Genetic Algorithm Step-by-Step Calculation

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Problem Identification

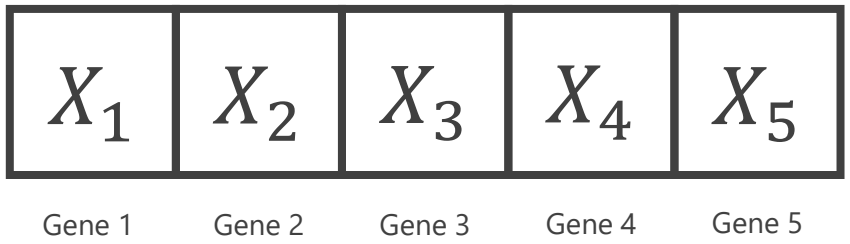
Suppose we have an equation

$$3X_1 + 2X_2 + 4X_3 + 2X_4 + 5X_5 = 100$$

To find the variables $(X_1, X_2, \dots, X_5)$, we can use the Genetic Algorithm in which trying to minimize the objective function

$$f(x) = 3X_1 + 2X_2 + 4X_3 + 2X_4 + 5X_5 - 100$$

Five variables $(X_1, X_2, \dots, X_5)$ help us construct the chromosomes, as follows



Initialization

Generation 0

We draw 5 chromosomes in which each genes contains integer from 0 to 10

	Gene 1	Gene 2	Gene 3	Gene 4	Gene 5
Chromosome 1	0	3	2	9	3
Chromosome 2	7	5	0	0	9
Chromosome 3	6	3	2	1	2
Chromosome 4	4	1	1	6	3
Chromosome 5	7	4	1	2	8

For the selection, we need to calculate the fitness function $\boldsymbol{F(c)}$

$$F(c) = \frac{1}{|Error|}$$

Where $Error = f(x)$

Selection

For example

	Gene 1	Gene 2	Gene 3	Gene 4	Gene 5
Chromosome 1	0	3	2	9	3

$$f(x) = |3X_1 + 2X_2 + 4X_3 + 2X_4 + 5X_5 - 100|$$
$$f(x) = |3(0) + 2(3) + 4(2) + 2(9) + 5(3) - 100|$$
$$f(x) = \mathbf{53}$$

So, the fitness value of chromosome 1

$$F(c) = \frac{1}{|1 + f(x)|} = \frac{1}{|1 + 53|}$$
$$F(c) = \mathbf{0.0185}$$

Note

To avoid the zero problem, we add 1 in the fitness function

Selection

Generation 0

Fittest chromosomes have higher probability to be selected in next generation

	Gene 1	Gene 2	Gene 3	Gene 4	Gene 5	$\lvert f(x) \rvert$	$F(c)$
Chromosome 1	0	3	2	9	3	53	0.0185
Chromosome 2	7	5	0	0	9	24	0.0400
Chromosome 3	6	3	2	1	2	56	0.0178
Chromosome 4	4	1	1	6	3	55	0.0181
Chromosome 5	7	4	1	2	8	23	0.0434

Selection

Generation 0

From previous calculation, we have the total value of fitness function

$$Total = 0.0185 + 0.0400 + 0.0178 + 0.0181 + 0.0434$$
$$Total = \mathbf{0.1378}$$

So, the probability of chromosomes is formulated as follows

$$P = \frac{F(c)}{Total}$$

For example, for chromosome 1, the probability to be selected is as follows

$$P_1 = \frac{F(c)_1}{Total} = \frac{0.0185}{0.1378}$$

$$P_1 = \mathbf{0.1342}$$

Selection

Generation 0

For each chromosomes, calculate its probability using previous formula

	Gene 1	Gene 2	Gene 3	Gene 4	Gene 5	$\lvert f(x) \rvert$	$F(c)$	P
Chromosome 1	0	3	2	9	3	53	0.0185	0.1342
Chromosome 2	7	5	0	0	9	24	0.0400	0.2902
Chromosome 3	6	3	2	1	2	56	0.0178	0.1291
Chromosome 4	4	1	1	6	3	55	0.0181	0.1313
Chromosome 5	7	4	1	2	8	23	0.0434	0.3149

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