Soft Computing Assignment-2

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Operators in genetic algorithm

Encoding

Encoding is the process of representing individual genes.

i) Binary encoding

Each chromosome encodes a binary string. Each bit in the string can represent some characteristic of the solution. The length of the string determines the accuracy. In such coding, integers are represented exactly, finite number of real numbers can be represented, number of real numbers represented increases with string length.

ii) Octal encoding

The encoding uses octal numbers.

iii) Hexadecimal encoding

The encoding uses hexadecimal numbers.

iv) Permutation encoded

Every chromosome is a string of integral or real values, which represents numbers in a sequence. This is useful only for ordering problems.

Binary	Chromosome 1	1101000111010
	Chromosome 2	0111111111100
Octal	Chromosome 1	03467216
	Chromosome 2	15723314
Hexadecimal	Chromosome 1	9CE7
	Chromosome 2	3DBA
Permutation	Chromosome 1	153264798
	Chromosome 2	856723149

Selection

Selection is the process of choosing two parents from the population for crossing - The purpose of selection is to emphasize fitter individuals in the population so their offspring may have higher fitness.

i) Roulette Wheel Selection

A string is selected from the mating pool with a probability proportional to fitness. Each individual is assigned a slice of the roulette wheel, the size of the slice being proportional to the individual's fitness - The wheel is spun N times, where N is the number of individuals - On each spin, an individual is selected to be in the pool of parents for the next generation.

ii) Random selection

It randomly selects a parent from the population.

iii) Rank selection

The rank selection ranks the population with the worst receiving fitness 1 and the best receiving fitness N. This results in slow convergence but preserves diversity.

iv) Tournament selection

A tournament is held within the population and the individual who wins the tournament is assigned highest fitness. This is repeated until all individuals have ranks assigned to them.

v) Boltzmann Selection.

A continuously varying temperature controls the rate of selection according to a ~~present~~ preset schedule. The temperature starts high, which means selection pressure is low, then it is lowered over time, gradually increasing selection pressure.

Crossover

Crossover is the process of taking two parent solutions and producing a child. After the good individuals are chosen via selection, crossover operator is applied to the mating pool with the hope that it creates better offspring.

It has 3 steps:

1) The reproduction operator selects at random 2 individual strings.
2) A cross site is selected at random along string length.
3) Position values are swapped between the 2 strings following the cross site.

8. The different types of crossover :

i) Single point crossover

The two chromosomes are cut at corresponding points and the sections after the cut are interchanged. The location of the cut determines offspring quality.

ii) Two point crossover

Two crossover points are chosen and the contents between these two cuts are interchanged.

iii) Multipoint crossover

This has 2 cases :

In case of even number of cross sites, the cross sites are randomly selected around a circle and information is exchanged.

In case of odd number of cross sites, the cross point is always assumed to be different at the string beginning.

iv) Uniform crossover

A binary crossover mask is generated with the same length as the chromosome length. The mask is filled with 1s or 0s chosen randomly. Where there is a 1 in the mask, the gene is copied from the first parent, and if there is a 0, gene is copied from the second parent.

v) 3 parent crossover

3 parents are randomly chosen. If the corresponding bits of first 2 parents are equal, it is added to gene of the offspring. Else, the bit from the 3rd parent is added instead.

vi) Crossover with reduced surrogate

This restricts the location of crossover points such that they occur only where gene values differ.

vii) Ordered crossover

2 random crossover points partition parents into left, middle and right parts. The child inherits the left and right section from parent 1, and the middle section is determined by genes in the middle section of parent 1, but rearranged in the order they appear within parent 2.

viii) Precedence preservative crossover.

This works as follows:

1) A vector of length the Sigma, representing the number of operations involved in the problem, is randomly filled with 1 or 2.
2) This vector defines the order in which the operations are successively drawn from parent 1 and parent 2.
3) We initialize empty offspring.
4) The leftmost operation in one of the 2 parents is selected in accordance with the order of parents given in the vector.
5) It is deleted in both parents and appended to the offspring.
6) This steps is repeated until parents are empty and offspring contains all the operations involved.

Mutation

Mutation plays the role of recovering the genetic materials as well as for randomly distributing genetic information. Mutation maintains diversity in the population and prevents the algorithm from being trapped in a local minimum.

The types of mutation are:

i) Flipping

A bit is flipped based on a mutation chromosome generated that is randomly generated.

Parent	1011 0101
Mutation	1000 1001
Child	0011 1100

ii) Reversing

A random position is chosen and the bits next to that position are reversed.

Parent	10110 : 101
Reversed child	10110 : 110

iii) Interchanging

2 random positions of the string are chosen and the bits corresponding to those positions are interchanged.

Stopping conditions in genetic algorithm

The various stopping conditions are:

1) Maximum generations : The GA stops when the specified number of generations have evolved

2) Elapsed time : The genetic process will end when a specified time has elapsed.

3) No change in fitness : The process ends when there is no change to population's best fitness after a specified number of generations.

4) Stall generations : The process ends when there is no improvement in the objective function for a sequence of consecutive generations of length "Stall Generations".

5) Stall time : The process ends if there is no improvement to objective function for a time interval of seconds equal to "stall time limit".

The termination / convergence techniques

i) Best individual - The convergence criterion stops the search once the minimum fitness in the population drops below the the convergence value.

ii) Worst individual - The convergence stops the search once the least fit individuals in the population have fitness less than the convergence criteria.

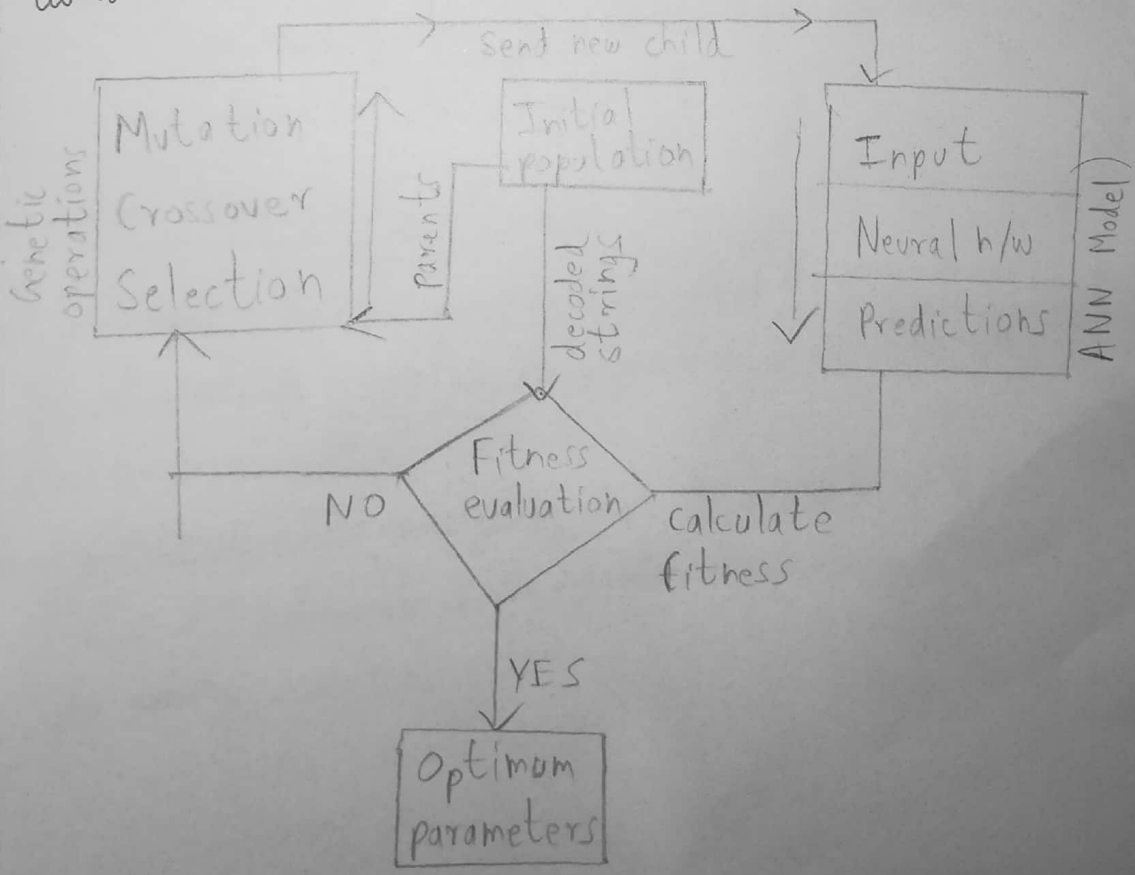
iii) Sum of fitness - The search stops when the sum of fitness in the entire population is less than or equal to the convergence value in the population record.

iv) Median fitness - Search stops when at least half the individuals are better than or equal to convergence value.

~~Neuro Hy~~

Neuro Genetic Hybrid Systems

A neuro genetic hybrid system is a system that combines Neural Networks which learns various tasks from examples, classify objects, and establish relation between them and Genetic algorithm, which serves search and optimization techniques.



The genetic algorithm modifies a population of individual solutions, GA uses ~~Selection~~ selection, crossover and mutation in order to form children.
These children are sent to the neural network as input.
Finally, calculation of fitness is performed by the ANN.

Advantages

i) It is used for topology optimization (i.e. for selecting no. of hidden layers, nodes and interconnection pattern for ANN).
ii) It can mimick human decision making process.
iii) Control parameters such as learning rate and tolerance level are also optimized using GA.

Disadvantages

i) Highly complex
ii) High maintenance cost
iii) Accuracy is dependent on initial population.

Applications

i) Face recognition
ii) DNA matching
iii) Animal & human research
iv) Behavioral system.