Computational Intelligence

Master in Artificial Intelligence

2021-22

Evolutionary Computation

Genetic Algorithms - Complementary Slides

Soft Computing Research Group

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
School of Professional & Executive Development

Selection methods: implementation details - I

Roulette wheel

$p_i = \frac{f_i}{\sum\limits_{j=1}^{\mu} f_j}$ is the probability of selecting individual i, with fitness f_i.

$w_i = \sum\limits_{j=1}^{i} p_j \ \in [0,1]$, for $i = 1, .., \mu$, points to the end of the i-th sector.

Let r be a random number in $[0,1)$, the position of the roulette pointer.

Then, the selected individual s is given by $s = \min\{i : w_i > r\}$

Stochastic universal sampling

Let r be a random number in $[0, 1/\mu)$, and define, for $k = 1, .., \mu$,

$r_k = r + (k-1)/\mu$ as μ equally spaced roulette pointers.

Then, μ selected individuals are $s_k = \min\{i : w_i > r_k\}$, for $k = 1, .., \mu$.

Selection methods: implementation details - II

Remainder stochastic sampling

$a_i = \frac{f_i}{(\sum\limits_{j=1}^{\mu} f_j)/\mu} = \frac{\mu f_i}{\sum\limits_{j=1}^{\mu} f_j}$ is the ratio of individual i over average fitness.

$a_i = c_i + r_i$, where $c_i = \lfloor a_i \rfloor$ and $r_i = a_i - c_i$ (integer part and remainder).

Note that $\sum_{i=1}^{\mu} a_i = \mu$, but $\sum_{i=1}^{\mu} c_i \leq \mu$.

Then, first select c_i copies of each individual i, and the rest $\mu - \sum\limits_{i=1}^{\mu} c_i$ are selected by standard roulette wheel using $p_i = \frac{r_i}{\sum\limits_{j=1}^{\mu} r_j}$ as probability.

Rank selection

Let $r_i \in \{1, .., \mu\}$ be the rank of individual i, where $r_i = 1$ means the best. Define probability $p_i = \frac{(\mu+1-r_i)}{\mu(\mu+1)/2}$ and apply standard roulette wheel.

Real-number representation in bits

Before applying Gray coding:

We want to represent a real number r within the range $[a, b]$ using n bits, thus determining the attainable precision.

Let i be an integer with such n-length bit representation.

Then $q(i) = \frac{i}{2^n - 1}$ is a real-value between 0 and 1.

And $r = a + q(i)(b - a)$ is a real-value between a and b, as desired, associated with integer i.

The Schema Theorem

Let n_s be the number of individuals represented by schema s in a population of size μ,

and let $f(s) = \frac{\sum_{j \in s} f_j}{n_s}$ be their average fitness.

$a_s = \frac{f(s)}{(\sum_{j=1}^{\mu} f_j)/\mu} = \frac{\mu f(s)}{\sum_{j=1}^{\mu} f_j}$ is the ratio of schema s over average fitness.

For consecutive generations g, $(g+1)$, ..., $(g+m)$ of the population,

if schema s is *short* and *low-order* **then** $n_s^{g+m} \approx n_s^g \prod_{g'=g}^{g+m-1} a_s^{g'}$.