

# Genetic Algorithm

g) Maximize the fun  $f(x) = x^2$  with  $x$  in intervals  $[0, 31]$

i.e  $x = 0, 1, \dots, 30, 31$

Step 1) Generate initial population at random. They are chromosome or genotype.

Eg: 01101 (13), 11000 (24), 01000 (8), 10011 (19)

Step 2) Calculate fitness

(a) Decode into an integer (called phenotypes)

01101  $\rightarrow$  13, 11000  $\rightarrow$  24, 01000  $\rightarrow$  8, 10011  $\rightarrow$  19

(b) Evaluate fitness  $f(x) = x^2$

13  $\rightarrow$  169, 24  $\rightarrow$  256, 8  $\rightarrow$  64, 19  $\rightarrow$  361

Step 3) Select parent (2 individuals) based on their fitness in  $P$ .

$$P_i = f_i / \left( \sum_{j=1}^n f_j \right)$$



$f_i$  - fitness for string  $i$  in population, exp as  $f(x)$

$P_i$  - prob. of string  $i$  being selected.

$n$  - no. of individuals in the population.

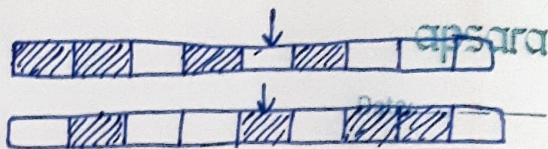
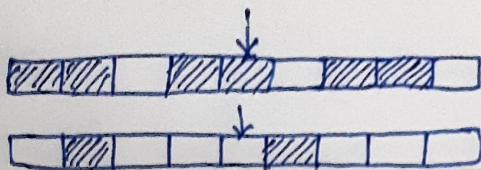
$n * P_i$  is Expected Count Roulette wheel?

String no.	Initial pop <sup>n</sup>	$n$ value	fitness $f_i$ $f(x) = x^2$	$P_i$	Expected $n * P_i$
1	01101	13	169	0.14	0.86
2	11000	24	576	0.49	1.97
3	01000	8	64	0.06	0.22
4	10011	19	361	0.31	1.23
				<u>1.00</u>	<u>4.00</u>

Sum		1170	1.00	4.00
Avg		293	0.25	1.00
MAX		576	0.49	1.97



One point



## Step 4) Crossover Operator

- Can be either of one-point or two point
- points select randomly

Eg:  $\begin{matrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 100 & 111 & 01 & & & & & \\ 10 & 101 & 011 & & & & & \end{matrix}$  (1 point)

$C_3$   $\begin{matrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 100 & 01 & 011 & & & & & \\ 101 & 111 & 01 & & & & & \end{matrix} \Rightarrow \text{Ans} \quad \begin{matrix} 100 & 01 & 011 \\ 101 & 111 & 01 \end{matrix}$

Eg:  $\begin{matrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 100 & 111 & 01 & & & & & \\ 101 & 011 & 011 & & & & & \end{matrix}$  (2 point)

$C_3 - C_4$   $\begin{matrix} 100 & 01 & 101 \\ 100 & 11 & 011 \end{matrix} \quad \begin{matrix} 100 & 01 & 101 \\ 101 & 11 & 011 \end{matrix}$

String	Parent	Crossover point	offspring	x-value	$f(x) = x^2$
1	01101	4	01100	12	144
2	110010	4	11001	25	625
2	111000	2	11011	27	729
4	101011	2	10000	16	256

1754

Eliminating

(3) by

(2)

C2's

2 is

Strongest

3 was

weakest



0 based index  $\rightarrow C_2 \Rightarrow$  Include  $C_2$   
 1 based index  $\rightarrow C_2 \Rightarrow$  Exclude  $C_2$

apsara

Date: \_\_\_\_\_

step 5

## Mutation

- applied to each child after Crossover
- 1 bit's exchanged from random position. for randomly selected strings.

Ex) String	offspring	offspring (mut)	r value	fitness $f(x)=x^2$
1	01100	11100	26	676
2	11001	11001	25	625
3	11011	11011	27	729
4	10000	10100	18	324

not change

Coz'  
has high  
Value.

Sum  $\rightarrow$  2354

Max  $\rightarrow$  729

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