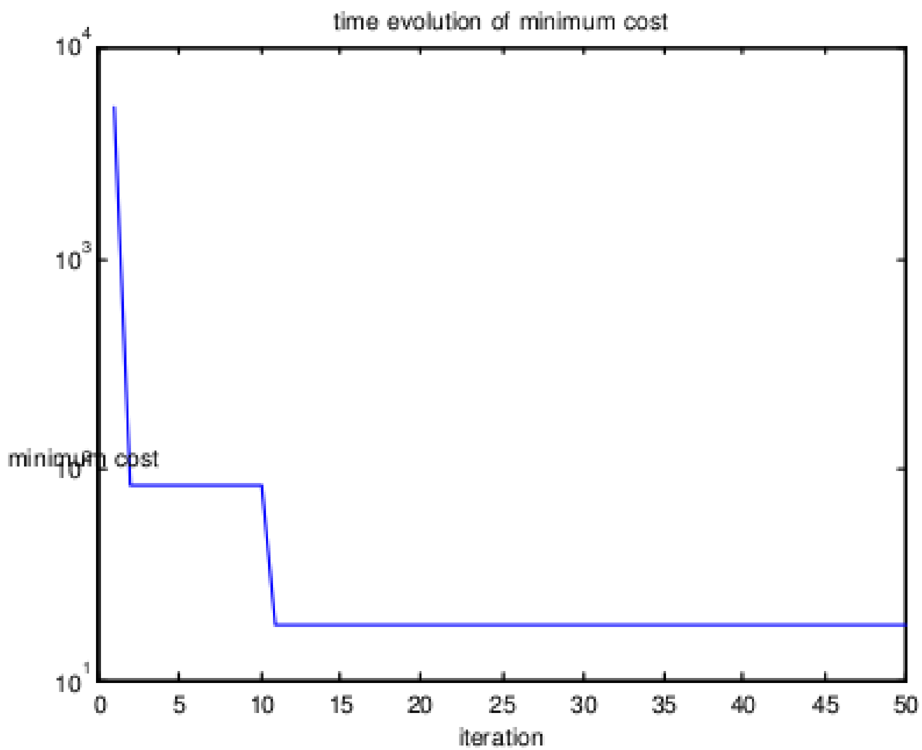

Fig. 9. This figure shows the evolution of the cost function using the GA to fit the nonlinear model.

```
[shinji@localhost ~]$ g++ ejercicio2.cpp
[shinji@localhost ~]$ ./a.out
Terminado en 15.5536 segundos  El valor optimo es :336
[shinji@localhost ~]$ ./a.out
Terminado en 15.6261 segundos  El valor optimo es :346
[shinji@localhost ~]$ ./a.out
Terminado en 15.9534 segundos  El valor optimo es :293
[shinji@localhost ~]$ ./a.out
Terminado en 16.0911 segundos  El valor optimo es :394
[shinji@localhost ~]$ ./a.out
Terminado en 14.9209 segundos  El valor optimo es :403
[shinji@localhost ~]$ ./a.out
Terminado en 14.9092 segundos  El valor optimo es :354
[shinji@localhost ~]$ ./a.out
Terminado en 15.2764 segundos  El valor optimo es :320
[shinji@localhost ~]$ ./a.out
Terminado en 15.4615 segundos  El valor optimo es :382
[shinji@localhost ~]$ ./a.out
Terminado en 15.2561 segundos  El valor optimo es :343
[shinji@localhost ~]$ ./a.out
Terminado en 15.0592 segundos  El valor optimo es :380
```

Fig. 10. Data of problem 2 the mean value is : 355.1