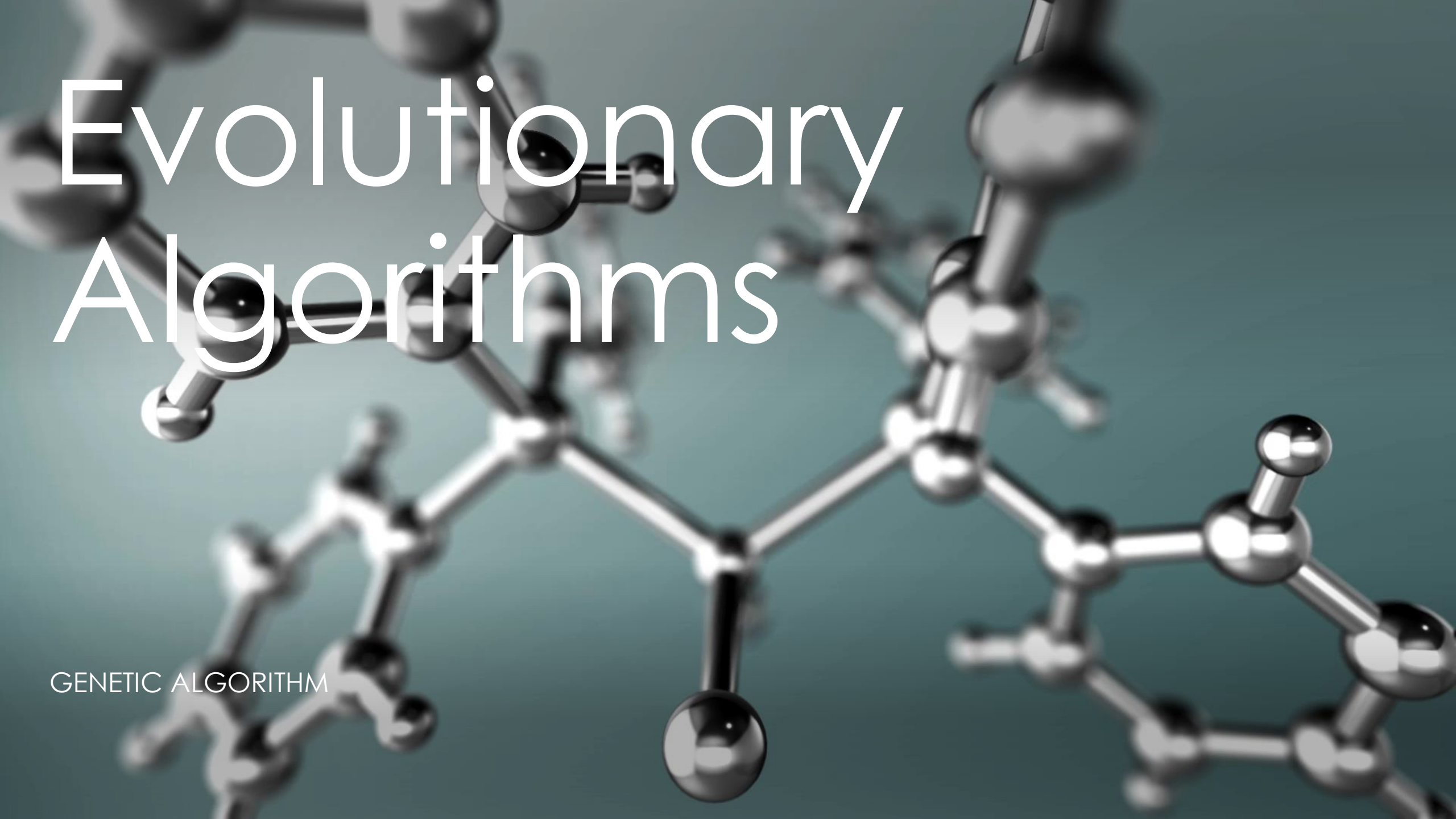


Evolutionary Algorithms

GENETIC ALGORITHM

Evolutionary Algorithms

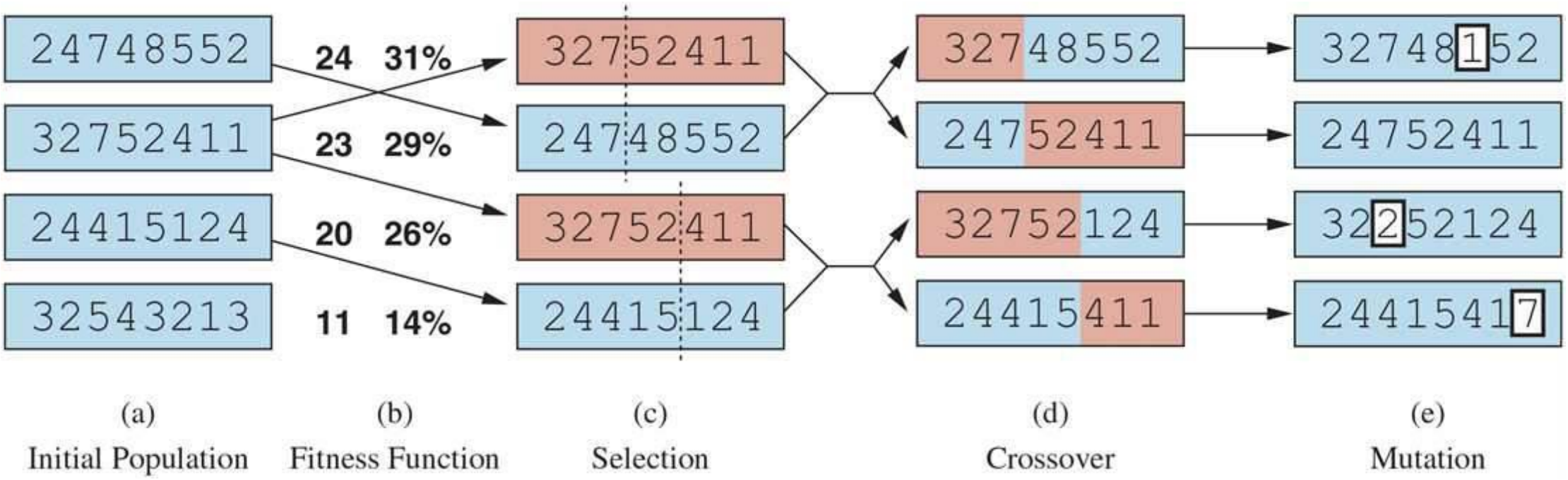
- Variants of Stochastic beam search.
- Explicitly motivated by the metaphor of natural selection in biology!

- **Recombination:** there is a population of individuals (states), in which the fittest (highest value) individuals produce offspring (successor states) that populate the next generation.

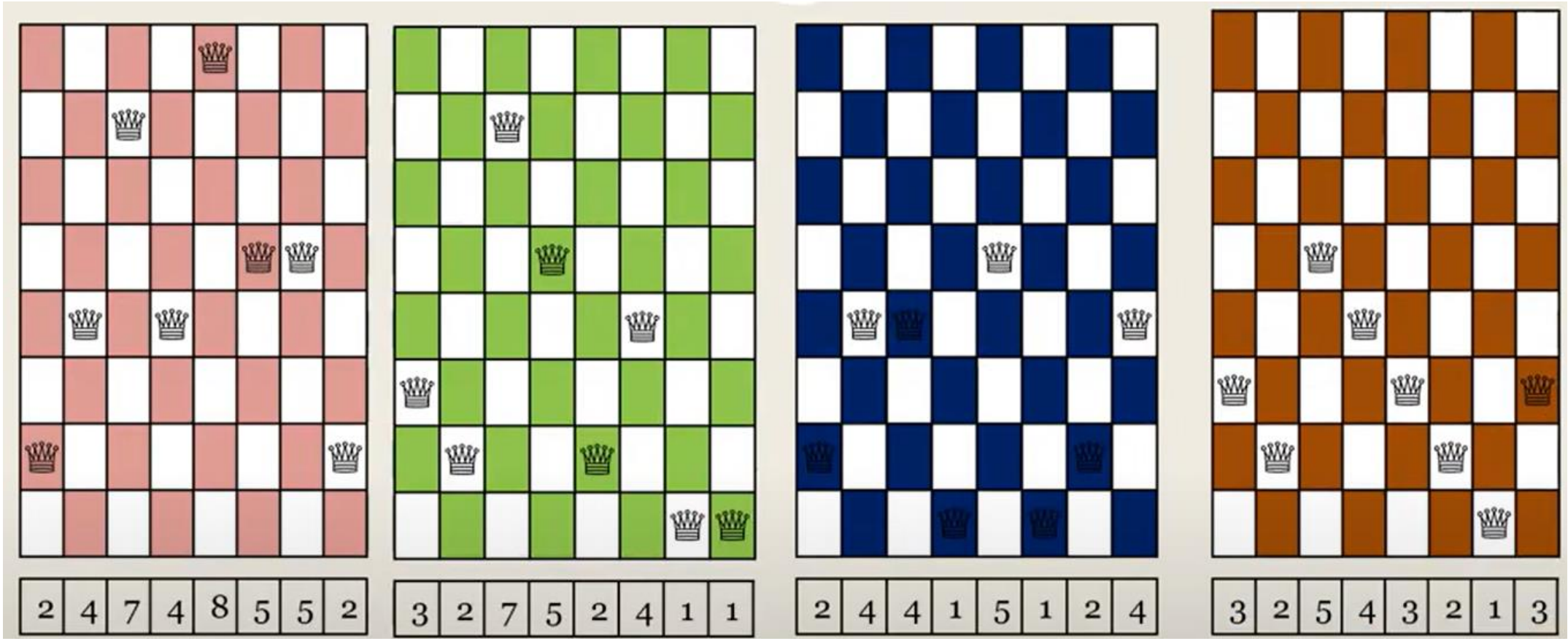
Variants of Evolutionary Algorithms

- Size of the population
- Representation of each individual
- The mixing number ρ
- Selection process ($n > \rho$)
- Recombination procedure
- Mutation rate
- The makeup of next generation

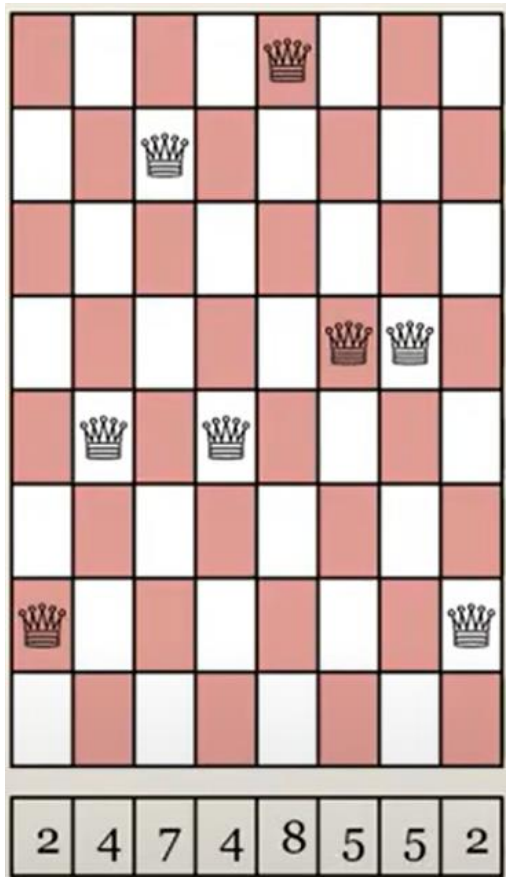
Genetic Algorithm | 8-queens problem



Initial Population

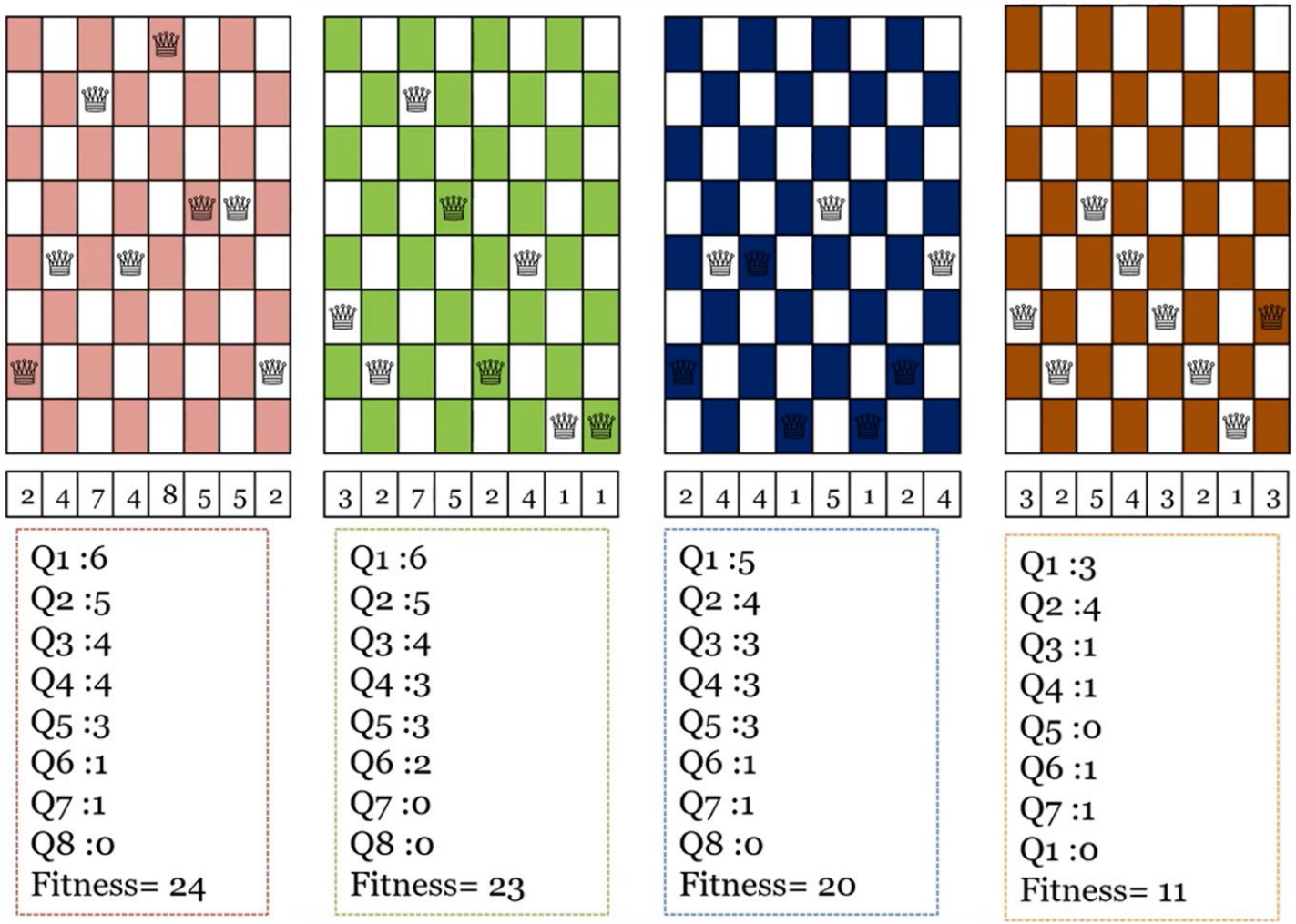


Fitness Function (#Non-Attacking Pairs)



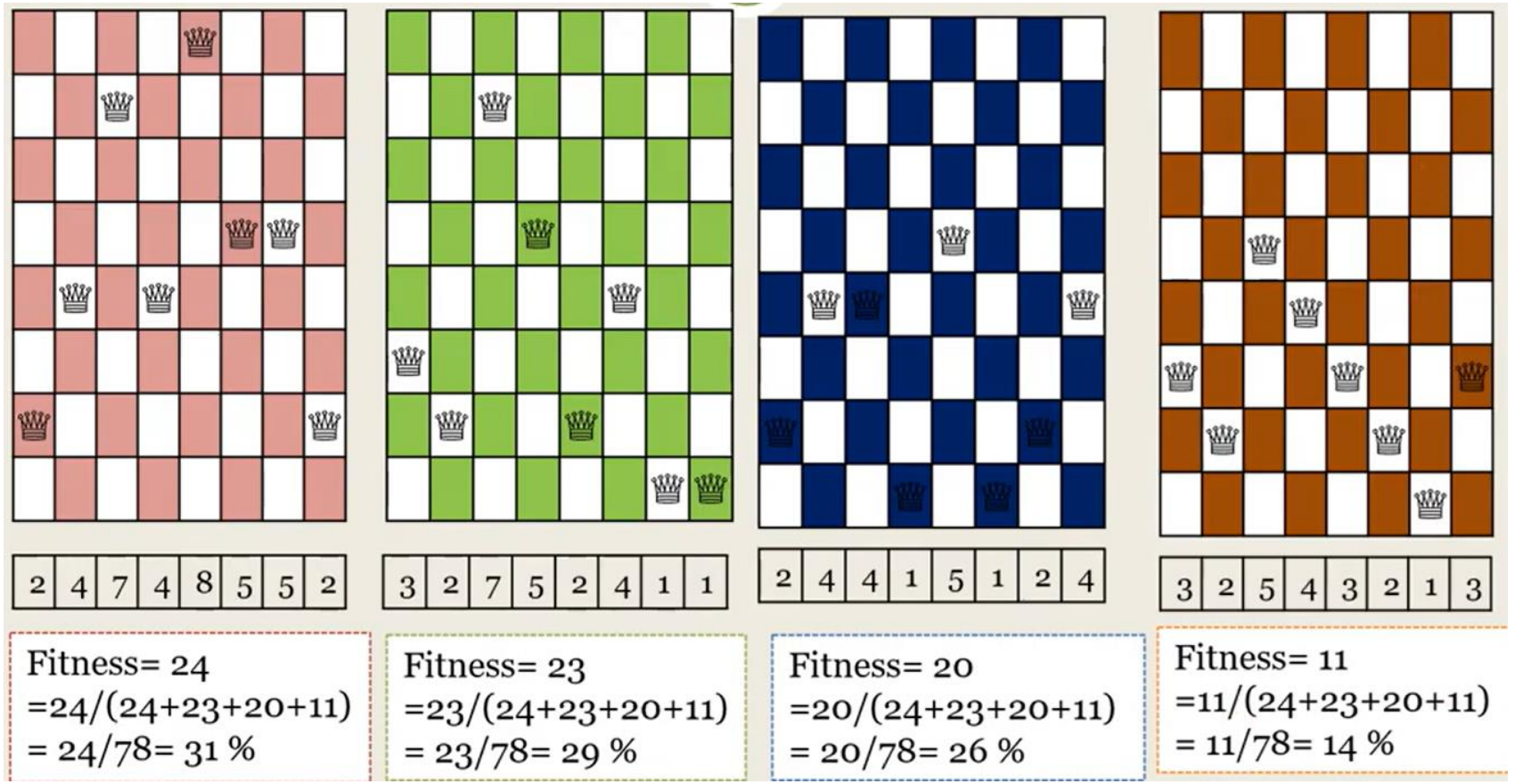
Q1: 6
Q2: 5
Q3: 4
Q4: 4
Q5: 3
Q6: 1
Q7: 1
Q8: 0
Fitness value: 24

Fitness Function (#Non-Attacking Pairs)

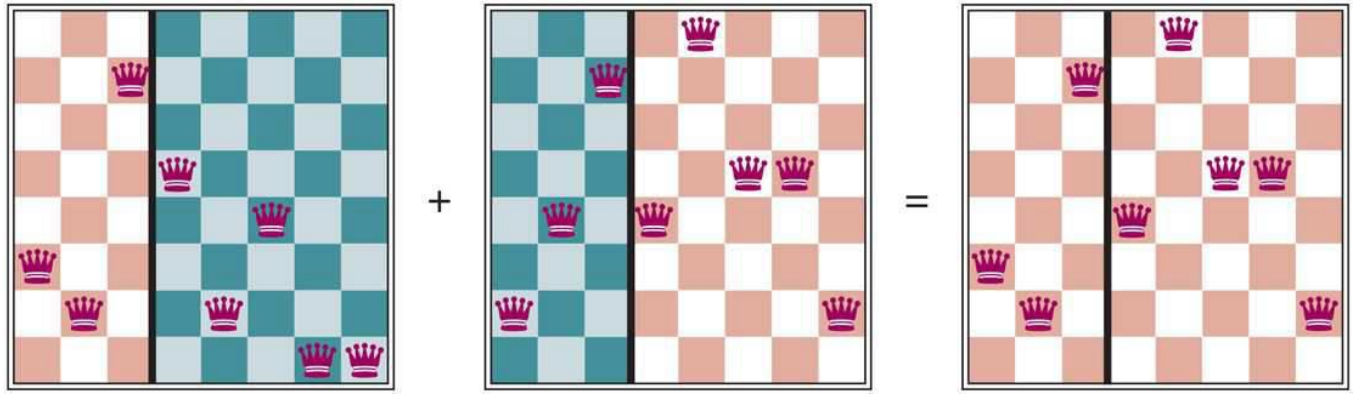


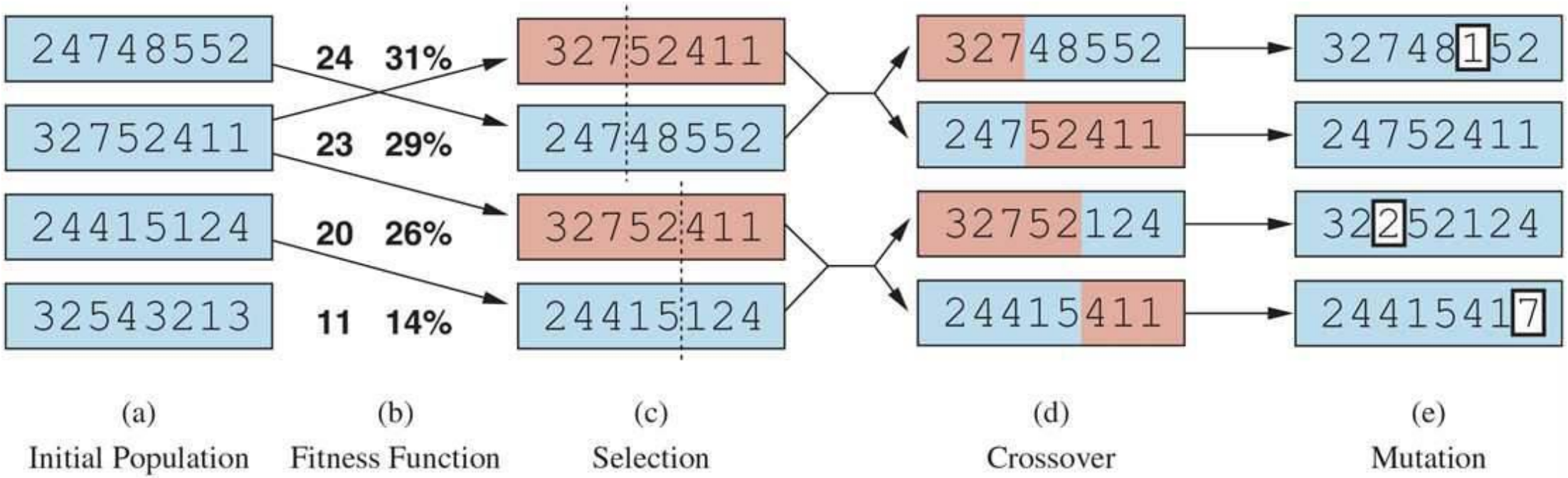
Max value of fitness function?
28

Selection based on Fitness Value

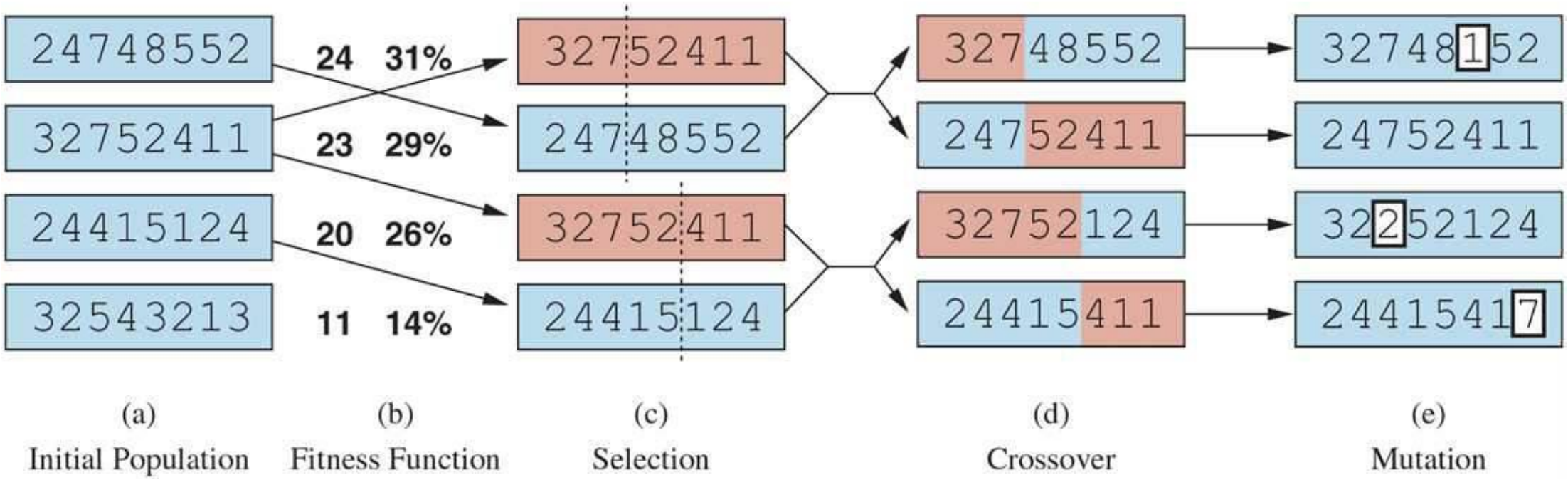


Crossover




24748552
32752411
24415124
32543213
24 31%
23 29%
20 26%
11 14%
32752411
24748552
32752411
24415124
32748552
24752411
32752124
24415411
32748152
24752411
32252124
24415417
(a)
Initial Population
(b)
Fitness Function
(c)
Selection
(d)
Crossover
(e)
Mutation

Mutation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(a)
Initial Population
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Fitness Function
(c)
Selection
(d)
Crossover
(e)
Mutation

Genetic Algorithm

- https://algorithmsinreallife.wordpress.com/2020/05/15/genetic-algorithm/

```
function GENETIC-ALGORITHM(population, fitness) returns an individual
  repeat
    weights ← WEIGHTED-BY(population, fitness)
    population2 ← empty list
    for i = 1 to SIZE(population) do
      parent1, parent2 ← WEIGHTED-RANDOM-CHOICES(population, weights, 2)
      child ← REPRODUCE(parent1, parent2)
      if (small random probability) then child ← MUTATE(child)
      add child to population2
    population ← population2
  until some individual is fit enough, or enough time has elapsed
  return the best individual in population, according to fitness

function REPRODUCE(parent1, parent2) returns an individual
  n ← LENGTH(parent1)
  c ← random number from 1 to n
  return APPEND(SUBSTRING(parent1, 1, c), SUBSTRING(parent2, c + 1, n))
```