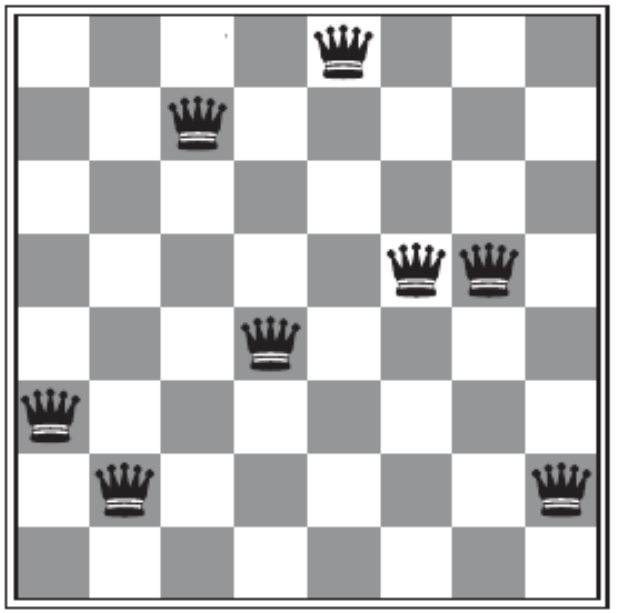
8-queens problem



3 2 7 4 8 5 5 2

Notion of completeness

- Completeness of a search algorithm

Notion of completeness

- Completeness of a search algorithm
- Is steepest ascent hill climbing complete?

Travelling salesman problem

n

$n!$

$(1, 2, .. n)$

$10! = 3628800$

$(2, 8, 1, \ldots)$

$20! = 2.433 \times 10^{18}$

$(4, 3, 1, 5, 2)$ $(4, 5, 1, 3, 2)$

$^{n}C_{2}$

Simulated Annealing

Q. Suppose we are at state A initially and $f(\cdot)$ is the fitness function. There are two neighbouring states B and C such that:

1. $f(B) - f(A) < 0$ and $f(C) - f(A) < 0$.
2. $|f(B) - f(A)| \ll |f(C) - f(A)|$.

Simulated Annealing

Q. Suppose we are at state A initially and $f(\cdot)$ is the fitness function. There are two neighbouring states B and C such that:

1. $f(B) - f(A) < 0$ and $f(C) - f(A) < 0$.
2. $|f(B) - f(A)| \ll |f(C) - f(A)|$.

a. Initially when T is large and current state is A which state is more likely to be the next state: B or C?

Simulated Annealing

Q. Suppose we are at state A initially and $f(\cdot)$ is the fitness function. There are two neighbouring states B and C such that:

1. $f(B) - f(A) < 0$ and $f(C) - f(A) < 0$.
2. $|f(B) - f(A)| \ll |f(C) - f(A)|$.

a. Initially when T is large and current state is A which state is more likely to be the next state: B or C?

b. As temperature decreases and current state is A which state becomes more likely to be the next state: B or C?

Simulated Annealing

Q. Suppose we are at state A initially and $f(\cdot)$ is the fitness function. There are two neighbouring states B and C such that:

1. $f(B) - f(A) < 0$ and $f(C) - f(A) < 0$.
2. $|f(B) - f(A)| \ll |f(C) - f(A)|$.

a. Initially when T is large and current state is A which state is more likely to be the next state: B or C?

b. As temperature decreases and current state is A which state becomes more likely to be the next state: B or C?

c. When temperature becomes very small and current state is A which state becomes more likely to be the next state: B or C?

More applications of Local search

- VLSI layout problem
  - optimize area (yield), power dissipation, etc.

More applications of Local search

- VLSI layout problem
  - optimize area (yield), power dissipation, etc.
- Factory layout problem
  - Minimize total transportation of materials

Beam search

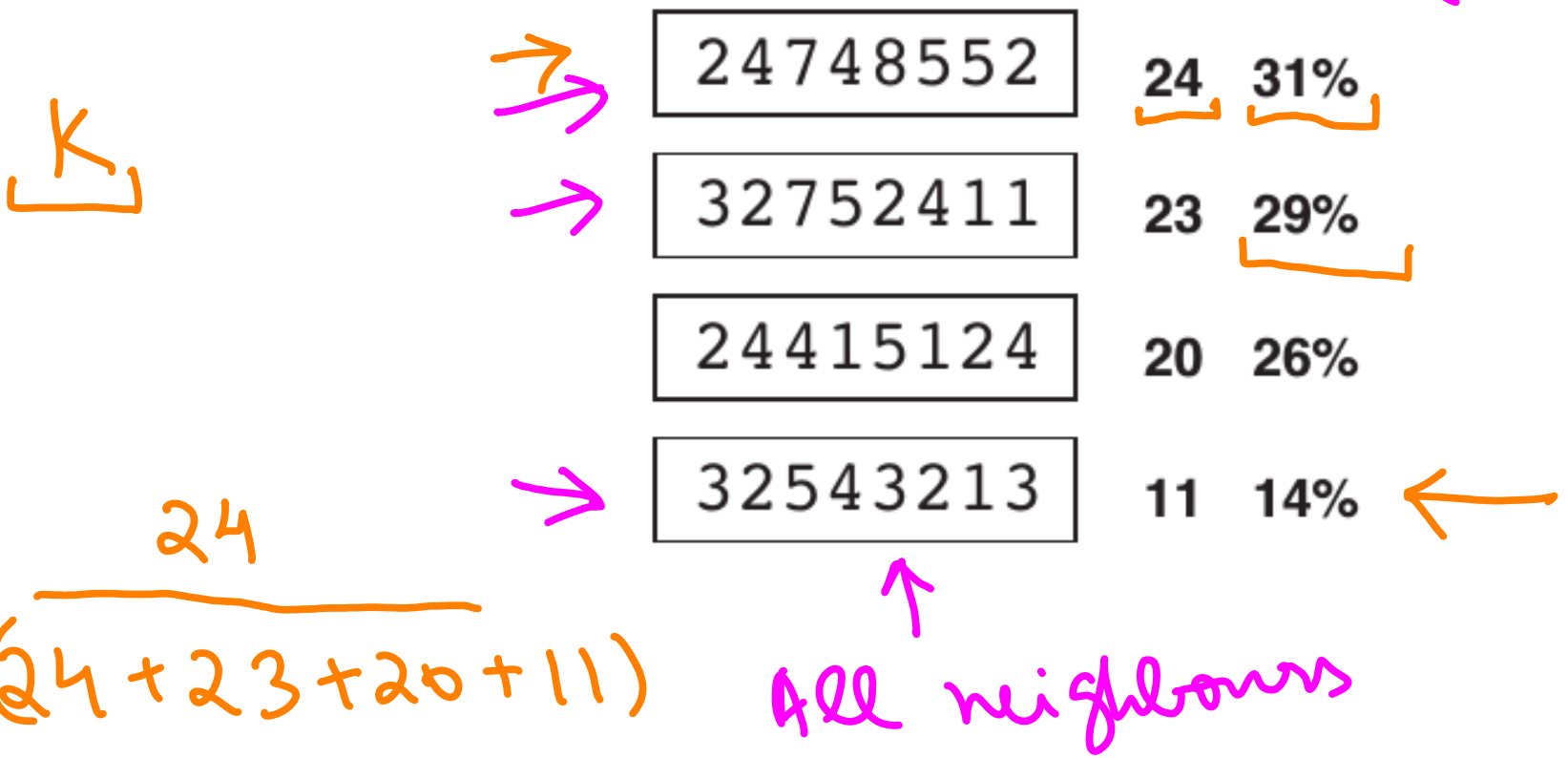
- **Local beam search**

K

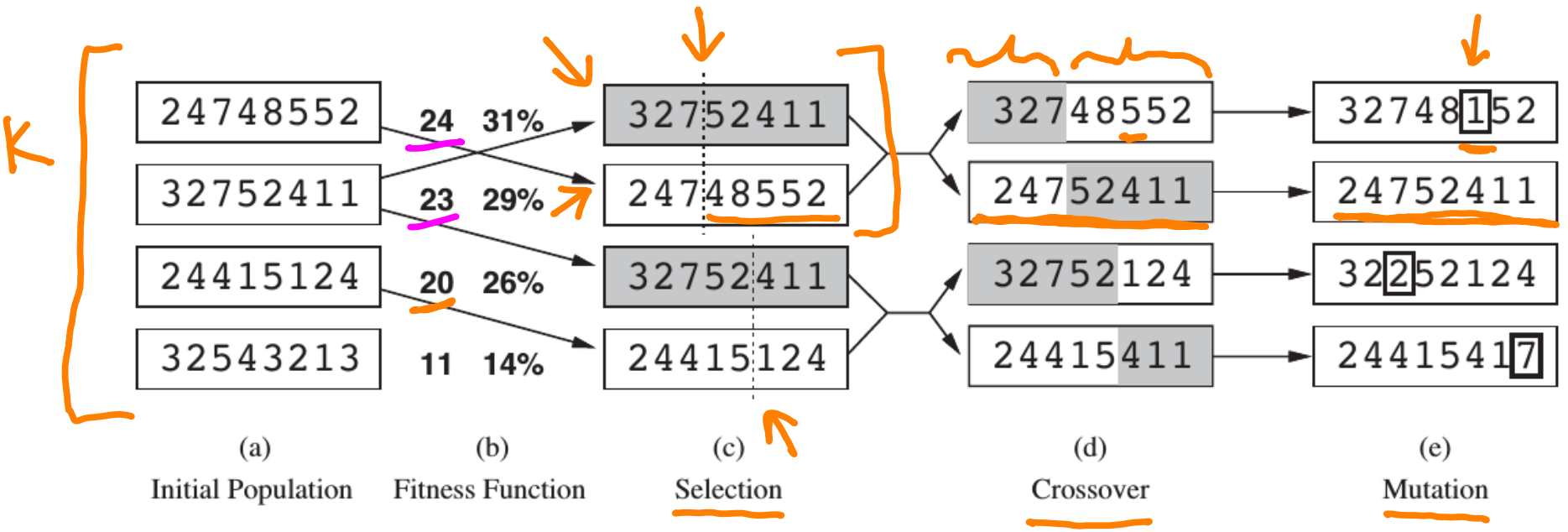
best 'K'

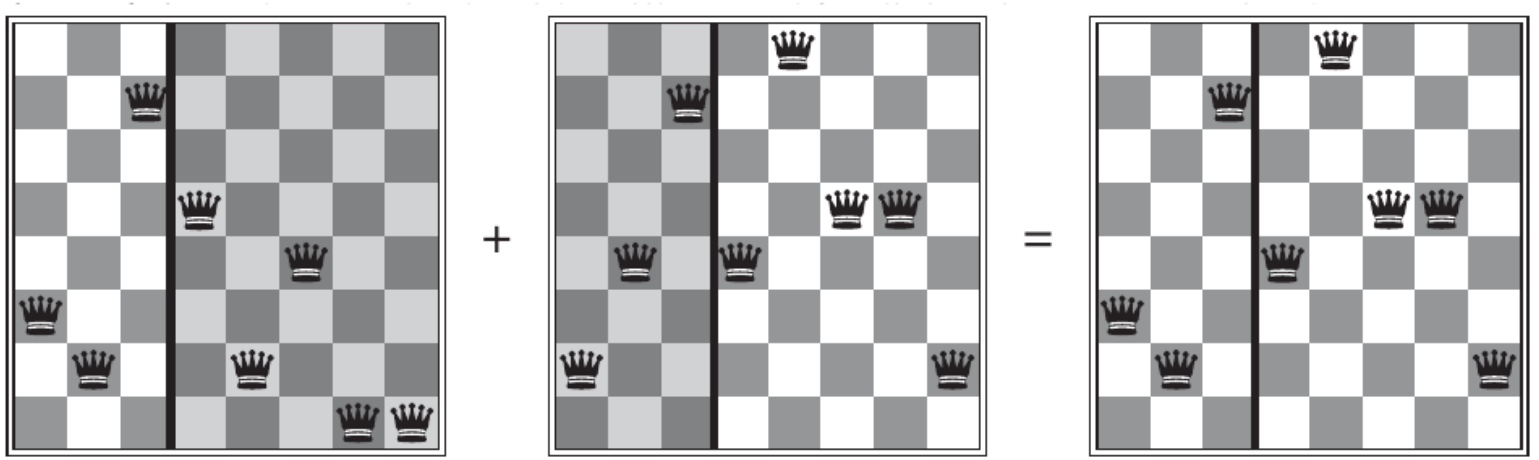
Beam search

- **Local beam search**
- **Stochastic beam search**



Genetic Algorithm





Genetic Algorithm

function GENETIC-ALGORITHM(*population*, FITNESS-FN) **returns** an individual
inputs: *population*, a set of individuals
FITNESS-FN, a function that measures the fitness of an individual

repeat
new_population ← empty set
for $i = 1$ **to** SIZE(*population*) **do**
x ← RANDOM-SELECTION(*population*, FITNESS-FN)
y ← RANDOM-SELECTION(*population*, FITNESS-FN)
child ← REPRODUCE(x, y)
if (small random probability) **then** *child* ← MUTATE(*child*)
add *child* to *new_population*
population ← *new_population*
until some individual is fit enough, or enough time has elapsed
return the best individual in *population*, according to FITNESS-FN

Genetic Algorithm

- Stochastic beam search vs. Genetic Algorithm

  Which algorithm will find a good solution in a faster manner?

Genetic Algorithm

- Stochastic beam search vs. Genetic Algorithm

  Which algorithm will find a good solution in a faster manner?

- What if we randomly permute each parent before crossover? Will the algorithm work?

Genetic Algorithm

- Stochastic beam search vs. Genetic Algorithm

  Which algorithm will find a good solution in a faster manner?
- What if we randomly permute each parent before crossover? Will the algorithm work?
- GA : schema and instances

Genetic Algorithm

- Stochastic beam search vs. Genetic Algorithm

  Which algorithm will find a good solution in a faster manner?
- What if we randomly permute each parent before crossover? Will the algorithm work?
- GA : schema and instances
- If average fitness of the instances of a schema is above mean, then the number of instances of the schema in the population will grow over time.

Genetic Algorithm

- Stochastic beam search vs. Genetic Algorithm

  Which algorithm will find a good solution in a faster manner?
- What if we randomly permute each parent before crossover? Will the algorithm work?
- GA : schema and instances
- If average fitness of the instances of a schema is above mean, then the number of instances of the schema in the population will grow over time.
- Succesful use of GA requires careful engineering of representation.