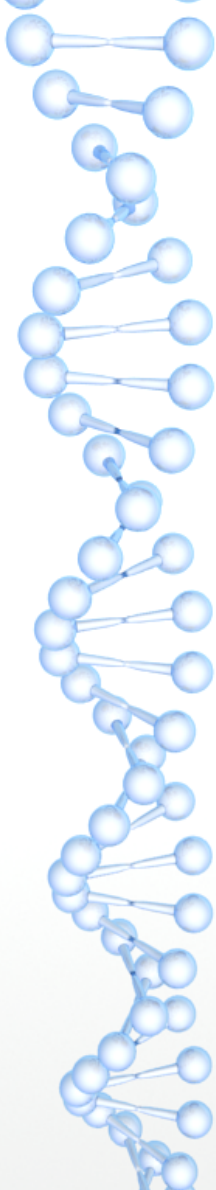
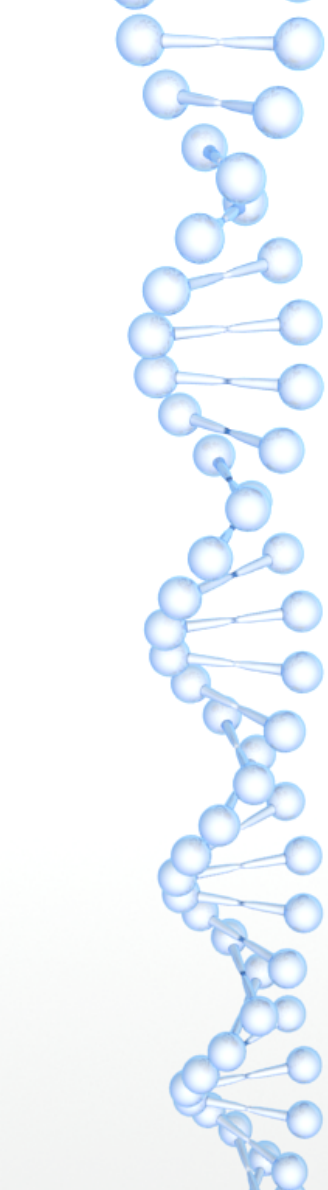


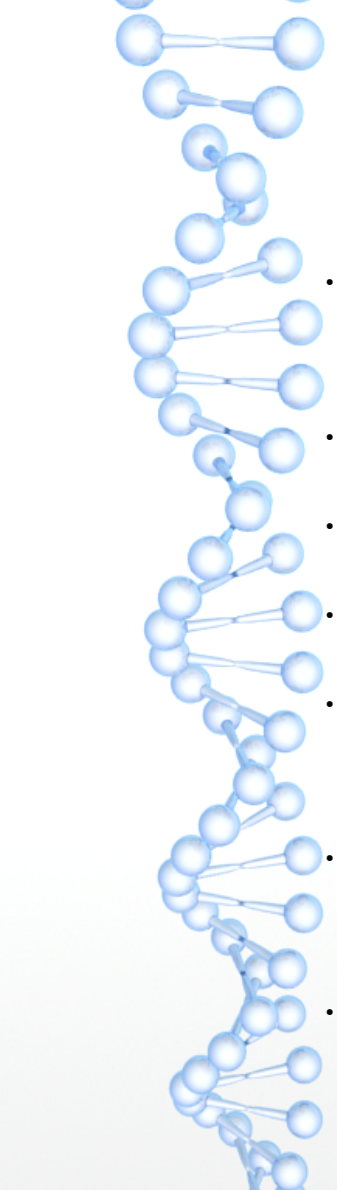
Artifical Bee Colony

Josef Raška



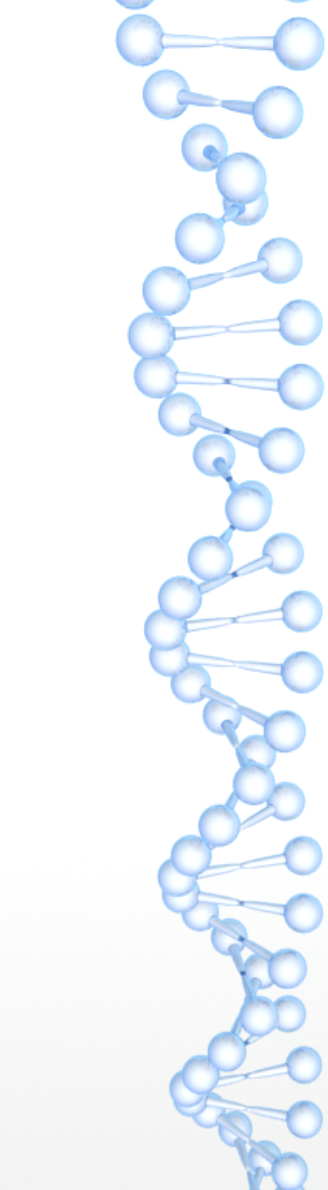
Introduction

- Introduced by Dr. Dervis Karatoga 2005
- Inspired by honey bee colonies
- Searching algorithm
- Self-organising collective intelligence
- Used for optimizing numerical problems, system control, image classification, internet traffic flow analysis, neural networks training and much more



Algorithm

- Goal is to find vector of parameters for given objective function getting minimal value
- Dimension of search space == size of parameters vector
- Food sources(vectors) are randomly initialized in search space
- Employed bees search for food and remember best solution
- Onlooker bees probabilistically select food based on employed bees information and perform search for neigbour solution
- Scouts randomly search solution space, emloyed bee which solution was not improved many times become scout
- Food search continues until search criteria are reached



Math – The problem

Minimize $f(\vec{x}), \vec{x}=(x_1, x_2, \ldots, x_i, \ldots, x_{n-1}, x_n) \in \mathbb{R}^n$

constrained by:

$$l_i \leq x_i \leq u_i, i=1, \ldots, n$$

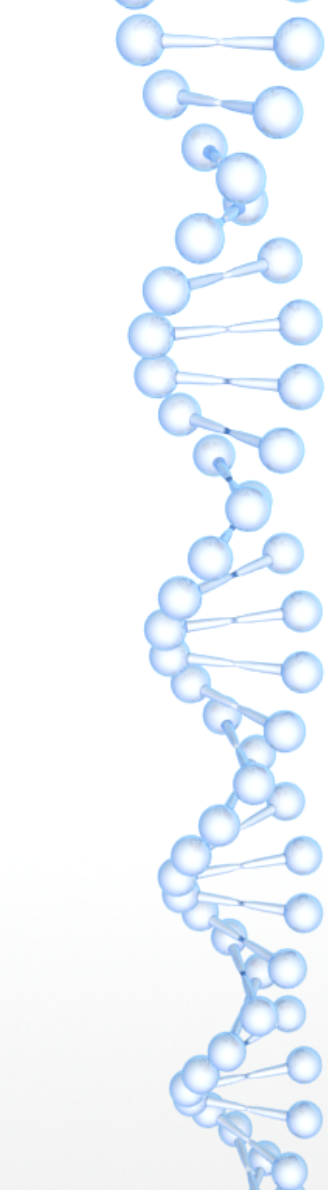
subject to

$$g_j(\vec{x}) \leq 0, for\ j=1, \ldots, p$$

$$h_j(\vec{x}) = 0, for\ j=p+1, \ldots, q$$

We call constrained search space $S^n \in \mathbb{R}^n$

p and q can be 0.



Math –Initialization

Let SN be population size, we randomly initialize all food sources $\vec{x}_m, m = 1, \ldots, n$

$$x_{mi} = l_i + rand(0,1) \cdot (u_i - l_i)$$

Math – Employee bees search

- Employee bees have last solution in memory
- Finding neighbour food source

$$v_{mi} = x_{mi} + \phi_{mi}\left(x_{mi} - x_{ki}\right)$$

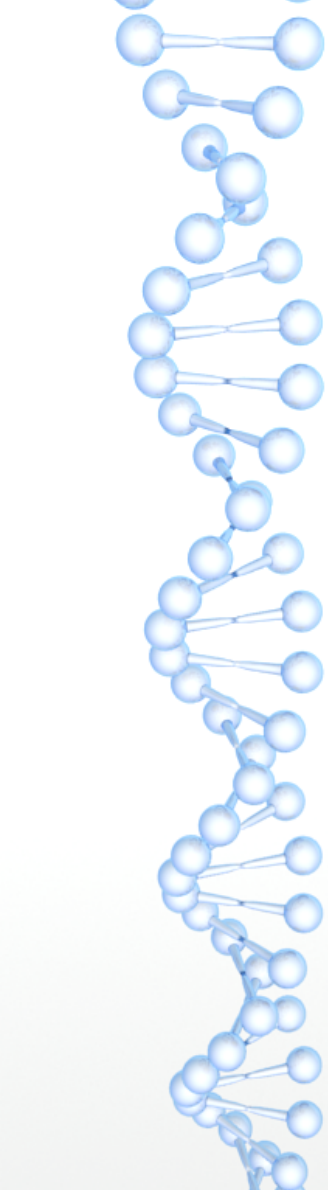
- where $\vec{x}_k$ is random food source and *i* is random index and ϕ_{mi} is random number between -α and α Then fitness is counted for both and better is chosen.

$$fit_m(\vec{x_m}) = \begin{cases} \dfrac{1}{1 + f_m(\vec{x_m})} & \text{if } f_m(\vec{x_m}) \geq 0 \\ 1 + abs(f_m(\vec{x_m})) & \text{if } f_m(\vec{x_m}) < 0 \end{cases}$$

Math – Onlooker bees

- Onlokers choose the food source based on employeed bees information nad search for neighbour solution.
- Probability of choosing food source *m*:

$$p_m = \frac{fit_m(\vec{x_m})}{\sum_{m=1}^{SN} fit_m(\vec{x_m})}$$



Scouts

- Employee bees keeps best found solution
- When there is no better solution after limit search, employed bee become scout
- Randomly search space as in initialization phase

Existing Literature

- Karaboga, D.
  An idea based on honey bee swarm for numerical optimization, 2005.
- Karaboga, D.; Basturk, B.
  A powerful and efficient algorithm for numerical function optimization: artificial bee colony (ABC) algorithm,
  2007, Journal of Global Optimization.
- Karaboga, D.; Gorkemli, B.; Ozturk, C,; Karaboga, N.
  A comprehensive survey: artificial bee colony (ABC) algorithm and applications,
  2014, Artificial Intelligence Review.

Existing Literature II

- Kang, F.; Li, J.; Xu, Q.
  Structural inverse analysis by hybrid simplex artificial bee colony algorithms,
  2009, Computers & Structures.
- Singh, A.
  An artificial bee colony algorithm for the leaf-constrained minimum spanning tree problem,
  2009, Applied Soft Computing.
- Alatas, B.
  Chaotic bee colony algorithms for global numerical optimization,
  2010, Expert systems and applications.

References

- Karaboga, D.
  Artificial bee colony algorithm
  Scholarpedia, 2010.
- Karaboga, D.
  An idea based on honey bee swarm for numerical optimization, 2005.
- Karabonga, D.
  Artificial Bee Colony Algorithm Homepage
  http://mf.erciyes.edu.tr/abc/

References II

- Burian, P.
  Uplatnění agentových kolon při ovládání a optimalizaci průmyslových procesů,
  2007, VŠCHT Praha.
- Chandrakala, D.; Sumathi, S.
  Application of Artificial Bee Colony Optimization Algorithm for Image Classification Using Color and Texture Feature Similarity Fusion,
  2012, Artificial Intelligence.