ARTIFICIAL BEE COLONY ALGORITHM

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- The artificial bee colony (ABC) algorithm is based on the behavior of bees and was first published in [Bastürk and Karaboga, 2006], [Karaboga and Bastürk, 2007].
- ABC is based on the **search by bees** for an optimal **food** source.
- The **location of a food source** is analogous to a **location in the search space** of an optimization problem.
- The **amount of nectar/honey** at a location is analogous to the **fitness of a candidate solution**.

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- ABC simulates three different types of bees.
- **Forager bees**, also called employed bees, travel back and forth between a food source and their hive.
- Each forager is **associated with a specific location**, and **remembers that location** as it travels back and forth between the hive.
- When a **forager takes its nectar to the hive**, it returns **to its food source**, but it **also engages in local exploration as it searches in the nearby vicinity for a better source**.

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- **Onlooker bees** are not associated with any particular food source, but they **observe the behavior of the foragers** when they return to the hive.
- **Onlookers** observe the **amount of nectar that is returned by the foragers** (that is, the **fitness of each forager's location** in search space), and use that information to decide **where to search for nectar**.
- The onlookers search location is decided **probabilistically based on their observations of the foragers**.

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- **Scout bees** are **explorers** and, like onlookers, are not associated with any particular food source.
- If a **scout sees that a forager has stagnated and is not progressively increasing the amount of nectar that it returns to the hive**, then the scout **randomly searches** for a new nectar source in the search space.
- **Stagnation** is indicated when the **explorer fails to increase the amount of nectar** it brings to the hive **after a certain number of trips**.

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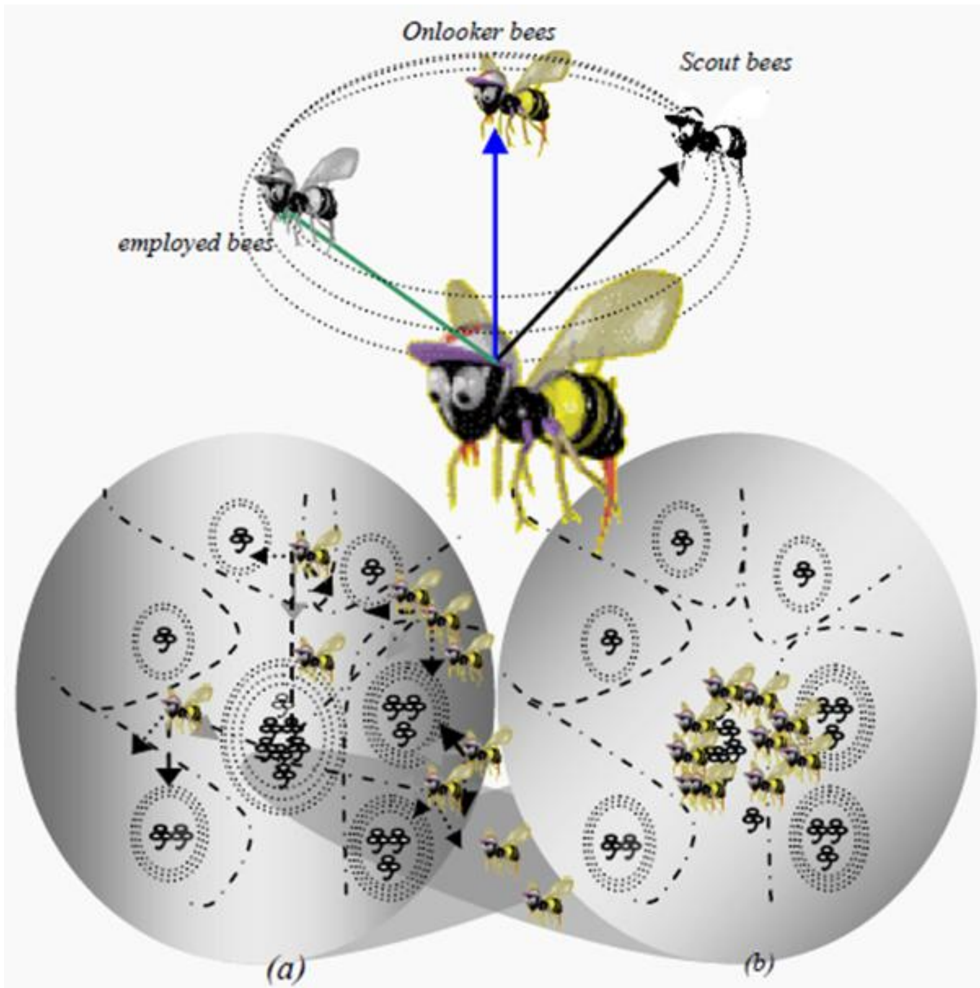

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- The key idea of the ABC algorithm is that **foraging, on-looking, and scouting** behaviors are simulated in the search for a global optimum

N = population size
Initialize the positive integer L, which is the stagnation limit
Initialize the forager population size $P_f < N$
Initialize the onlooker population size $P_o = N - P_f$
Initialize a random population of foragers $\{x_i\}$ for $i \in [1, P_f]$
Initialize the forager trial counters $T(x_i) = 0$ for $i \in [1, P_f]$

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While not(termination criterion)

Forager Bees:

For each forager x_i, $i \in [1, P_f]$

$k \leftarrow$ random integer $\in [1, N]$ such that $k \neq i$

$s \leftarrow$ random integer $\in [1, n]$

$r \leftarrow U[-1, 1]$

$v_i(s) \leftarrow x_i(s) + r(x_i(s) - x_k(s))$

If $f(v_i)$ is better than $f(x_i)$ then

$x_i \leftarrow v_i$

$T(x_i) \leftarrow 0$

else

$T(x_i) \leftarrow T(x_i) + 1$

End if

Next forager

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Onlooker Bees:

For each onlooker v_i, $i \in [1, P_o]$

Select a forager x_j, where $\Pr(x_j) \propto \text{fitness}(x_j)$ for $j \in [1, P_f]$

$k \leftarrow$ random integer $\in [1, P_f]$ such that $k \neq j$

$s \leftarrow$ random integer $\in [1, n]$

$r \leftarrow U[-1, 1]$

$v_i(s) \leftarrow x_j(s) + r(x_j(s) - x_k(s))$

If $f(v_i)$ is better than $f(x_j)$ then

$x_j \leftarrow v_i$

$T(x_j) \leftarrow 0$

else

$T(x_j) \leftarrow T(x_j) + 1$

End if

Next onlooker

$$pr(xi) = \frac{fit(xi)}{\sum_{i=1}^{pf} fit(xi)}$$

$$roulette - wheel - selection$$

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Scout Bees:

For each forager x_i, $i \in [1, P_f]$

    If $T(x_i) > L$ then

        $x_i \leftarrow$ randomly-generated individual

        $T(x_i) \leftarrow 0$

    End if

Next forager

Next generation

For further read

1. Karaboga, D., & Basturk, B. (2007). A powerful and efficient algorithm for numerical function optimization: artificial bee colony (ABC) algorithm. *Journal of global optimization*, *39*(3), 459-471.
2. Karaboga, D., & Basturk, B. (2008). On the performance of artificial bee colony (ABC) algorithm. *Applied soft computing*, *8*(1), 687-697.

Thank you