Genetic Algorithm

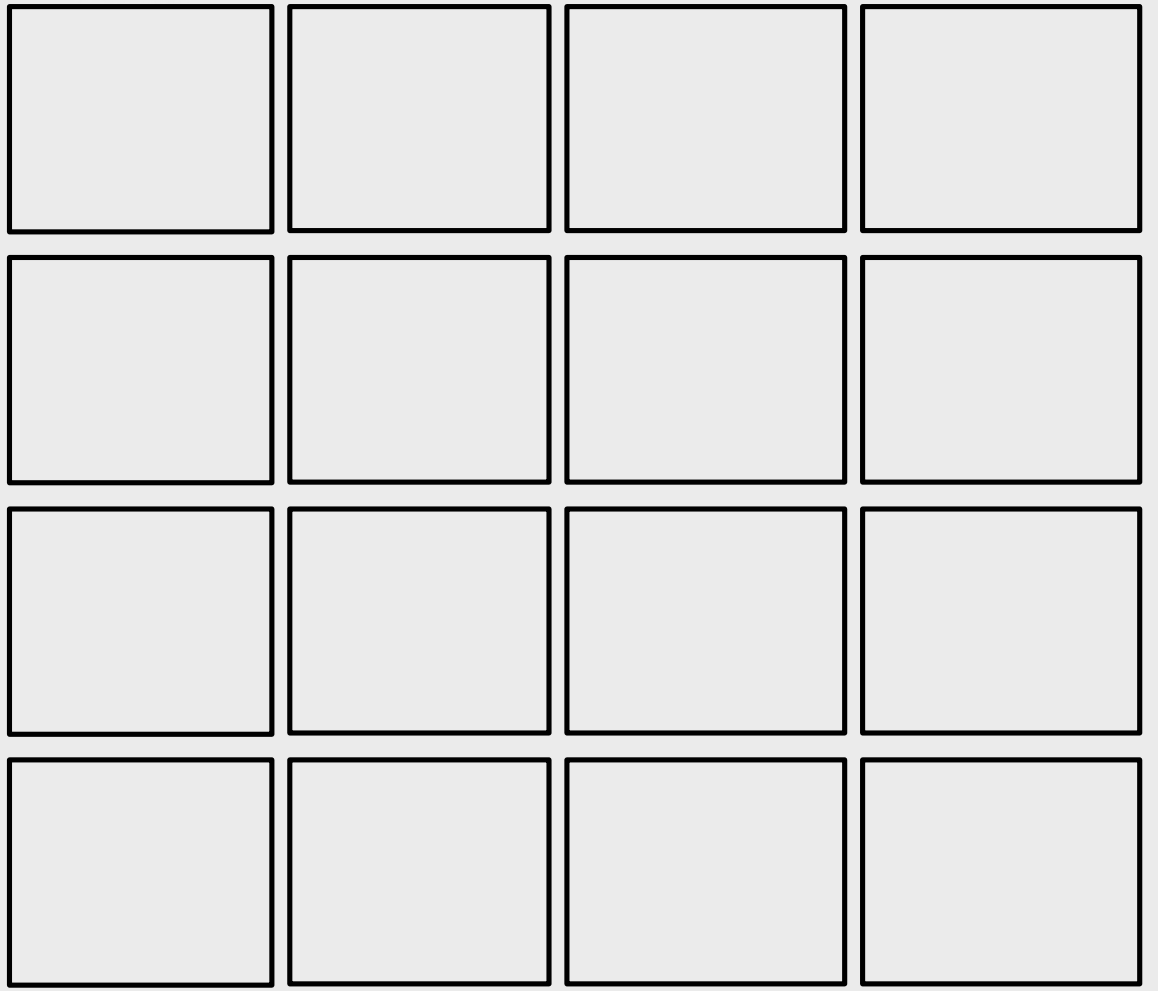
Presentation Outline:

1) Introducing the 4-Queen problem
2) **Activity**: Solving 4-Queen problem using artifacts
3) Solution of 4-Queen problem in Backtracking approach
4) Demerits of Backtracking approach
5) Introducing 8-Queen problem
6) Discussion on Genetic Algorithm
7) Solution of 8-Queen problem using GA
8) Conclusion

The 4-Queen Problem

Once upon a time, there was a great king in India. However, it was a matter of shame that he had 4 Queens. The Queens were so arrogant and they didn't even want see one another. Therefore, the King built a castle of 4 x 4 rooms. However, he couldn't find way the to place the 4 Queens in 4 separate rooms, so that they couldn't see each others.

Would, you please help the King to place the Queens? Avoid placing two Queens in a same row, same column and even same diagonal rooms.



Solution of the 4-Queen Problem Using Backtracking Approach

Therefore , the king called Professor John Holland of the University of Michigan to solve the 4-Queen problem. And Professor solved the 4-Queen problem in backtracking approach.

The 5-Queen Problem

One month later, Professor received a call from the great King to solve his 5-Queen problem. Professor, solved the 5-Queen problem in backtracking approach.

Solution of the 5-Queen Problem Using Backtracking Approach

6-Queen Problem

John Holland introduced **Genetic Algorithm** (**GA**)

Darwin's theory of evolution

Fortunately, one month later, the King requested the professor to solve 6-Queen problem. The professor thought that the King may request him to solve 16-Queen problem within next 10 months.

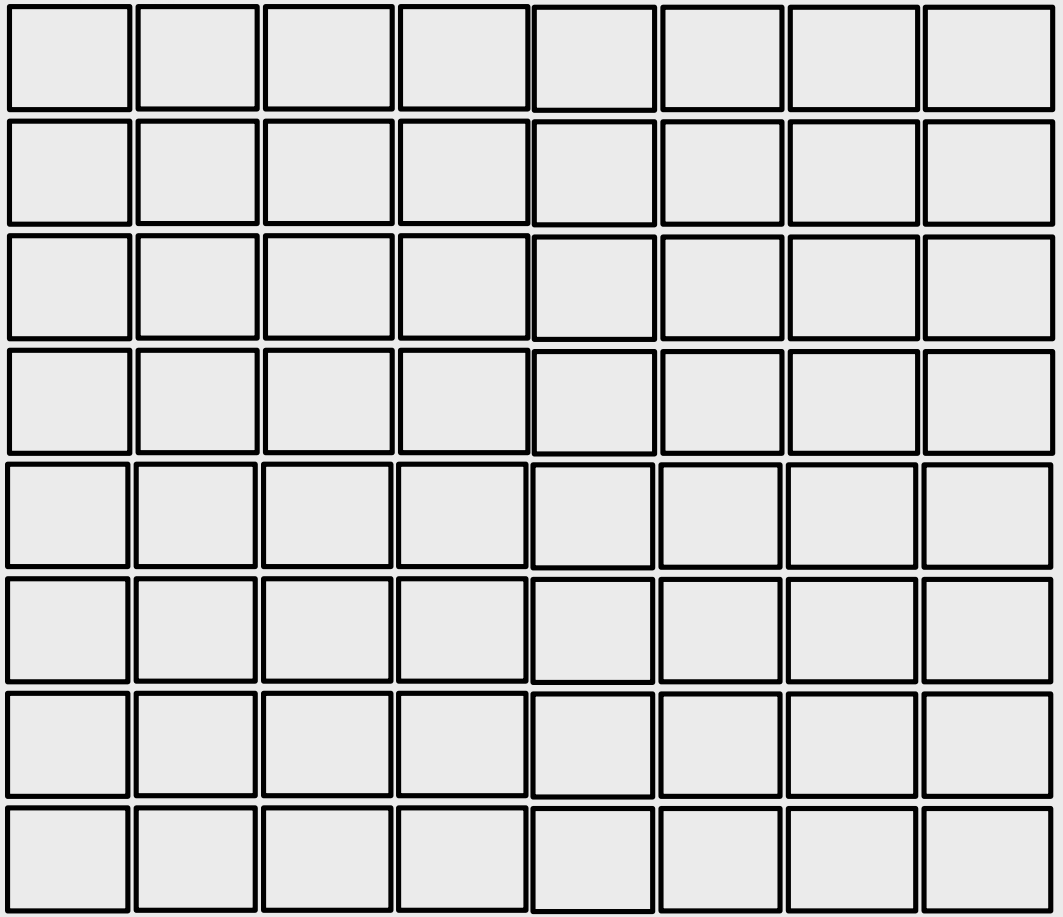
Backtracking approach will not be efficient to solve the 8 or 16-Queen problems.

Therefore, professor invented Genetic Algorithm to solve the n-Queen problem.

8-Queen Problem

John Holland introduced **Genetic Algorithm** (**GA**)

Darwin's theory of evolution



Genetic Algorithms
Successor States are Generated Combining Two Parent S

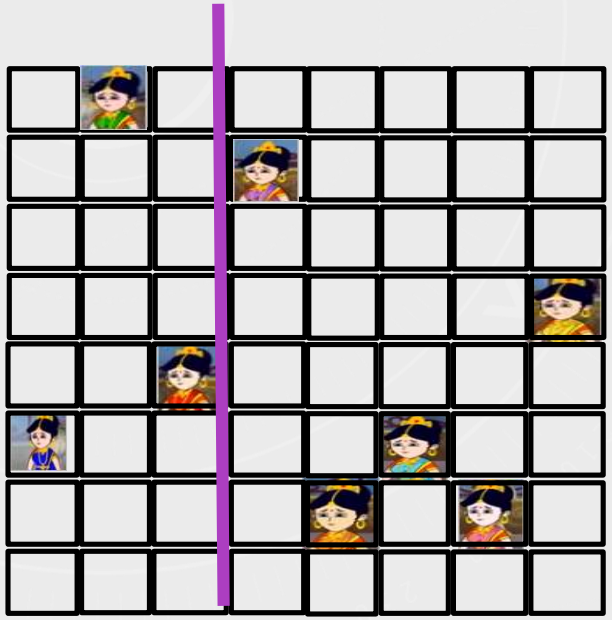
Introduced in the 1970s by John Holland at University of Michigan

- begin with *k* randomly generated states (population)
- each state (individual) is a string over some alphabet (chromosome)
- fitness function (bigger number is better)
- crossover
- mutate (evolve?)

Formulation of Genetic Algorithm

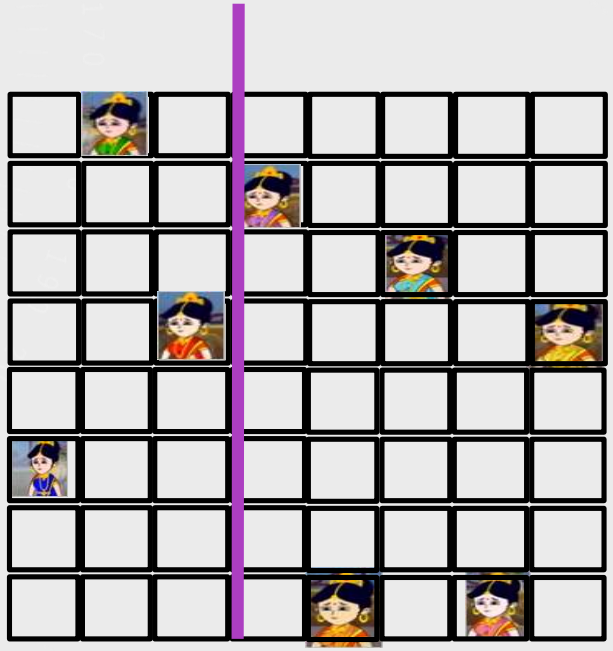
John Holland introduced **Genetic Algorithm (GA)**

Darwin's theory of evolution



3 8 4 7 2 3 2 5

Fitness=28-7=21



3 8 5 7 1 6 1 5

Fitness=28-4=24

Fitness function: number of non-attacking pairs of queens

Maximum number of pairs: 8 × 7/2 = 28

[Q1 Q2]
[Q1 Q3]
[Q1 Q4]
[Q1 Q5]
[Q1 Q6]
[Q1 Q7]
[Q1 Q8]
.....
[Q8 Q7]

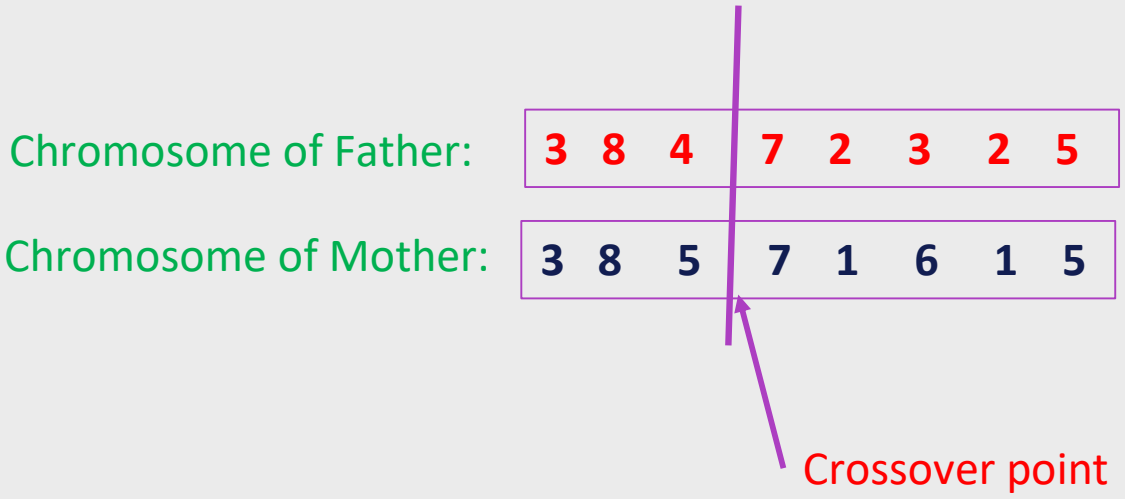
Chromosome of Father: 3 8 4 7 2 3 2 5

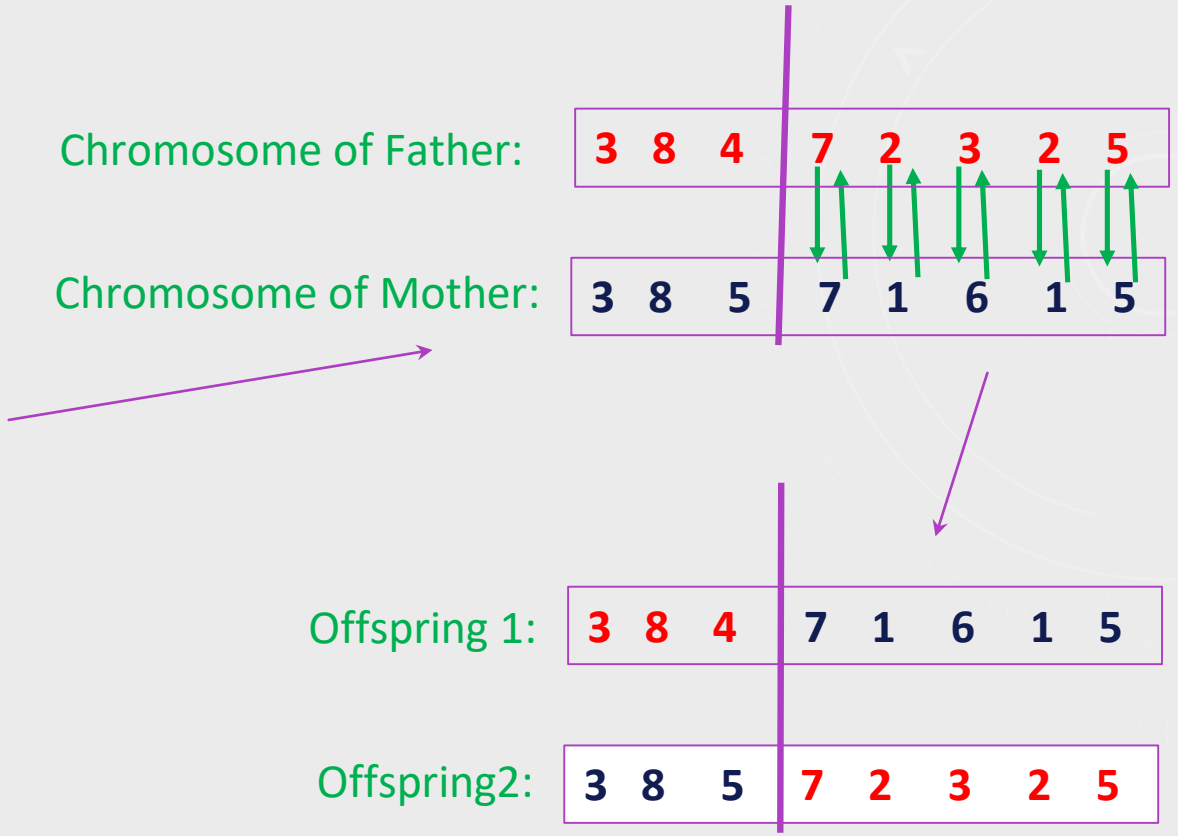
Chromosome of Mother: 3 8 5 7 1 6 1 5

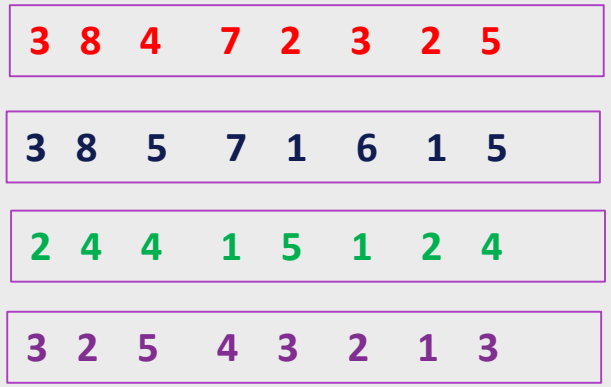
Pseudo-code of GA:

```
START
    Generate the initial population
    Compute fitness
    REPEAT
                        Selection
                        Crossover
                        Mutation
                        Compute fitness
    UNTIL population has converged
STOP
```

Crossover:


Chromosome of Father:
3 8 4 7 2 3 2 5
Chromosome of Mother:
3 8 5 7 1 6 1 5
Crossover point


Chromosome of Father:
3 8 4 7 2 3 2 5
Chromosome of Mother:
3 8 5 7 1 6 1 5
Offspring 1:
3 8 4 7 1 6 1 5
Offspring2:
3 8 5 7 2 3 2 5


3 8 4 7 2 3 2 5
3 8 5 7 1 6 1 5
2 4 4 1 5 1 2 4
3 2 5 4 3 2 1 3

Mutation:

Before Mutation:

Offspring 1: 3 8 4 7 1 6 1 5

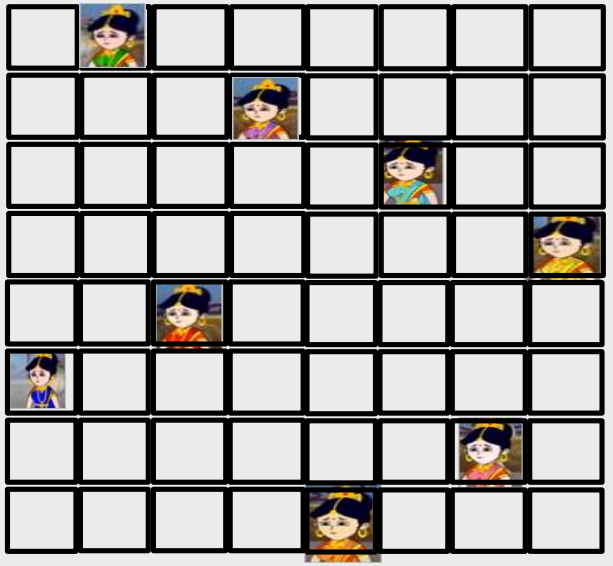
Offspring2: 3 8 5 7 2 3 2 5

After Mutation:

Offspring 1: 3 8 4 7 1 6 2 5

Offspring2: 3 8 6 7 2 3 2 5

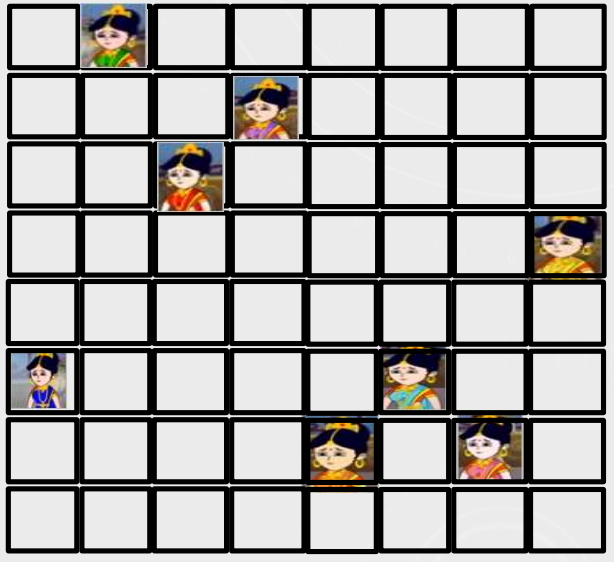
Offspring 1:



3 8 4 7 1 6 2 5

Fitness=28-0=28

Offspring2:

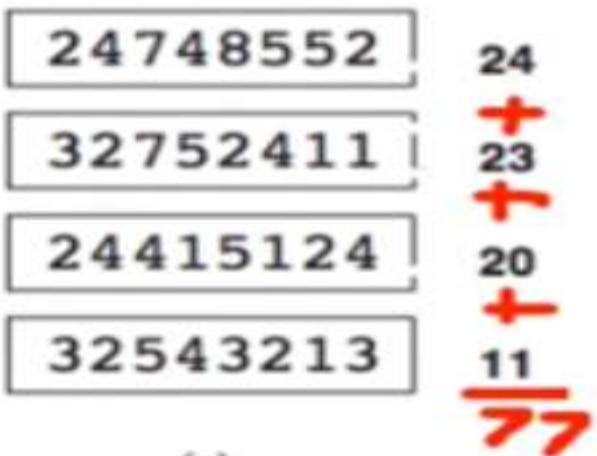


3 8 6 7 2 3 2 5

Fitness=28-5=23

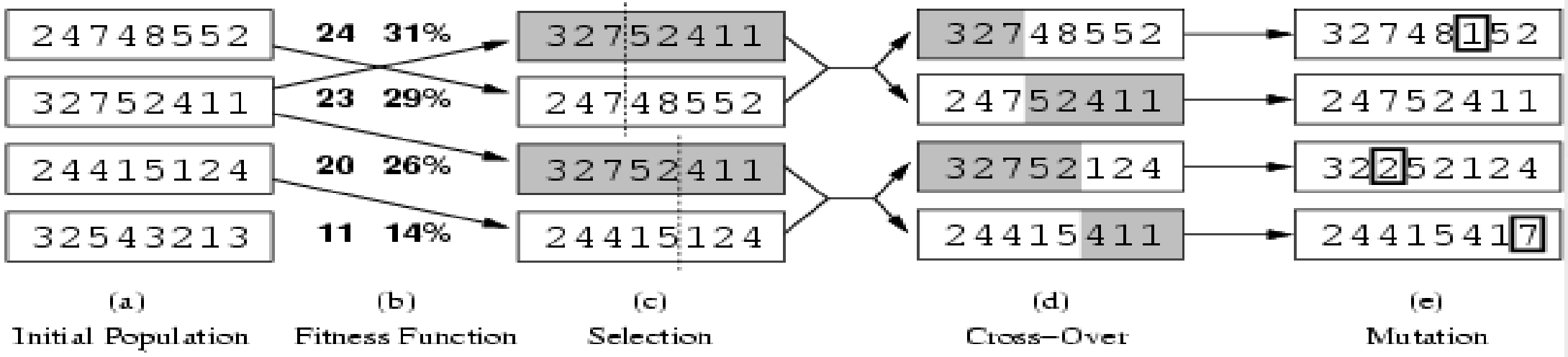
Genetic Algorithms
Example

Represent states and compute fitness function.



(a)
Initial Population

GENETIC ALGORITHMS



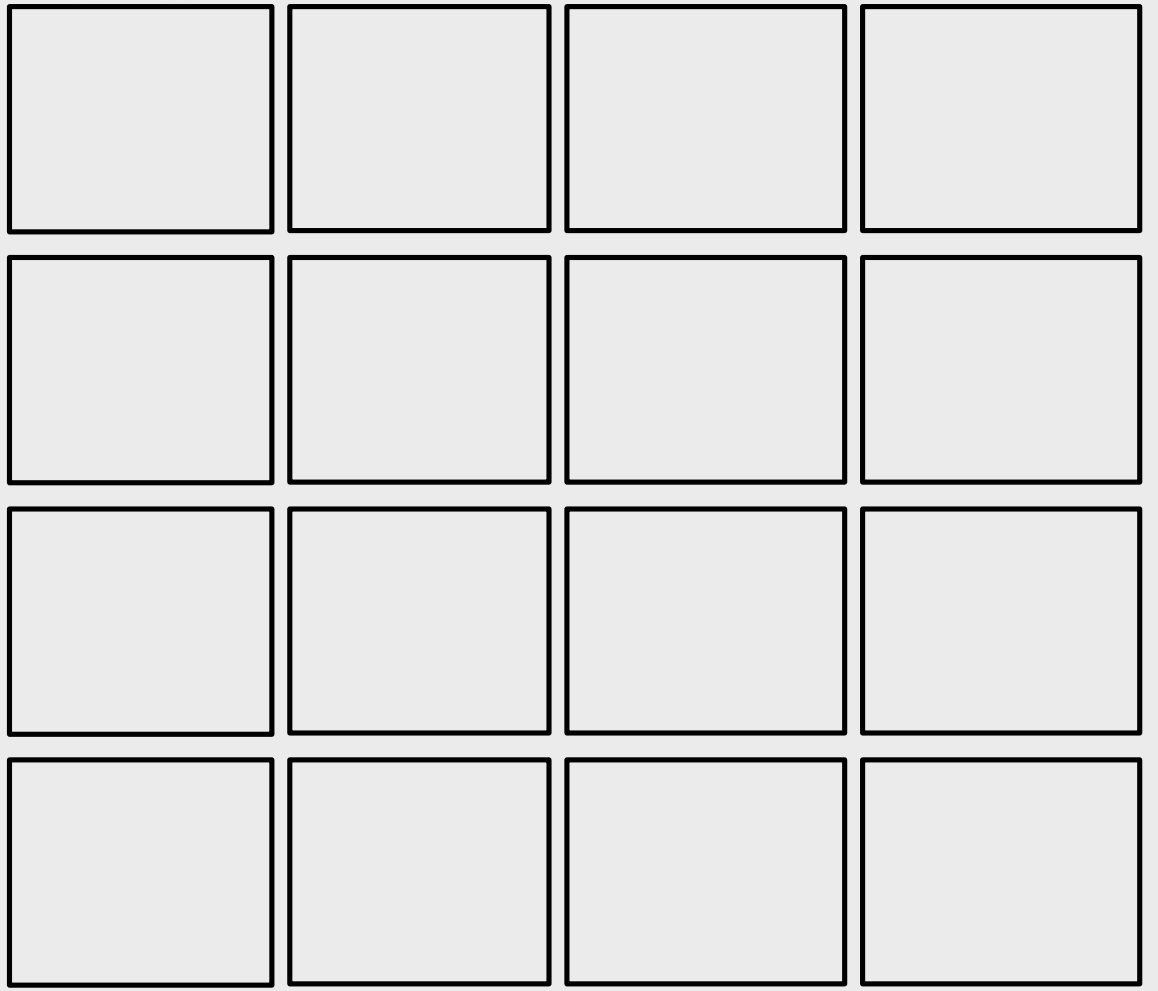
- Fitness function: number of non-attacking pairs of queens (min = 0, max = 8 × 7/2 = 28)
  24/(24+23+20+11) = 31%
  23/(24+23+20+11) = 29% etc

Solution of 8-Queen Problem using Genetic Algorithm

John Holland introduced **Genetic Algorithm (GA)**

Darwin's theory of evolution

The 4-Queen Problem



Fitness function: number of non-attacking pairs of queens

What is the Maximum fitness value: ????

4-Queen Problem Using Backtracking Approach

Therefore , the king called Professor John Holland of the University of Michigan to solve the 4-Queen problem. And solved the 4-Queen problem in backtracking approach.

Solution of the 4-Queen Problem Using GA

Initial Population

Conclusion

Application areas of GA:

- Game programming
- Cloud resource allocation
- Job scheduling of operating systems
- Channel assignment in communication system
- Combinatorial optimization
- Creative design (NASA antenna)
- Operational research

REFERENCES

- *Fraser, Alex; Burnell, Donald (1970). Computer Models in Genetics. New York: McGraw-Hill.*
- *Crosby, Jack L. (1973). Computer Simulation in Genetics. London: John Wiley & Sons.*
- UC Berkeley's Hans Bremermann, professor emeritus and pioneer in mathematical biology, has died at 69
- *Fogel, David B. (editor) (1998). Evolutionary Computation: The Fossil Record. New York: IEEE Press.*
- *Barricelli, Nils Aall (1963). "Numerical testing of evolution theories. Part II. Preliminary tests of performance, symbiogenesis and terrestrial life". Acta Biotheoretica (16): 99–126.*

RESEARCH

A Dynamic Scheduling Method for Collaborated Cloud with Thick Clients

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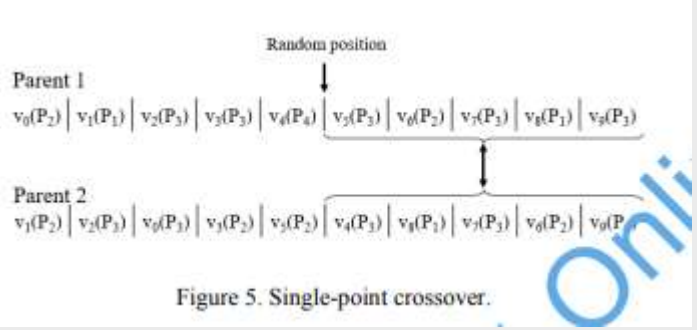

Figure 5. Single-point crossover.

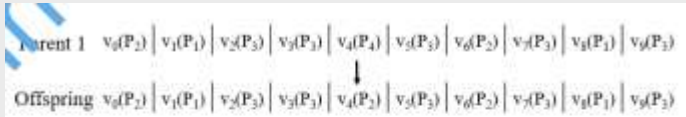

Figure 8. Replacing mutation.

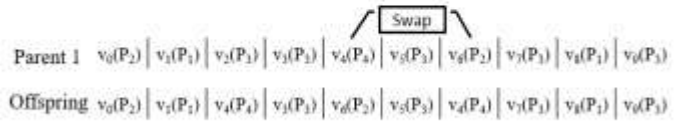

Figure 9. Swapping mutation.