Fitness, Selection and Population

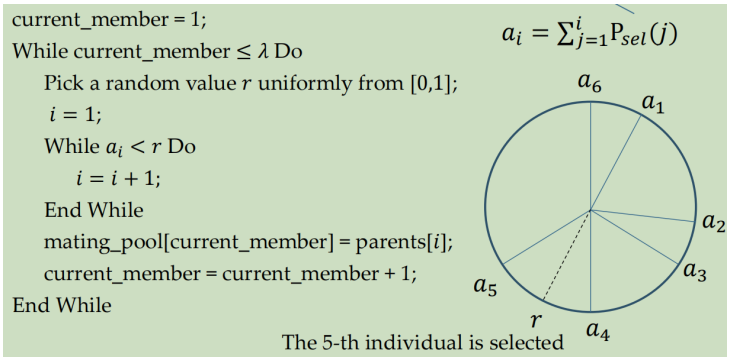
幸存者选择

一、sampling

> 得到概率之后怎么抽，要选λ个

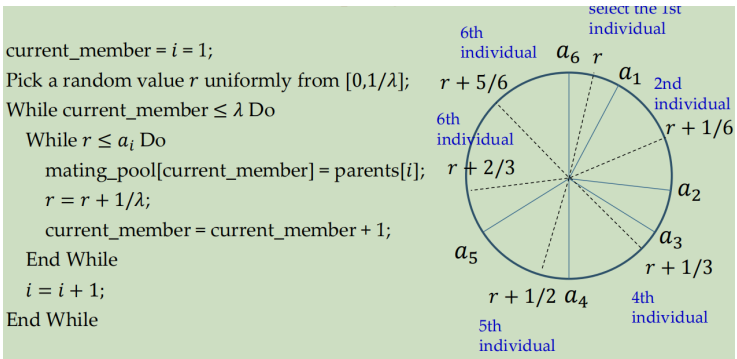
Roulette wheel

多次重复随机



Stochastic universal sampling

随机初始化+等分概率递增



二、parent selection

FPS

> Fitness propotional selection

- fi占总fi比例
- 为增大不同解之间选择压力，经常把所有评分都减去最小的

When fitness values are all very close, there is almost no selection pressure

Individual	Fitness	Sel. prob. P_{FPS}
A	101	0.326
B	104	0.335
C	105	0.339

Windowing:

$$f_i = f_i - \beta^t$$

e.g., $\beta^t = \min_{j \in \{1,2,\ldots,u\}} f_j$

the least fitness of the current population

LRS

> Linear ranking selection

- RS：最好的i是u-1，最差是0
- 最差的也有概率被选中
- 选中最好的概率是s/u，抽u次期望为s
- s越大，选中好解（above-median fitness）概率越大

$$P_{LRS}(i) = \frac{2-s}{\mu} + \frac{2i(s-1)}{\mu(\mu-1)}$$

rank

the probability of selecting the worst individual

The sum of the probabilities:

$$\sum_{i=0}^{\mu-1} P_{LRS}(i) = \frac{2-s}{\mu} \cdot \mu + \frac{2(s-1)}{\mu(\mu-1)} \cdot \frac{\mu(\mu-1)}{2} = 1$$

The influence of $s \in (1,2]$: $(2i-(u-1)) \cdot s$

- As s increases, the prob. of selecting individuals with above-media fitness increases, while that with below-median fitness decreases
- When μ is odd, the probability of selecting the individual with median fitness is a constant, i.e., $1/\mu$

Individual	Fitness	Rank	P_{LRS} with $s = 1.5$	P_{LRS} with $s = 2$
A	1	0	0.1	0
B	4	1	0.15	0.1
C	5	2	0.2	0.2
D	7	3	0.25	0.3
E	9	4	0.3	0.4

TS

> Tournament selection

每次在k个中选最好的，共λ次

Assume that the selection is without replacement, and the best solution is unique

The probability of selecting the best solution at least once:

$$1-\left(1-\left(\binom{\mu-1}{k-1}\Big/\binom{\mu}{k}\right)\right)^{\lambda}=1-(1-(k/\mu))^{\lambda}$$

US

纯随机

三、Survive selection

> μ个父代，λ个子代

Aged-based

- 每个个体存活相同轮数

- Fitness is not taken into account
- Each individual exists in the population for the same number of iterations

- For example, population size: μ, number of offspring: λ
  - If $\lambda = \mu$, the μ individuals in the current population are simply discarded, and replaced by the μ offspring
  - If $\lambda < \mu$, λ individuals (selected by the FIFO strategy) in the current population are replaced by the λ offspring

Fitness-based

> 保留适应的

Replace worst λ

- Replace worst (GENITOR) for $\mu > \lambda$
  - The worst λ individuals in the current population is replaced by the λ offspring
- (μ, λ) selection for $\mu < \lambda$ — May be better in leaving local optima
  - The best μ offspring forms the next population

best μ from λ

（μ,λ）扔掉了所有parent

best μ from (λ+μ)

round-robin tournament小组赛

> 选择压力与参数q正相关

- Each individual x is evaluated against q other individuals randomly chosen from the current population and the offspring
- For each comparison, a "win" is assigned if x is better than its opponent
- The μ individuals with the greatest number of wins are retained to form the next population

The parameter q controls the selection pressure — Positively corelated

$q = \mu + \lambda - 1$ ⇨ $(\mu + \lambda)$ selection

$q = 1$ ⇨ Even the worst individual can be selected

四、population diversity

> 种群多样性
>
> 种群：维护的多个解的集合，不能太像

fitness sharing

有很多邻居时，降低fitness

个体只有邻近才会在分母贡献

特点：最高峰上明显会保存更多

crowding

子代和相近的父代竞争，留一个

特点：在不同区域会有相对均匀划分

Island model

切分成多个子种群，希望可以探索不同部分，算法可以不一样

某个种群的好个体交互给其他的

经验：25-150代传递一次，每次传递2-5个

copy or move? fitness or random?