Genetic Algo

24 September 2024 06:02

Popln — subset of all possible solⁿ

Chromosome — one such hypothesis

Genotype — set of genes that represent all chromosomes

Phenotype — genotype in solution space.

Eg. TSP

10 cities ⇒ how many genes in chromosome?

10 − 1 = (9) → no. of links

10 starting points = 9 × 10 = 90

HB = BH so — $\frac{90}{2}$ = (45) total genes.

total genes in alphabet = 45

includes: B → B.

Eg:

Q Represent the following as a chromosome (= hypothesis) in Genetic Algorithm.

if weather = (cloudy OR sunny OR not-rainy) AND (Day of week == SAT OR SUN)

THEN GOTOMOVIE = TRUE

	T	F
Gotomovie —	1	0

	Sat	Sun
Day of week —	3	2

	Cloudy	Sunny	Not-raining
Weather —	6	5	4

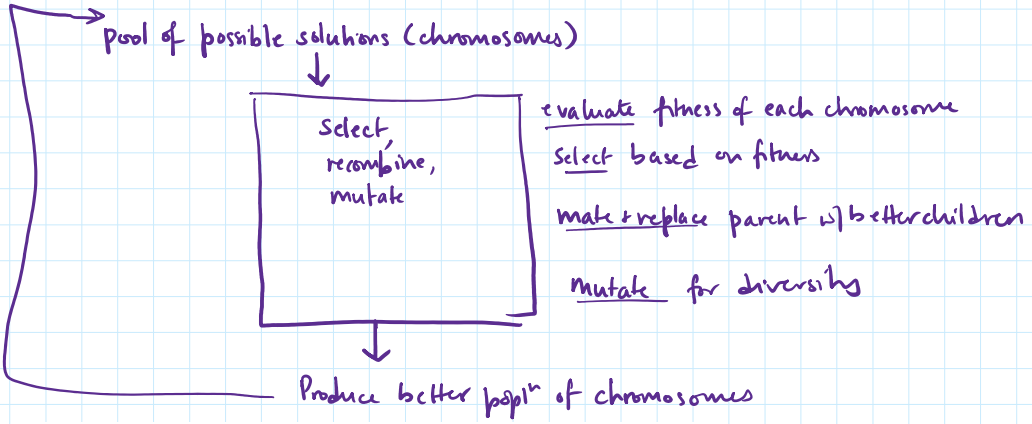
Days — 7 possible.

⇒ Solution space =

cloudy	sunny	not-raining	sat	sun	gotomovie T	gotomovie F
1	0	0	1	0	1	
1	0	0	0	1	1	
0	0	1	1	0	1	
0	0	1	0	1	1	
0	1	0	1	0	1	
0	1	0	0	1	1	
	3		2		2	

⇒ (27) subset of that are chromosomes

Algorithm:



fitness ()

Input: hypothesis

Output: numerical evaluation

P: population of hypotheses

r: fraction of population subjected to cross-over

m: fraction of population subjected to Mutation

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Init : Generate random population of size P such that $h \in P$

Evaluate : Calculate fitness(h) for every $h \in P$

While fitness(h) < fitness_threshold do :

Create a new population P_s

1. Select : a portion $(1-r)P$ and $P_s \leftarrow (1-r)P$
   using $P(h) = \frac{\text{fitness}(h)}{\sum \text{fitness}(h)}$ (Selection based on fitness)

2. Cross-over : Select $\frac{rP}{2}$ pairs from rP left out such that each pair makes parents + Create offspring . Put these offsprings in P_s $P_s \leftarrow P_s + \left(\frac{rP}{2}\right) * 2$
   Now, $P_s = |P|$ again. → cross over = exploitation.

3. Mutate : Select mP_s & mutate. → Mutation = exploration

4. Update $P_s \rightarrow P$

5. Evaluate fitness(h) for $h \in P$

This will run till the fitness criteria is satisfied !!

Eg : chromosome : X = a b c d e f g h
each gene can be from 0-9
fitness fn $f(X) = (a+b) - (c+d) + (e+f) - (g+h)$

	a	b	c	d	e	f	g	h
Initial pop^n : X1 :	6	5	4	1	3	5	3	2
X2 :	8	7	1	2	6	6	0	1
X3 :	2	3	9	2	1	2	3	5
X4 :	4	1	8	5	2	0	9	4

① Fitness of each chromosome.
$f(X_1) = 7$
$f(X_2) = 23$
$f(X_3) = -16$
$f(X_4) = -19$.

Overall fitness (popln)
$f(P_1) = \frac{7+23-16-19}{4} = 1.5$

$f(X_2) > f(X_1) > f(X_3) > f(X_4)$ → so discard.

② Single point crossover @ midpoint for X1 X2

X1 : 6 5 4 1 | 3 5 3 2
X2 : 8 7 1 2 | 6 6 0 1

Offspring : 6 5 4 1 6 6 0 1
8 7 1 2 3 5 3 2

Two point crossover @ (b)(c) of X3, X1

X1 : 6 5 | 4 1 3 | 5 3 2
X2 : 2 3 | 9 2 1 | 2 3 5

offspring : 6 5 9 2 1 5 3 2
2 3 4 1 3 2 3 5

Uniform crossover @ (a)(d)(f) of X2, X3

Uniform crossover @ (a)(d)(f) of x2, x3

	*		*		*		
x2:	8	7	1	2	6	6	0	1
x3:	2	3	9	2	1	2	8	5
Offspring:	2	7	1	2	6	2	0	1
	8	3	9	2	1	6	8	5

③ New population

								f(x)
6	5	4	1	6	6	6	1	17
8	7	1	2	3	5	3	2	15
6	5	9	2	1	5	3	2	1
2	3	4	1	3	2	8	5	-8
2	7	1	2	6	2	0	1	13
8	3	9	2	1	6	8	5	-6

→ avg. fitness $= \frac{17+15+1-8+13-6}{6}$

$= 5.3$

⇒ Avg. fitness ↑