Knapsack Problem by using Genetic Algorithm

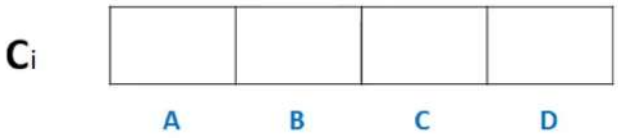
ITEM	WEIGHT	VALUE
A	5 kg	$12
B	3 kg	$ 5
C	7 kg	$ 10
D	2 kg	$ 7

There are four items. Each item is associated with some weight (W) and value at item (v).

There is a knapsack (k) with limited capacity that can hold atmost 12 kg.

Knapsack Problem by using Genetic Algorithm

STEP -1: Chromosomes Encoding



Gene: **0** – represents absence of item in the knapsack
1 – represents presence of item in the knapsack

ITEM	WEIGHT	VALUE
A	5 kg	$12
B	3 kg	$ 5
C	7 kg	$ 10
D	2 kg	$ 7

4 bits are requested to represent chromosomes encoding

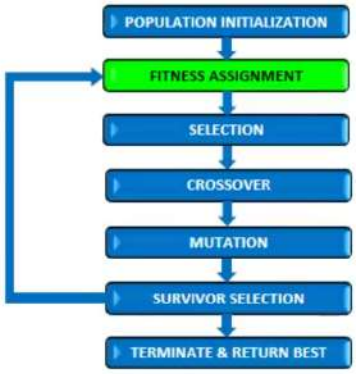
Set space = 2^4

Initial population is created and chromosomes randomly created

Generation 1

C_1	0	1	1	0
C_2	0	1	0	1
C_3	1	1	0	1
C_4	1	1	1	1

Knapsack Problem by using Genetic Algorithm



STEP -2: Fitness Function

Next Step is to determine fitness function which is used to evaluate how good particular solution is. Lets take C_1

C_1	0	1	1	0
	A	B	C	D

represent that knapsack has presence of item B & C and absence of item A & D

- value of knapsack = value of B + value of C
  = 5 + 10 = 15
- Weight of knapsack = weight of item B + weight of item C
  = 3 + 7 = 10 kg

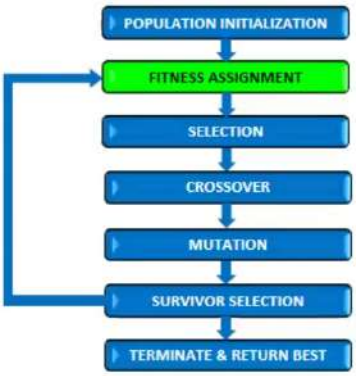
Knapsack capacity = 12 kg as 12kg> 10kg **so C_1 is accepted**

ITEM	WEIGHT	VALUE
A	5 kg	$12
B	3 kg	$ 5
C	7 kg	$ 10
D	2 kg	$ 7

Chromosome Encoding

C1	0	1	1	0
C2	0	1	0	1
C3	1	1	0	1
C4	1	1	1	1

Knapsack Problem by using Genetic Algorithm



STEP -2: Fitness Function

Next Step is to determine fitness function which is used to evaluate how good particular solution is. Lets take C_2

C_2	0	1	0	1
	A	B	C	D

represent that knapsack has presence of item B & D and absence of item A & C

- value of knapsack = value of B + value of D
  = 5 + 7 = 12
- Weight of knapsack = weight of item B + weight of item D
  = 3 + 2 = 5 kg

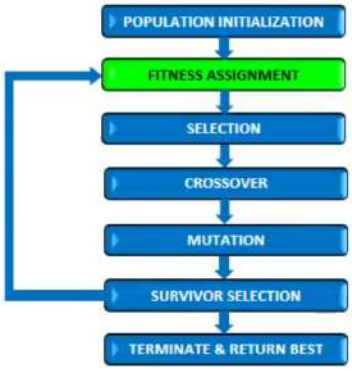
Knapsack capacity = 12 kg as 12kg> 5kg **so C_2 is accepted**

ITEM	WEIGHT	VALUE
A	5 kg	$12
B	3 kg	$ 5
C	7 kg	$ 10
D	2 kg	$ 7

Chromosome Encoding

C1	0	1	1	0
C2	0	1	0	1
C3	1	1	0	1
C4	1	1	1	1

Knapsack Problem by using Genetic Algorithm



STEP -2: Fitness Function

Next Step is to determine fitness function which is used to evaluate how good particular solution is. Lets take C_3

C_3	1	1	0	1
	A	B	C	D

represent that knapsack has presence of item A, B & D and absence of item C.

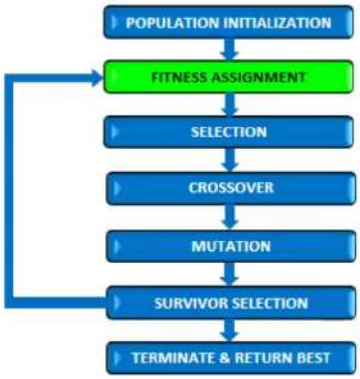
- value of knapsack = value of A + value of B + value of D
  = 12 + 5 + 7 = 24
- Weight of knapsack = weight of B + weight of C + weight of D
  = 5 + 3 + 2 = 10 kg

ITEM	WEIGHT	VALUE
A	5 kg	$12
B	3 kg	$ 5
C	7 kg	$ 10
D	2 kg	$ 7

Chromosome Encoding

C1	0	1	1	0
C2	0	1	0	1
C3	1	1	0	1
C4	1	1	1	1

Knapsack Problem by using Genetic Algorithm



STEP -2: Fitness Function

Next Step is to determine fitness function which is used to evaluate how good particular solution is. Lets take C_4

	A	B	C	D
C_4	1	1	1	1

represent that knapsack has presence of all item A, B, C & D

- value of knapsack = value of A + value of B + value of C + value of D
  = 12 + 5 + 10 + 7 = 34
- Weight of knapsack = weight of B + weight of C + weight of B + weight of C
  = 5 + 3 + 7 + 2 = 17 kg

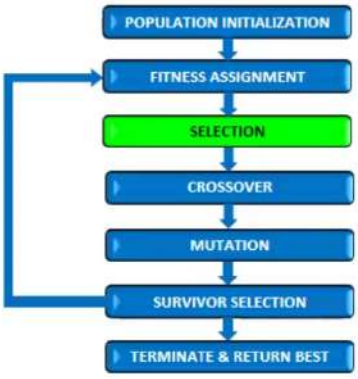
As 17 kg > knapsack capacity; 17 kg > 12 kg **so C_4 is discarded.**

ITEM	WEIGHT	VALUE
A	5 kg	$12
B	3 kg	$ 5
C	7 kg	$ 10
D	2 kg	$ 7

Chromosome Encoding

C1	0	1	1	0
C2	0	1	0	1
C3	1	1	0	1
C4	1	1	1	1

Knapsack Problem by using Genetic Algorithm

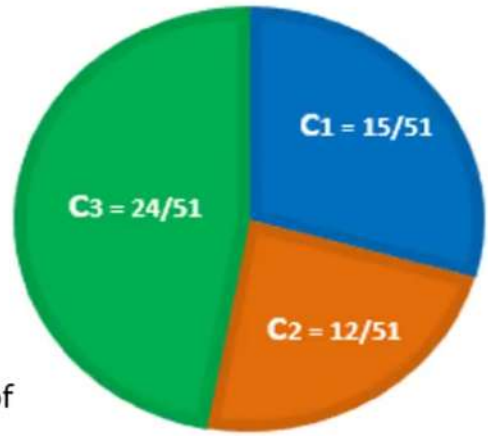


STEP -3: Selection

Next step is to collect the filter individual and wake up the next generation, chromosome

By using Roulette Wheel Selection

- Spin the Roulette Wheel and whenever the wheel stops, the individual gets selected at that point.
- The individual that has the highest fitness value gets larger share of the wheel



e.g. total fitness value = 15 + 12 +24 + 0 = 51

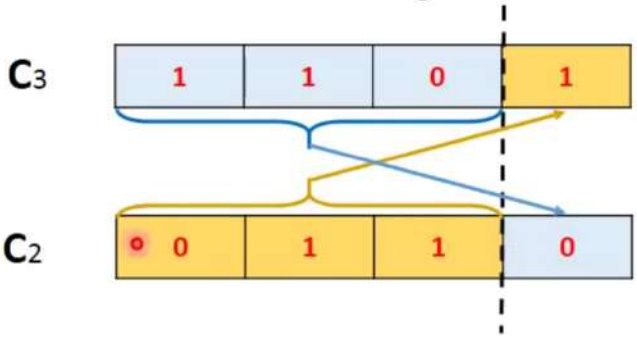
Fitness value of C_3 = 24 ; largest fitness

So, C_3 occupies half of the wheel as 24/51

C_4 has zero chance of wining, C_3 has the highest probability of getting selected in the next generation

Knapsack Problem by using Genetic Algorithm

One point crossover – Randomly select the position on the chromosomes about which gene would be exchange.



ITEM	WEIGHT	VALUE
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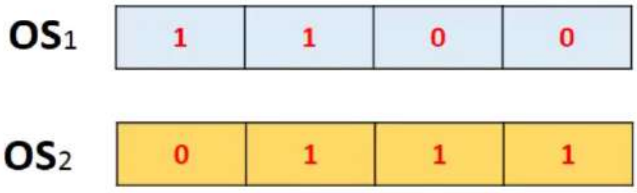
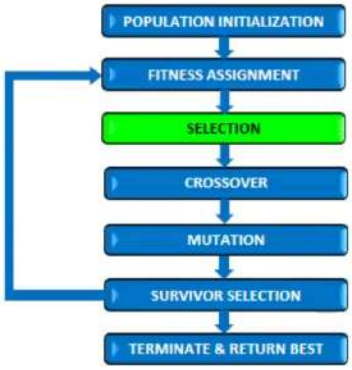
Result of one point crossover i.e. produced offspring



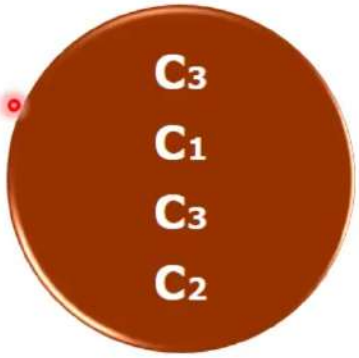
Knapsack Problem by using Genetic Algorithm



After spinning Roulette wheel, in the first spin **C_3** will be selected and then **C_1** after that **C_3** and **C_2**.

Individuals of next generation are selected as follows:

Generation 2



ITEM	WEIGHT	VALUE
A	5 kg	$12
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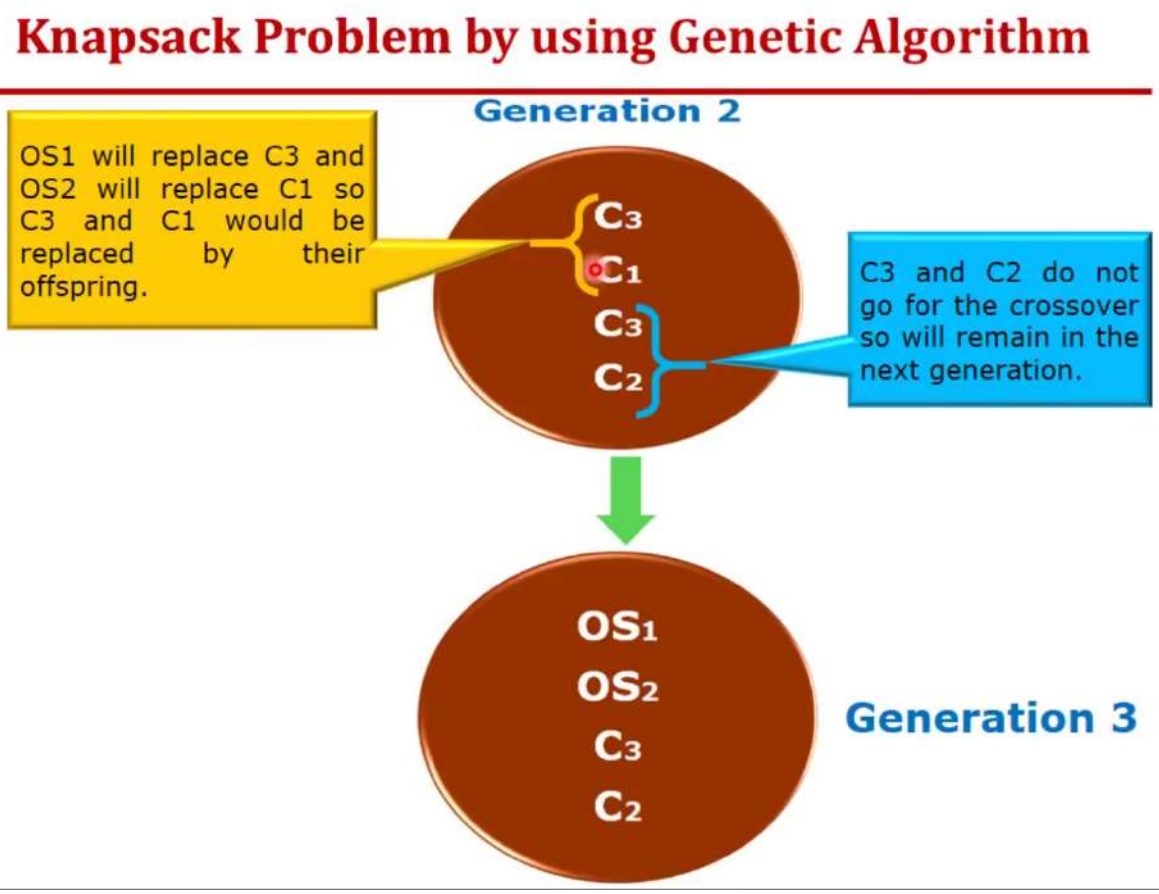
Knapsack Problem by using Genetic Algorithm



Knapsack Problem by using Genetic Algorithm

STEP -4: Mutation

Introduces the diversity within the population so that search algorithm does not necessarily get stuck at local maxima.

Lets us consider chromosomes C. Now randomly select a gene from C. A Flip happens at the selected genes and zero become one and one becomes zero