

GENETIC ALGORITHM

User case

Andi wants to climb Mount Merapi during his vacation, Andi wants to bring a lot of stuff for a trip when climbing to the mountain. However, he couldn't carry many things at once because he didn't have enough bags. How can Andi choose as many items to carry if you can only carry items weighing ≤ 35 kg and these items are really important to carry? Determine the solution to this problem using the Genetic Algorithm according to the questions below.

It is known that the data of goods owned by Andi:

Name of	Heavy Goods (Kg)	Priority Value
of Goods 1	5	70
Goods 2	7	10
Goods 3	9	100
Goods 4	4	40
Items 5	1	50
Goods 6	6	90
Items 7	2	20
Goods 8	8	80
Goods 9	3	60
Item 10	10	30

a. Initialization of the Population

Based on the Data Determine the weight of the 6 chromosomes that will be the solution to be initialized into the Genetic Algorithm:

Item Name	Weight (kg)	Value Priority	K1	K2	K3	K4	K5	K6
Item 1	5	70	1	0	1	0	1	1
Goods 2	7	10	0	0	0	0	0	1
Goods 3	9	100	1	0	1	0	0	0
Items 4	4	40	1	1	1	0	0	0
Goods 5	1	50	1	0	0	0	1	0
Items 6	6	90	0	1	0	1	1	1
Goods 7	2	20	0	1	0	0	1	1
Goods 8	8	80	0	0	0	0	0	1
Items 9	3	60	1	1	1	0	0	0
Items 10	10	30	0	1	0	1	0	0
Total weight (kg)			22	25	16	16	13	28

b. Fitness Calculation

Calculate the fitness value of the created chromosome. in the table below

Item Name	Weight (kg)	Value	K1	K2	K3	K4	K5	K6
Goods 1	5	70	70	0	70	0	70	70
Goods 2	7	10	0	0	0	0	0	10
Goods 3	9	100	100	0	100	0	0	0
Items 4	4	40	40	40	40	0	0	0
Goods 5	1	50	50	0	0	0	50	0
Goods 6	6	90	0	90	0	90	90	90
Goods 7	2	20	0	20	0	0	20	20
Goods 8	8	80	0	0	0	0	0	80
Goods 9	3	60	60	60	60	0	0	0
Item 10	10	30	0	30	0	30	0	0
Total Fitness			320	240	270	120	230	270
Total = 1450								

c. Selection

Determine the relative and cumulative function values of the existing population to perform n processes Roulette Wheel selection in the table below.

*cat : Take the first 3 digits after the comma by doing rounding

Ex: 0.1562112 -> 0.156

Chromosome	Fitness Relative (K[i])	Fitness Cumulative (C[i])
1	$320/1450 = 0.220$	$0 - 0.220$
2	0.165	$0.220 - 0.385$
3	0.186	$0.385 - 0.571$
4	0.082	$0.571 - 0.653$
5	0.158	$0.653 - 0.811$
6	0.186	$0.811 - 1$

After that, it is known that the random value of chromosome R[i] is as follows:

- $R[1] = 0.211$
 - $R[2] = 0.565$
 - $R[3] = 0.422$
 - $R[4] = 0.829$
 - $R[5] = 0.7221$
 - $R[6] = 0.321$
- Mention the parent chromosome (eg: chromosome 1, chromosome 2, etc.) !

Answer: Chromosome 1, chromosome 3, chromosome 5, chromosome 6

- Determine which chromosome has exchanged based on the results of the Roulette Wheel! (state and illustrate the results of the exchange)

1	0	1	1	0	0	0	0	1	0
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new Chromosome 3 (exchange gene contents with chromosome 2)

0	0	0	1	0	1	1	0	1	1 New
---	---	---	---	---	---	---	---	---	----------

Chromosome 4 (exchange gene contents with chromosome 5)

1	0	0	0	1	1	1	0	0	0
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Chromosome 5 is new (exchange gene contents with chromosome 5)

0	0	0	0	0	1	0	0	0	1
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d. CrossOver

Pair 1 = chromosome 6 & chromosome 2

Pair 2 = chromosome 4 & chromosome 3

Pair 3 = chromosome 1 & chromosome 5

Determine and illustrate the result of a pair experiencing CrossOver, if the crossover probability (P_c) = 0.5 and random value $P[i]$ is known is as follows

!!

0.241 $P[1]$ is smaller than PC

- $P[2] = 0.565$
- $P[3] = 0.853$

*cat :

- Minimum gene value that undergoes crossover is 3 ($N = 3$)

- from the left of chromosome

Chromosome 6 before crossover

1	1	0	0	0	1	1	1	0	0
---	---	---	---	---	---	---	---	---	---

Total = 28 Kg

Chromosome 6 after crossover

1	0	1	0	0	1	1	1	0	0
---	---	---	---	---	---	---	---	---	---

Total = 30 Kg (increase)

Chromosome 2 before crossover

1	0	1	1	0	0	0	0	1	0
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Total = 21 Kg

Chromosome 2 after crossover

1	1	0	1	0	0	0	0	1	0
---	---	---	---	---	---	---	---	---	---

Total = 19 Kg (decrease)

e. Mutation

Determine and illustrate the result of a chromosome experiencing mutation, if the crossover probability (P_m) = 0.3 and random value $P[i]$ is as follows !!

$$M[1] = 0.341$$

$$M[2] = 0.865$$

$$M[3] = 0.525$$

$$M[4] = 0.213$$

$$M[5] = 0.025 \rightarrow \text{Pm is mutated (chromosome 5)}$$

$$M[6] = 0.113$$

*cat :

- Gene value The minimum that has crossover is 2 ($N = 2$).
- Make a swap from *right of chromosome **f. Elitism**
- Write down the results of the chromosomes before being in Elitism and which have been changed based on the previous process in the table below

Item Name	Weight (kg)	Value Priority	K1	K2	K3	K4	K5	K6
Items 1	5	70	1	1	0	1	0	1
Item 2	7	10	0	1	0	0	0	0
Goods 3	9	100	1	0	0	0	1	1
Items 4	4	40	1	1	1	0	0	0
Goods 5	1	50	1	0	0	1	0	0
Goods 6	6	90	0	0	1	1	1	1
Items 7	2	20	0	0	1	1	0	1
Item 8	8	80	0	0	0	0	0	1
Item 9	3	60	1	1	1	0	0	0
Item 10	10	30	0	0	1	0	1	0

Total Fitness	320	180	240	230	220	360
Total Weight (kg)	20	19	25	14	25	2

has the lowest fitness value, then chromosome 2 is replaced with the chromosome with the best value in the parent generation.

- Determine the result of the chromosome after is carried out Elitism process

Name of Heavy Goods	(kg)	Value Priority	K1	K2	K3	K4	K5	K6
Goods 1	5	70	1	0	0	1	0	1
Goods 2	7	10	0	0	0	0	0	0
Goods 3	9	100	1	0	0	0	1	1
Item 4	4	40	1	1	1	0	0	0
Goods 5	1	50	1	0	0	1	0	0
Goods 6	6	90	0	1	1	1	1	1
Goods 7	2	20	0	1	1	1	0	1
Goods 8	8	80	0	0	0	0	0	1
Goods 9	3	60	1	1	1	0	0	0
Items 10	10	30	0	1	1	0	1	0
Total Fitness			320	1220	320	230	220	360

