HOCHSCHULE
HANNOVER
UNIVERSITY OF
APPLIED SCIENCES
AND ARTS
–
Fakultät IV
Wirtschaft und
Informatik

Artificial Feeding Birds

Metaheuristic for TSP and SOP

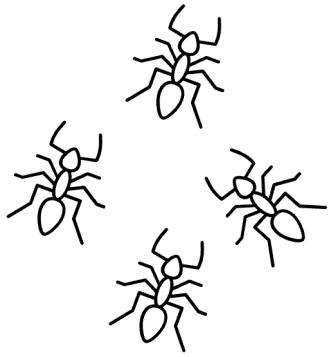
Pit Hüne; Tim Cares, 24.10.2023

Inhaltsverzeichnis

Inhaltsverzeichnis

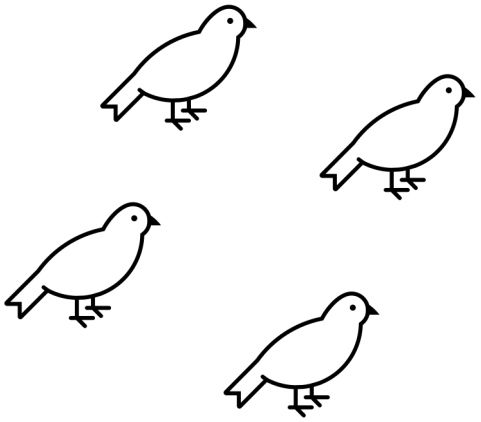
Motivation

- Swarm intelligence
  - Allows a search of the solution space with simple strategies
  - Can yield complex behavior for multiple agents (e.g. ants)

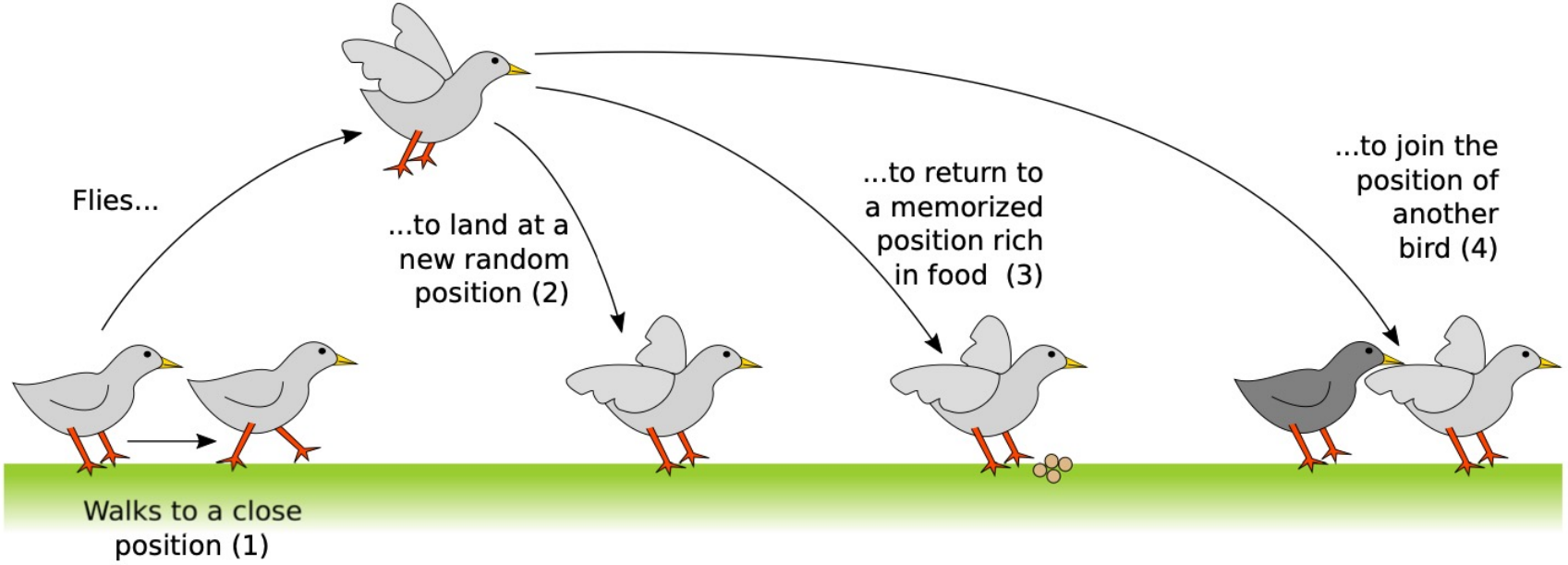


- Inspiration for Artificial Feeding Birds: Pigeons searching for food
  - Behaviors common in nature are more generally effective than rare ones

- Each pigeon (agent) can have the following behavior:
  - Walk a small distance
  - Fly to an arbitrary position
  - Return to a food source
  - Join another bird



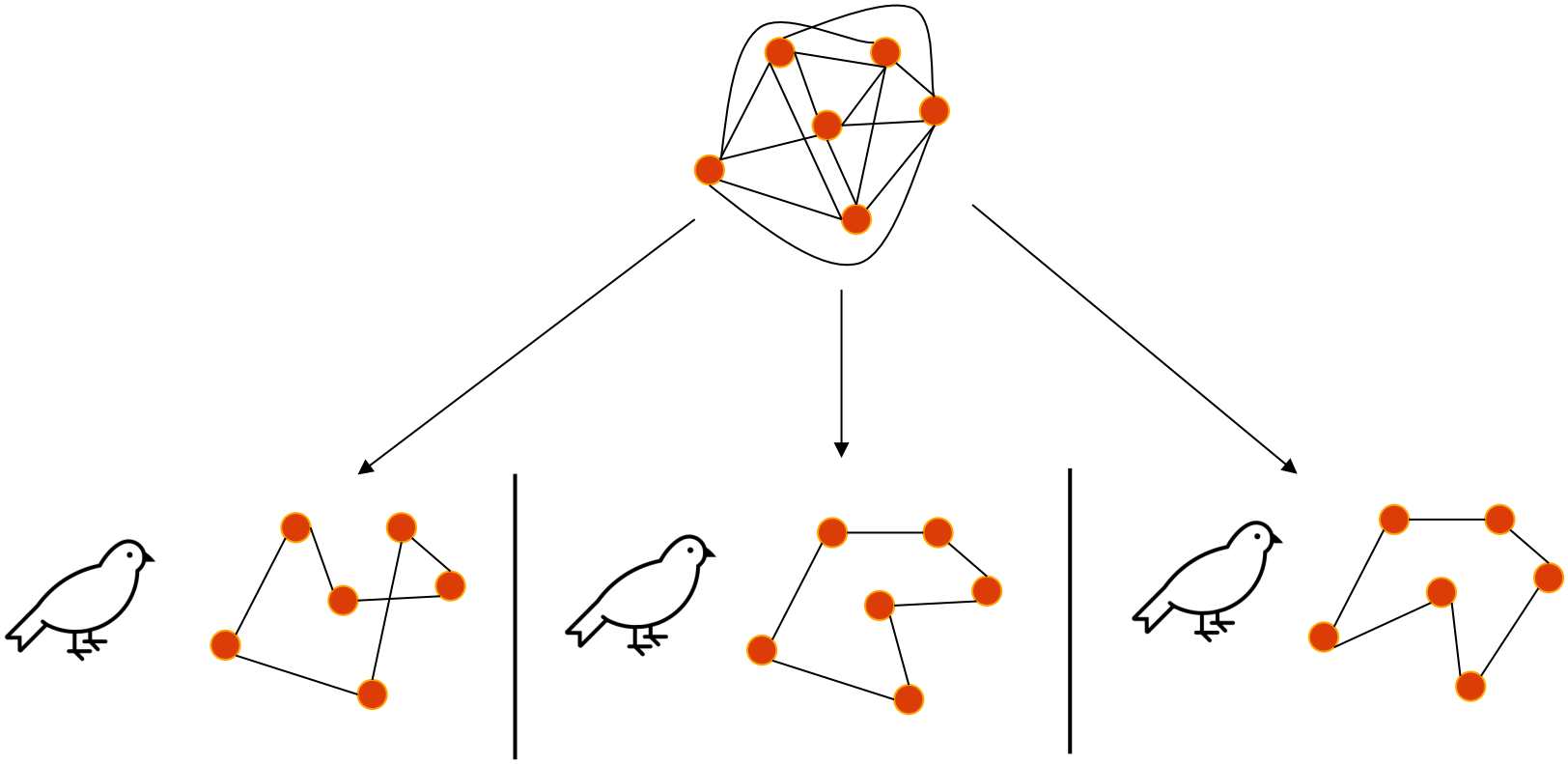
Motivation


Flies...
...to land at a new random position (2)
...to return to a memorized position rich in food (3)
...to join the position of another bird (4)
Walks to a close position (1)

Inhaltsverzeichnis

From Birds to TSP

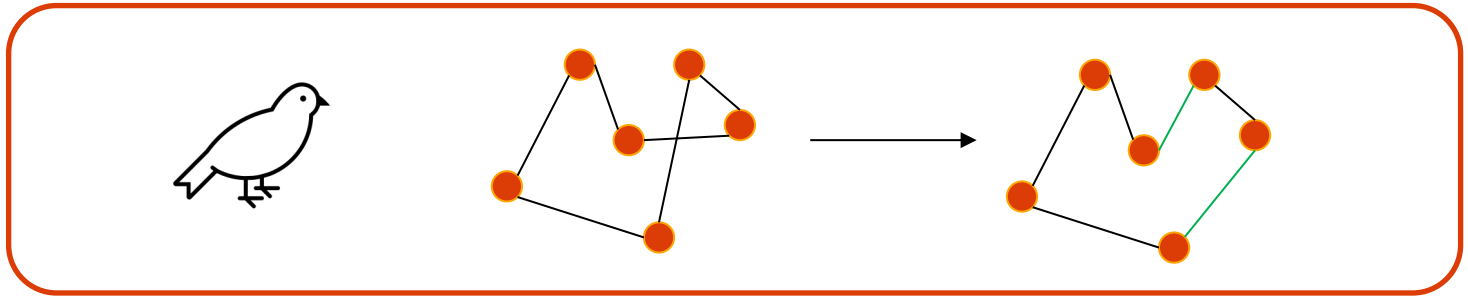
- Each Birds represents one possible solution (one tour)
- Each operation performed by a bird, alters its respective solutions



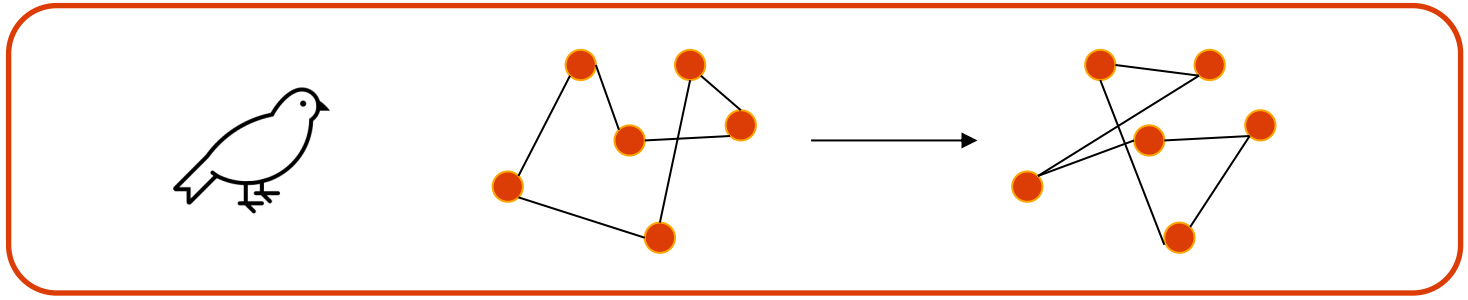
From Birds to TSP

- Each action of a bird corresponds to a change of its own solution
- Each solution is valid
- The number of candidate solutions (or agents respectively) does not change (currently)

(1) Walk

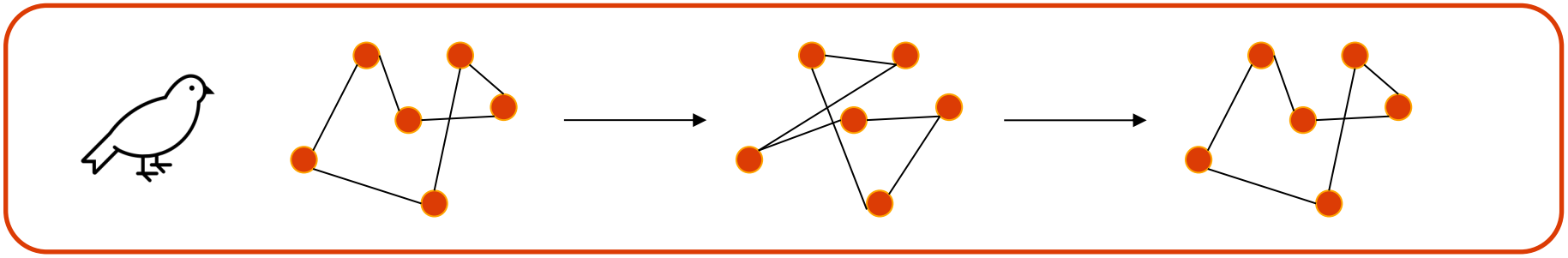


(2) Fly

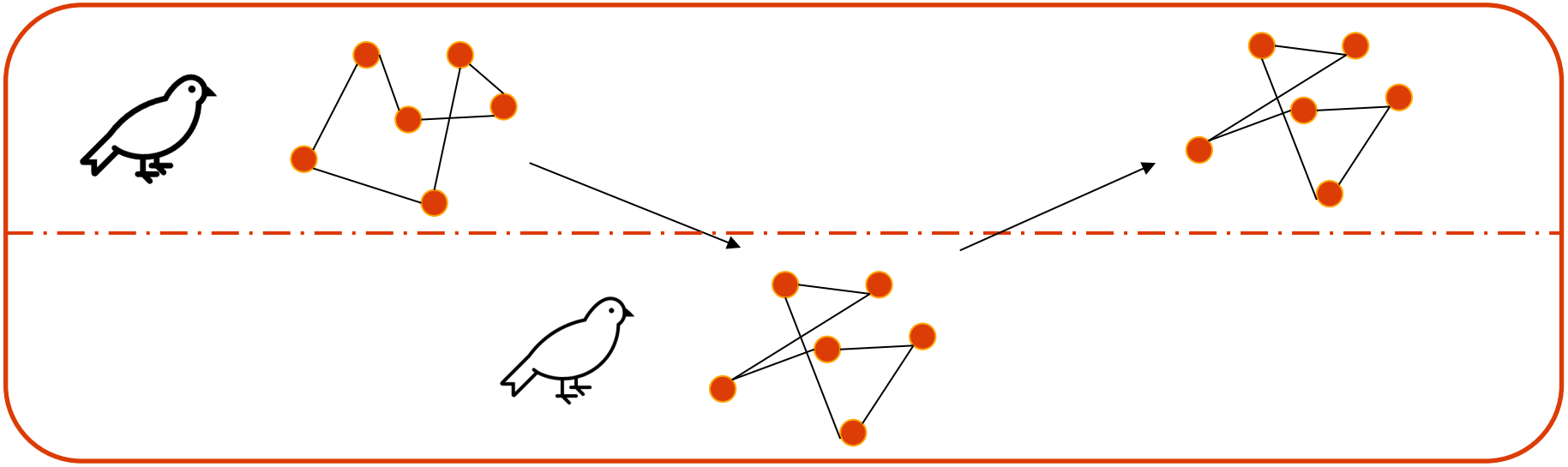


From Birds to TSP

(3) Return



(4) Join

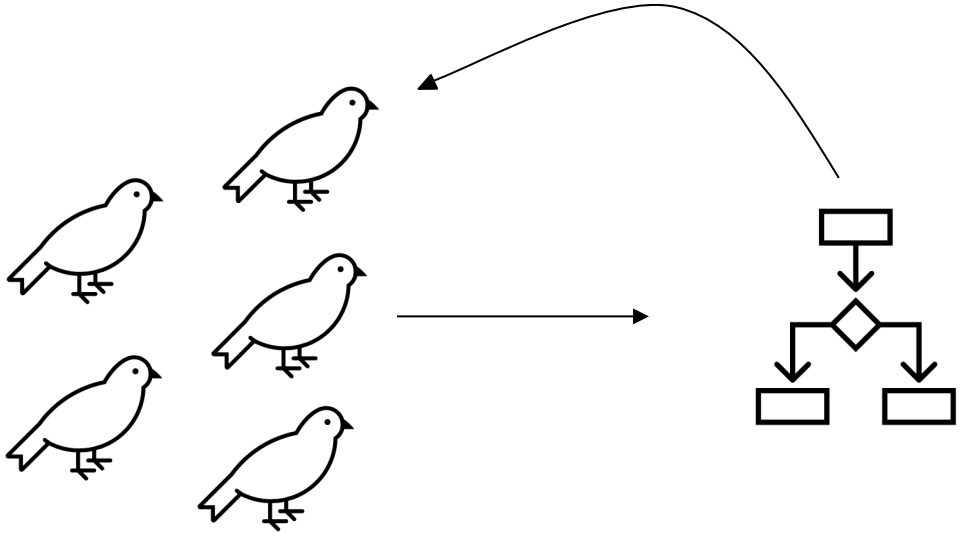


Inhaltsverzeichnis

Algorithm

Preconditions

- The algorithm runs in iterations
- How many it runs must be set beforehand

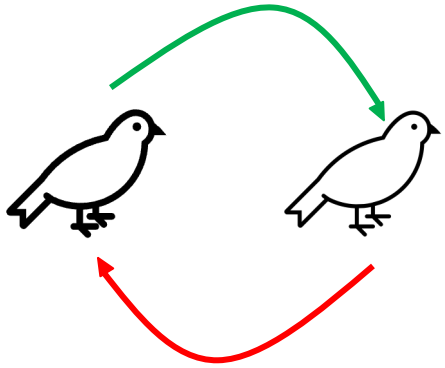


- In each iteration all birds perform one of the 4 moves
- The number of birds must be set beforehand

- One iteration ≠ All birds move once
- One iteration = The cost of any tour is calculated
  - Return (3) and Join (4) are not counted as an iteration

Algorithm

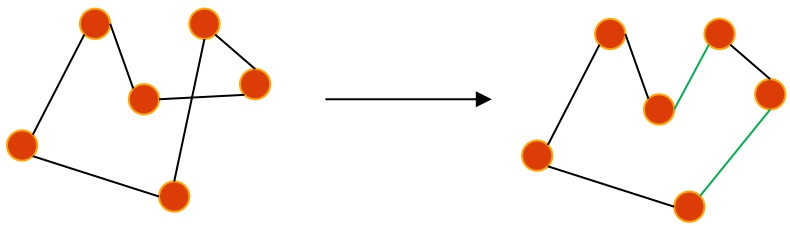
Preconditions



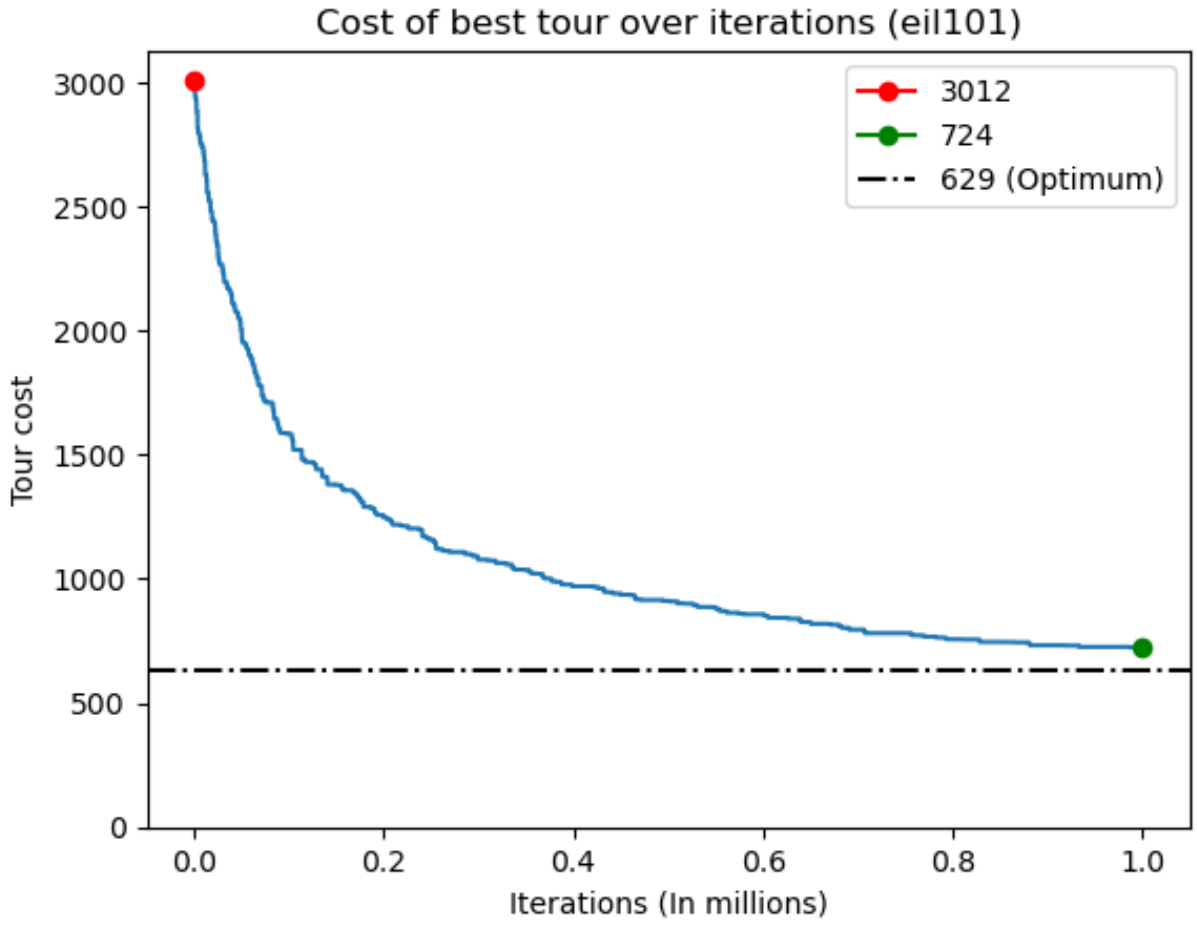
- There are ”big” and “small” birds
  - Ratio set beforehand
- Only a big bird can join a small bird

- Which action an agent (bird) performs depends on the probability of the move
  - The probability for a move is a hyperparameter

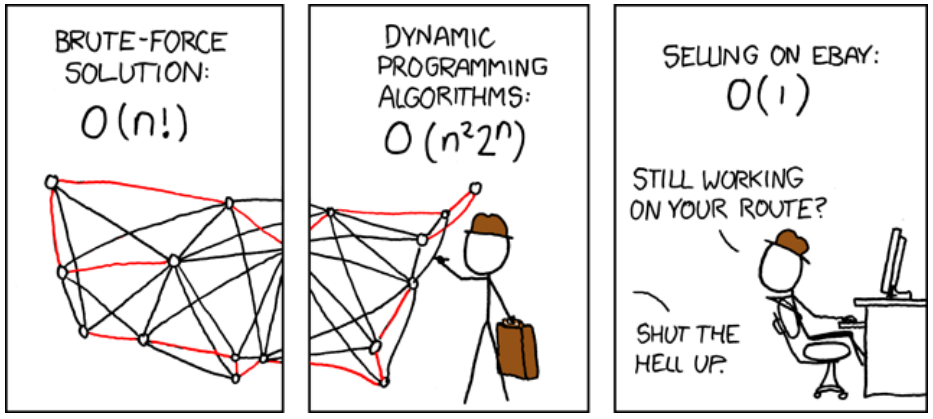
- A bird walks, if
  1. He currently resides at his best solution
  2. If he flew beforehand
  3. If the action ‘walk’ was randomly selected



Algorithm
Initial Results



Vielen Dank für Ihre Aufmerksamkeit!



Source: https://www.explainxkcd.com/wiki/index.php/399:_Travelling_Salesman_Problem

Literature

- Jean-Baptiste Lamy. Artificial Feeding Birds (AFB): a new metaheuristic inspired by the behavior of pigeons. Advances in nature-inspired computing and applications, 2019, 10.1007/978-3-319-96451- 5_3 . hal-02264232

Algorithm

Variable	Meaning
x	Current tour
f	Cost of current tour
X	Best tour
F	Cost of best tour
s	Big bird?
m	Previous move

Algorithm 1 The AFB metaheuristic in pseudo-code.

For $1 \leq i \leq n$:
  $x_i = X_i = fly()$
  $f_i = F_i = cost(x_i)$
  $m_i = 2$
  $s_i = 0$ if $i \leq r \times n$, 1 otherwise

Repeat:
  For $1 \leq i \leq n$:
    If $m_i \in \{2, 3, 4\}$ or $f_i = F_i$:
      $p = 1$
    Else, if $s_i = 0$:
      $p =$ random real number between $p4$ and 1
    Else:
      $p =$ random real number between 0 and 1

Algorithm

Variable	Meaning
x	Current tour
f	Cost of current tour
X	Best tour
F	Cost of best tour
s	Big bird?
m	Previous move

If $p \geq p_2 + p_3 + p_4$:
  $m_i = 1$
  $x_i = walk(i)$
  $f_i = cost(x_i)$
Else, if $p \geq p_3 + p_4$:
  $m_i = 2$
  $x_i = fly()$
  $f_i = cost(x_i)$
Else, if $p \geq p_4$:
  $m_i = 3$
  $x_i = X_i$
  $f_i = F_i$
Else:
  $m_i = 4$
  $j =$ random integer number between 1 and n, with $j \neq i$
  $x_i = x_j$
  $f_i = f_j$

If $f_i \leq F_i$:
  $X_i = x_i$
  $F_i = f_i$

Check stopping condition

The best solution found is X_k, with $1 \leq k \leq n$ such as $F_k = min(\{F_i \mid 1 \leq i \leq n\})$