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In 2005/2006, the course INFOEA was given by Dirk Thierens.

Evolutionary Computing (INFOEA)
January 31, 2006

Question 1

A magic square is a $N \times N$ square where all integers from 1 to $N \times N$ occur exactly once. The integers need to be placed in such a way that the sum of each row, column, and the two mean diagonals return the same value $S = \frac{N(N^2+1)}{2}$. We would like to search for the position of the integers with an evolutionary algorithm. Specify the most suitable fitness function, representation, mutation operator, and crossover operator you can think of.

Question 2

Consider the following two selection procedures:

a) truncation selection with treshold $\tau = 20\%$

b) tournament selection with tournament size $s = 5$

- Assume we have a very large population: which selection method will converge faster, or will they converge at the same rate?
- Suppose we run a number of experiments where we gradually reduce the population size: which selection method will be the first to prematurely converge, or will this happen at the same population size for both procedures?

Question 3

Explain – in detail – how mutation is done in Evolutionary Strategies. Your answer should explain in your own words everything one needs to know to understand this search operator (this means that you should not simply copy the formulas from the slides).

Question 4

The fitness function F is defined on a binary string of length ℓ and constructed by concatenating m identical sub-functions $F1$ with argument a bit-string of length $2(x_i \in \{0,1\})$:

$$F(x_1 \ldots x_\ell) = F1(x_1x_2) + F1(x_3x_4) + \ldots + F1(x_{\ell-1}x_\ell)$$

$F1$ are functions of unitation (= the fitness values are determined by the number of one-bits): $F1(00) = 1, F1(01) = F1(10) = 0, F1(11) = 2$.
Adapt the population sizing model that we have derived for the counting-ones problem to calculate the critical population size for the underlying problem.

Question 5

The 'Extended Compact Genetic Algorithm' (ECGA) builds a model of the parent pool using the 'minimum description length' (MDL) measure. Why cannot we simply choose the model which has the most likely fit of the parents?

Question 6

We are applying the adaptive pursuit algorithm and the probability matching algorithm for allocating an operator to the current state of our search process. Assume we have 4 possible operators to choose from ($A = \{a_1, a_2, a_3, a_4\}$). The current probability vector is $P(t) = [0.1; 0.2; 0.3; 0.4]$ and the current reward estimate is $Q(t) = [5; 10; 15; 20]$. After applying the currently most likely operator we receive a reward of 40. Calculate in both cases the updated values $P(t+1)$ and $Q(t+1)$ when $\alpha = 0.5, \beta = 0.75$, and $P_{\max} = 0.85$.