Week 2: Operators

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2023 年 2 月 20 日

1 Operators

表 1: Operators

Which dimensions (positions) to modify on Single (the j-th) dimension value function					all	per-bit crossover rate	random m positions	k-points
					All the d dimensions.	For each dimension (position), change by independent probability p.	Randomly select m positions.	Cut into (k+1) segments, and alternatively select positions from even segments.
Name	Parameters	#Input	#Output	Function				
exchange two values	–	2 $x_1^{(j)}$, $x_2^{(j)}$	2 $x'^{(j)}$, $x''^{(j)}$	$\begin{cases} x'^{(j)} = x_2^{(j)} \\ x''^{(j)} = x_1^{(j)} \end{cases}$		Uniform Crossover (for binary values) (p10) Global Discrete Recombination (for real values) (p12)		k-point Crossover (for binary values) (p7-8) Multi-point discrete Recombination (for real values) (p11)
weighted arithmetic average	–	2 $x_1^{(j)}$, $x_2^{(j)}$	2 $x'^{(j)}$, $x''^{(j)}$	$\begin{cases} x'^{(j)} = \alpha \cdot x_1^{(j)} + (1-\alpha) \cdot x_2^{(j)} \\ x''^{(j)} = (1-\alpha) \cdot x_1^{(j)} + \alpha \cdot x_2^{(j)} \end{cases}$ weight $\alpha \sim U(0,1)$	Arithmetic Recombination (p14-15)		Single Arithmetic Recombination (for $m = 1$) (p18-19)	Simple Arithmetic Recombination (for $k = 2$) (p16-17)
heuristic escape	–	2 $x_1^{(j)}$, $x_2^{(j)}$	1 $x'^{(j)}$	$x'^{(j)} = x_2^{(j)} + \alpha \cdot (x_2^{(j)} - x_1^{(j)})$ escape weight $\alpha \sim U(0,1)$	Heuristic Recombination (p20)			
simplex	–	n $x_i^{(j)} \forall i \in [1,n]$	1 $x'^{(j)}$	$x'^{(j)} = \frac{1}{n-1}(\sum_{i=1}^{n} x_i^{(j)} - x_n^{(j)}) + (x_1^{(j)} - x_n^{(j)})$	Simplex Recombination (p20)			
geometric average	–	2 $x_1^{(j)}$, $x_2^{(j)}$	1 $x'^{(j)}$	$x'^{(j)} = \sqrt{x_1^{(j)} \cdot x_2^{(j)}}$	Geometric Recombination (p21)			
quadratic	–	3 $x_1^{(j)}$, $x_2^{(j)}$, $x_3^{(j)}$	1 $x'^{(j)}$	$x'^{(j)} = ...$	Quadratic Recombination (p21-22)			
bit flipping	–	1 $x_1^{(j)} \in \{0,1\}$	1 $x'^{(j)}$	$x'^{(j)} = 1 - x_1^{(j)}$		Bitwise Mutation (usually $p = \frac{1}{d}$) (p27)	One-bit Flipping / One-bit Mutation (for $m = 1$) (p26) Multi-bit Flipping (for $m > 1$) (p26)	
another random integer	image S	1 $x_1^{(j)} \in S$	1 $x'^{(j)}$	$x'^{(j)} = X'$ $X' \in (S - \{x_1^{(j)}\})$		Random Mutation (p28)		
random real	lower bound lb_j upper bound ub_j	1 $x_1^{(j)} \in \mathbb{R}$	1 $x'^{(j)}$	$x'^{(j)} = X'$ $X' \sim U(lb_j, ub_j)$		Uniform Mutation (p32)		
Gaussian	standard deviation σ lower bound lb_j upper bound ub_j	1 $x_1^{(j)}$	1 $x'^{(j)}$	$x'^{(j)} = curtailing(x_1^{(j)} + \Delta, lb_j, ub_j)$ mutation step-size $\Delta \sim \mathcal{N}(0, \sigma^2)$	Nonuniform Mutation using Gaussian (p33-35)			
Cauchy	scale t lower bound lb_j upper bound ub_j	1 $x_1^{(j)}$	1 $x'^{(j)}$	$x'^{(j)} = curtailing(x_1^{(j)} + \Delta, lb_j, ub_j)$ mutation step-size $\Delta \sim \mathcal{C}(0, t)$	Nonuniform Mutation using Cauchy (p33-35)			