Genetic Algorithms

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Introduction

- Definition
  - A class of stochastic search algorithms based on biological evolution
- GA applies few steps as by Davis, 1991 and Mitchell, 1996.

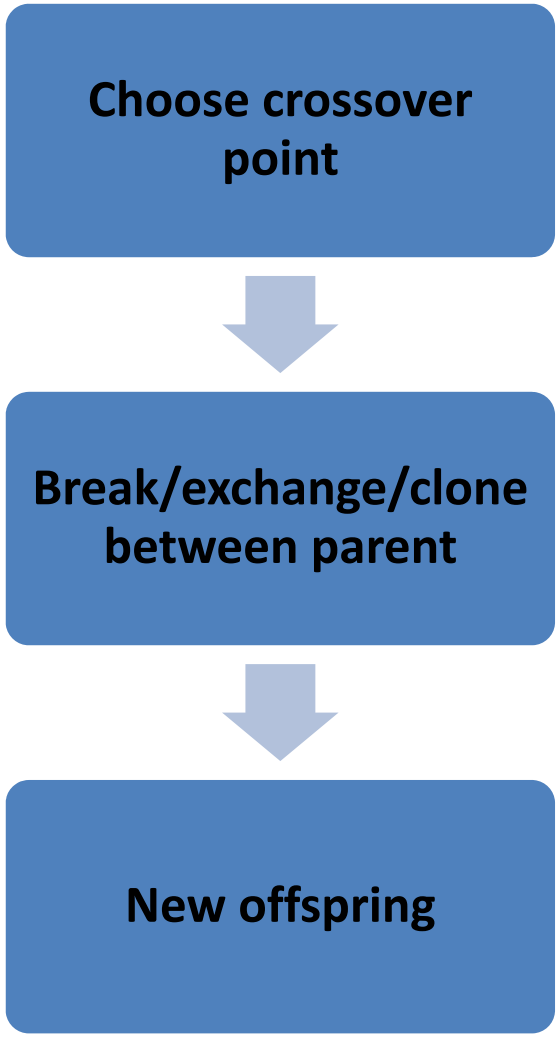
GA Steps

- Step 1: Set population size and probability
- Step 2: Define fitness function
- Step 3: Generate initial population
- Step 4: Calculate fitness for each chromosome
- Step 5: Mating of chromosomes
- Step 6: Create offspring-crossover & mutation
- Step 7: Offspring in new population
- Step 8: Repeat Step 5 until new=initial population
- Step 9: Replace initial population with new
- Step 10: To Step 4 & repeat until criteria achieved

About GA

- Common practise - To terminate GA after specified number of generations to examine the best chromosome
- Roulette wheel selection – chromosome selection technique

How does Crossover operator work?



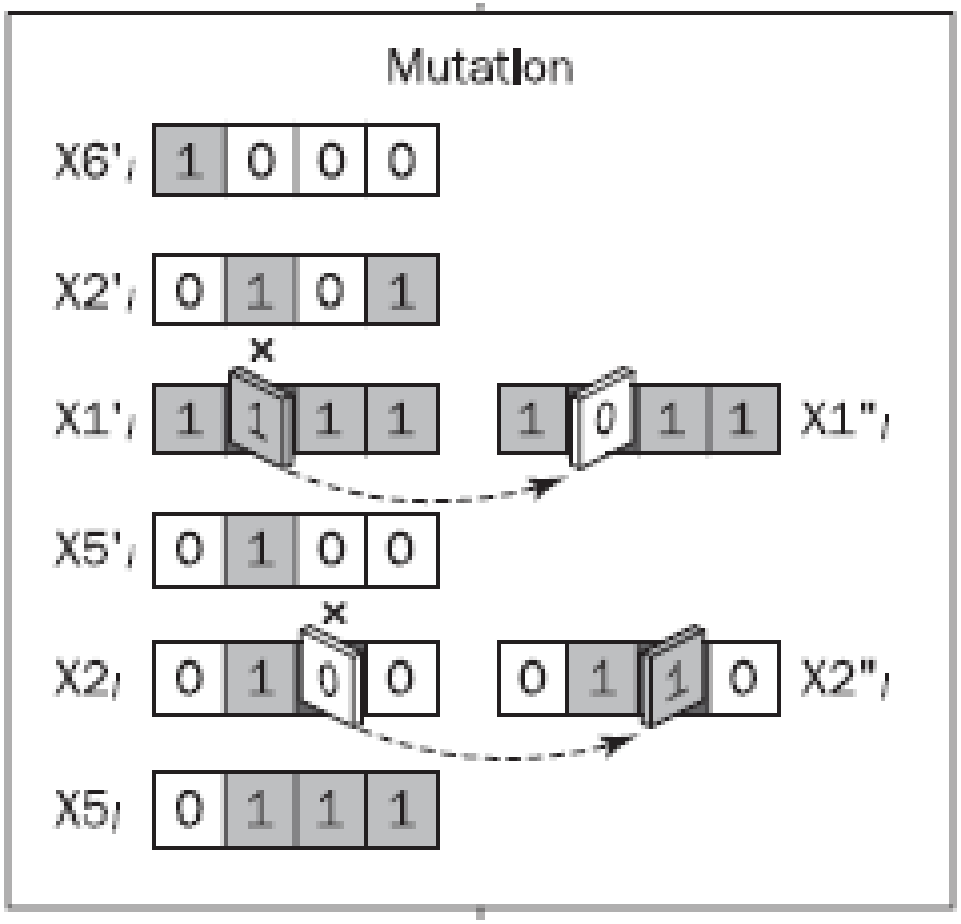
Mutation

- Change in gene
- 2 consequences: GOOD and BAD
- Purpose: prevent search algorithm trapped on local optimum.
- Mutation=random search, aids in avoiding loss of genetic diversity

-Randomly **flips** a selected gene.

-Occur in any gene with specific probability.

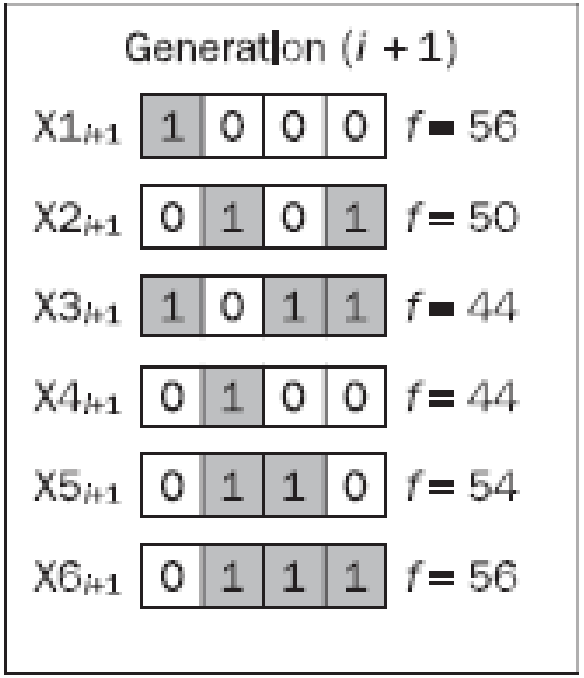
-probality: small (0.001 -0.01)



-Genetic algorithms assure : the continuous improvement of the average fitness

-after a number of generations : the population evolves to a near-optimal solution.

-In the example, the final population would consist of only chromosomes 1000 and 0111, both with highest fitness.



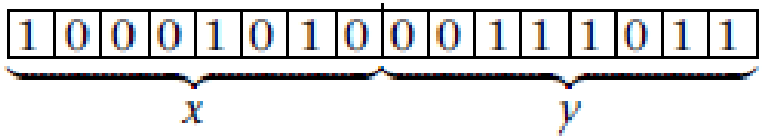
E.g: A “peak” function with two variables:

$$f(x,y) = (1-x)^2 e^{-x^2-(y+1)^2} - (x - x^3 - y^3)e^{-x^2-y^2}$$

-To find the maximum of the function :

Step 1: represent parameters x and y as a concatenated binary string.

Step 2: choose size a



Step 3: calculate the fitness (decode to real numbers and substitute in “peak” function)

-16 bits to 8 bits partition:

1	0	0	0	1	0	1	0	and	0	0	1	1	1	0	1	1

- Convert from base 2 to (decimal value) base 10:

$$(10001010)_2 = (138)_{10}$$

$$(00111011)_2 = (59)_{10}$$

- The -3 to 3 range mapped to handle the 8-bits:

$$\frac{6}{256-1} = 0.0235294$$

- Actual value : multiply decimal value with mapped range.

$$x = (138)_{10} \times 0.0235294 - 3 = 0.2470588$$

$$y = (59)_{10} \times 0.0235294 - 3 = -1.6117647$$

-Using value of x and y, calculate the fitness.

- To find the maximum: crossover probability = 0.7 and mutation probability = 0.001

-Specify num. of generations: e.g 100.

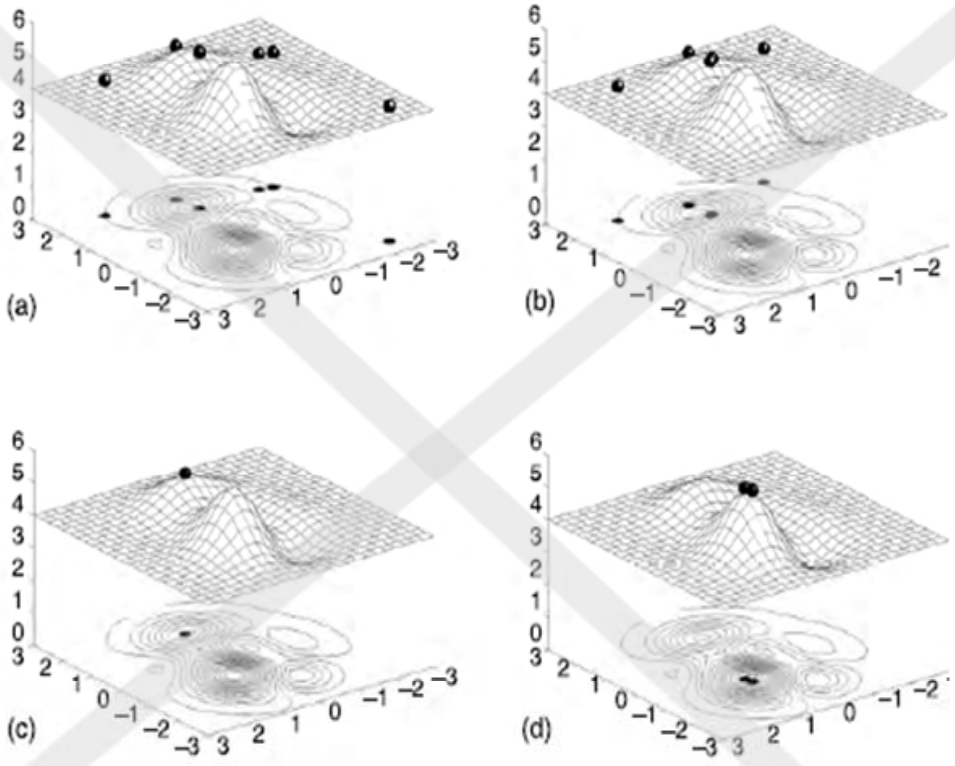
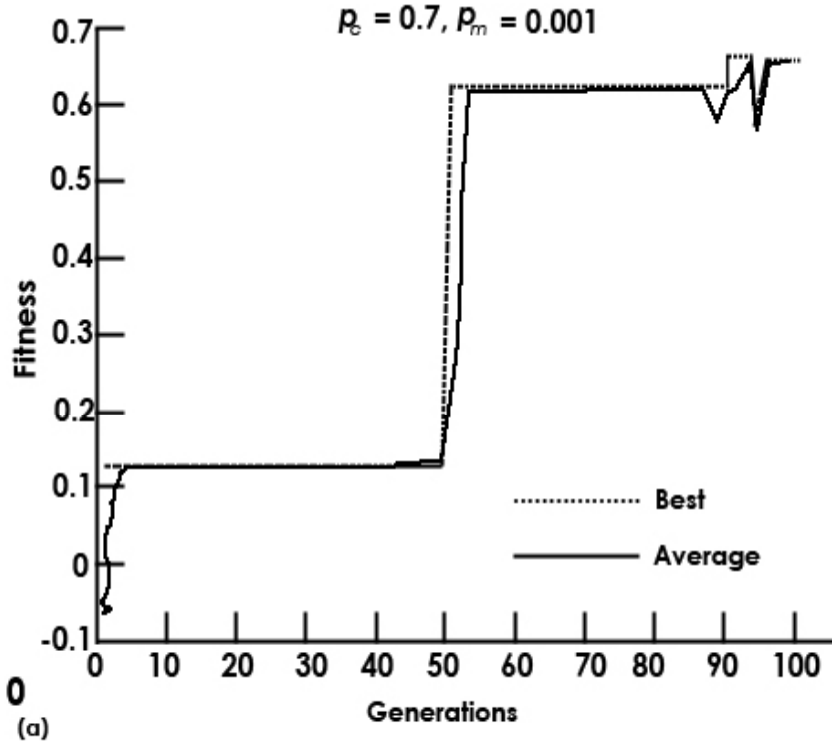


Figure 7.6 *Chromosome locations on the surface and contour plot of the 'peak' function: (a) initial population; (b) first generation; (c) local maximum solution; (d) global maximum solution*

- Used to represent the fitness function for the real world problems with stochastic **(random)** solution like GA.

-shows: **average** performance of entire population and performance of **best** individual chromosome,



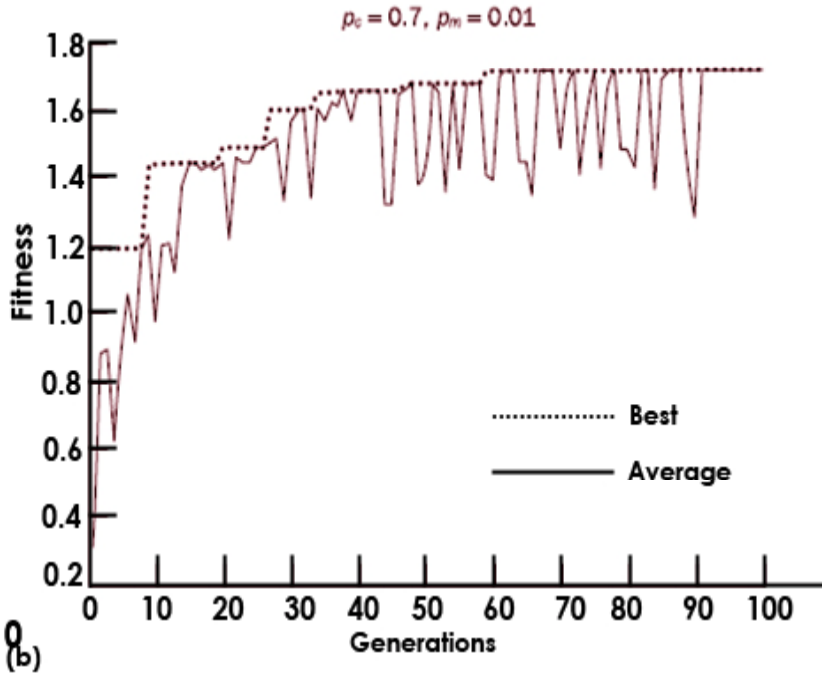


Figure 7.7 Performance graphs for 100 generations of 6 chromosomes: (a) local maximum solution and (b) global maximum solution of the 'peak' function

- erratic behaviour of average curve: because of mutation.

-solution: increase the chromosome population.

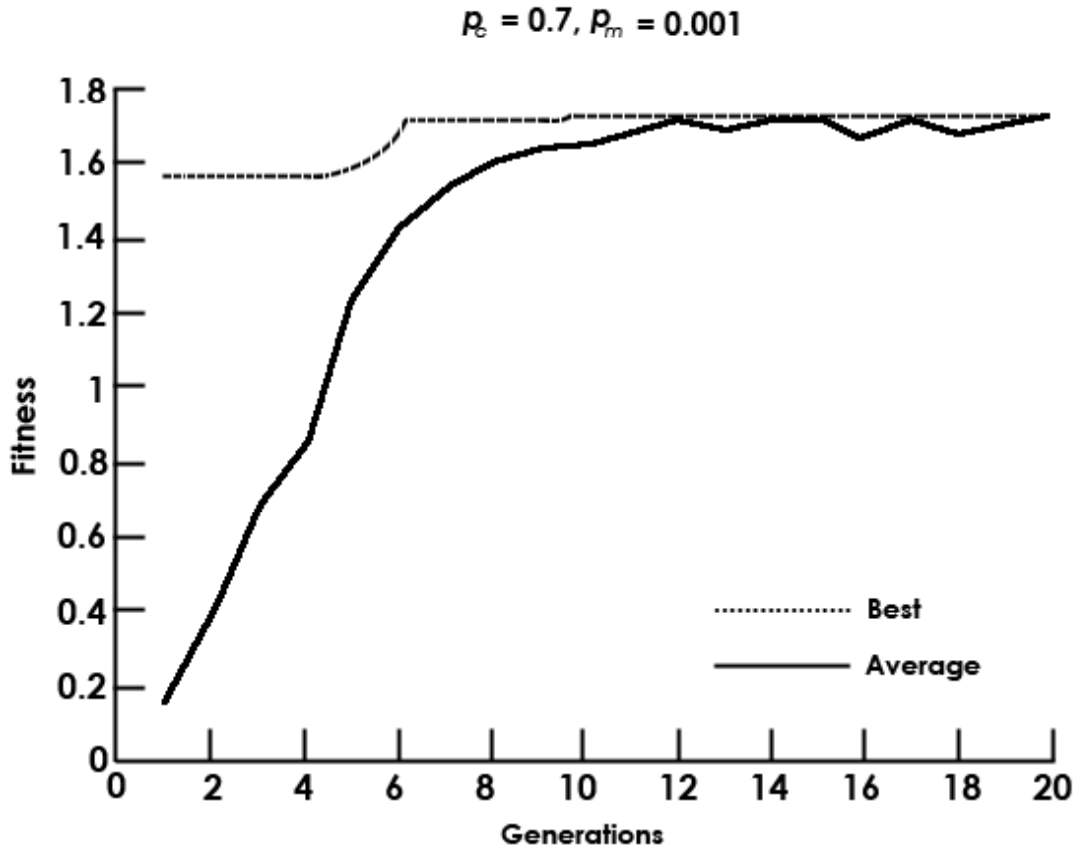


Figure 7.8 Perfomance graphs for 2.0 generations of 60 chromosomes