MONASH University

MONASH BUSINESS SCHOOL

Artificial Bee Colony (ABC) algorithm and Clustering

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Outline

1 Artificial Bee Colony (ABC)

2 Comparison

3 Clustering

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Phases

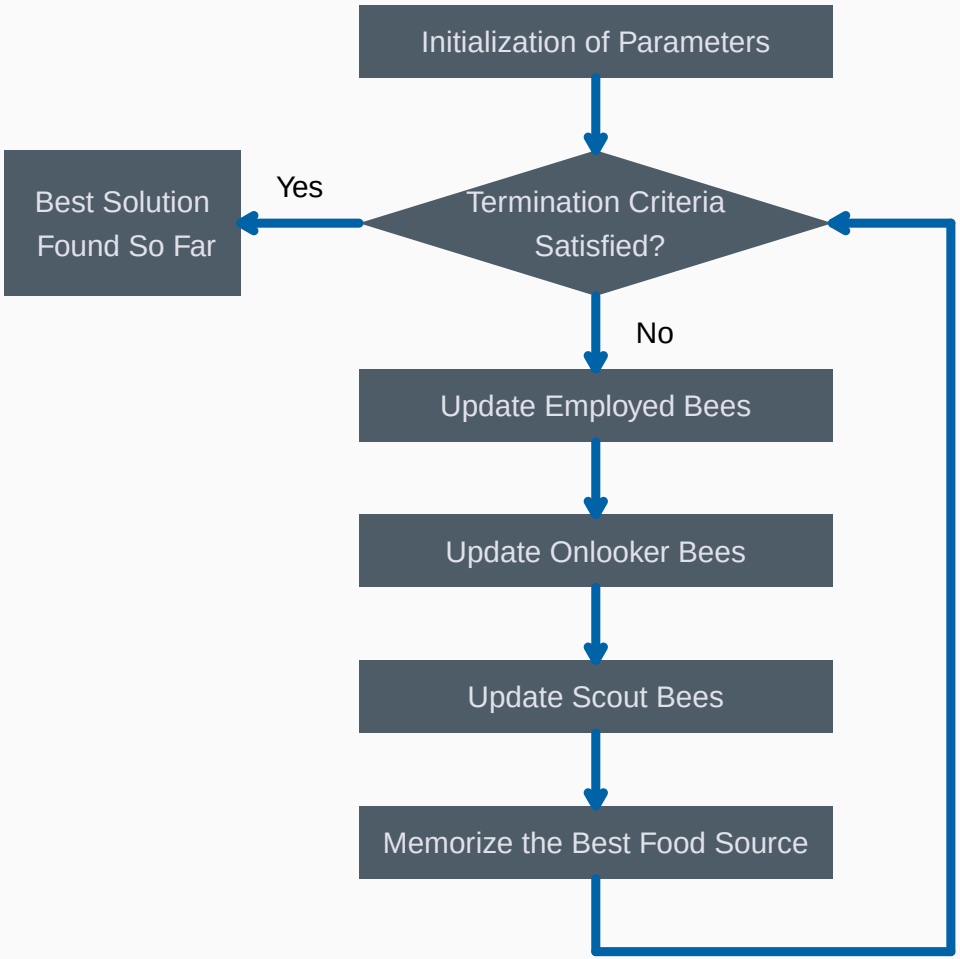

Figure 1: Phases of ABC. Source: Kumar, S. et al. (2014)

Initialization

```
1. Data
2. Generate the initial solution
3. Evaluate the nectar (fitness)
```

Parameters:

- The number of initial food sources $SN = 20$

Simulation:

- Initial solution input
- Initial food sources

Employed bees

```
4. While (Condition not met){
5. For each employed bee{
     Produce new solution
     Greedy selection }
```

Finding neighbour

$$\nu_{ij} = z_{ij} + \phi_{ij}(z_{ij} - z_{kj})$$

Employed bees

```
4. While (Condition not met){
5. For each employed bee{
     Produce new solution
     Greedy selection }
```

Calculate fitness

$$fit_i = \frac{1}{1 + f_i}$$

Onlooker bees

```
6. Calculate the probabilities of solution
7. For each onlooker bee{
    Select a solution using probabilities
    Produce new solution
    Greedy selection }
```

Calculate probabilities

$$p_i = \frac{fit_i}{\sum_{i=1}^{SN} fit_i}$$

Scout bees

```
8. Abandon non-improving solution
9. Replace it with new solution
```

Parameter:

- The limit: 40

Scout bees

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9. Replace it with new solution
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Parameter:

- The limit: 40

Finding new solution

$$z_i^j = z_{min}^j + \delta_i^j (z_{max}^j - z_{min}^j)$$

Stopping criteria

```
10. Record the best solution }
11. End
```

Parameters:

- Maximum number of iterations: 700
- Maximum number of unimproved global minimum: 200

Intensification vs Diversification

Local search

Create new solution from neighbours

- The employed bee
- The onlooker bee (with tendency)

Intensification vs Diversification

Local search

Create new solution from neighbours

- The employed bee
- The onlooker bee (with tendency)

Global search

Replace current solution using new solution found from solution space

- Abandon scheme
- The scout bee

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Escaping local optima

Simulated annealing:

- Being able to accept worse solution based on temperature

Escaping local optima

Simulated annealing:

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ABC:

- Abandon solution that does not improve for many iterations (combined with global search)

Reproduction

Genetic Algorithm:

- Selection
- Crossover
- Mutation
- Evaluation
- Update

Reproduction

Genetic Algorithm:

- Selection
- Crossover
- Mutation
- Evaluation
- Update

Each bee in ABC:

- Finding neighbour
- Creating new solution
- Calculating fitness
- Greedy selection

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Adjustment

Solution representation:

$k \times D$ matrix

Adjustment

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$k \times D$ matrix $\Rightarrow$ vector

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Standardization

$$z_{ij}^{*} = \frac{z_{ij}}{\max |z_{ij}|}$$

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Initialize different foods sources

- Evenly assigned across the solution space $\times$
- Randomly sampled between bounds $\times$

Adjustment

Solution representation:

$k \times D$ matrix $\Rightarrow$ vector

Standardization

$$z_{ij}^{*} = \frac{z_{ij}}{\max |z_{ij}|}$$

Initialize different foods sources

- Evenly assigned across the solution space $\times$
- Randomly sampled between bounds $\times$
- Sampled from the existing data points

Constraint and Relaxation

Minimum cluster size: $\frac{n}{2k}$

Too hard to find a solution so we:

- Simulate initial input solution up to 4000 times
- Initialize food sources up to 2500 times
- Globally search in the scout bee up to 2000 times

Constraint and Relaxation

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Too hard to find a solution so we:

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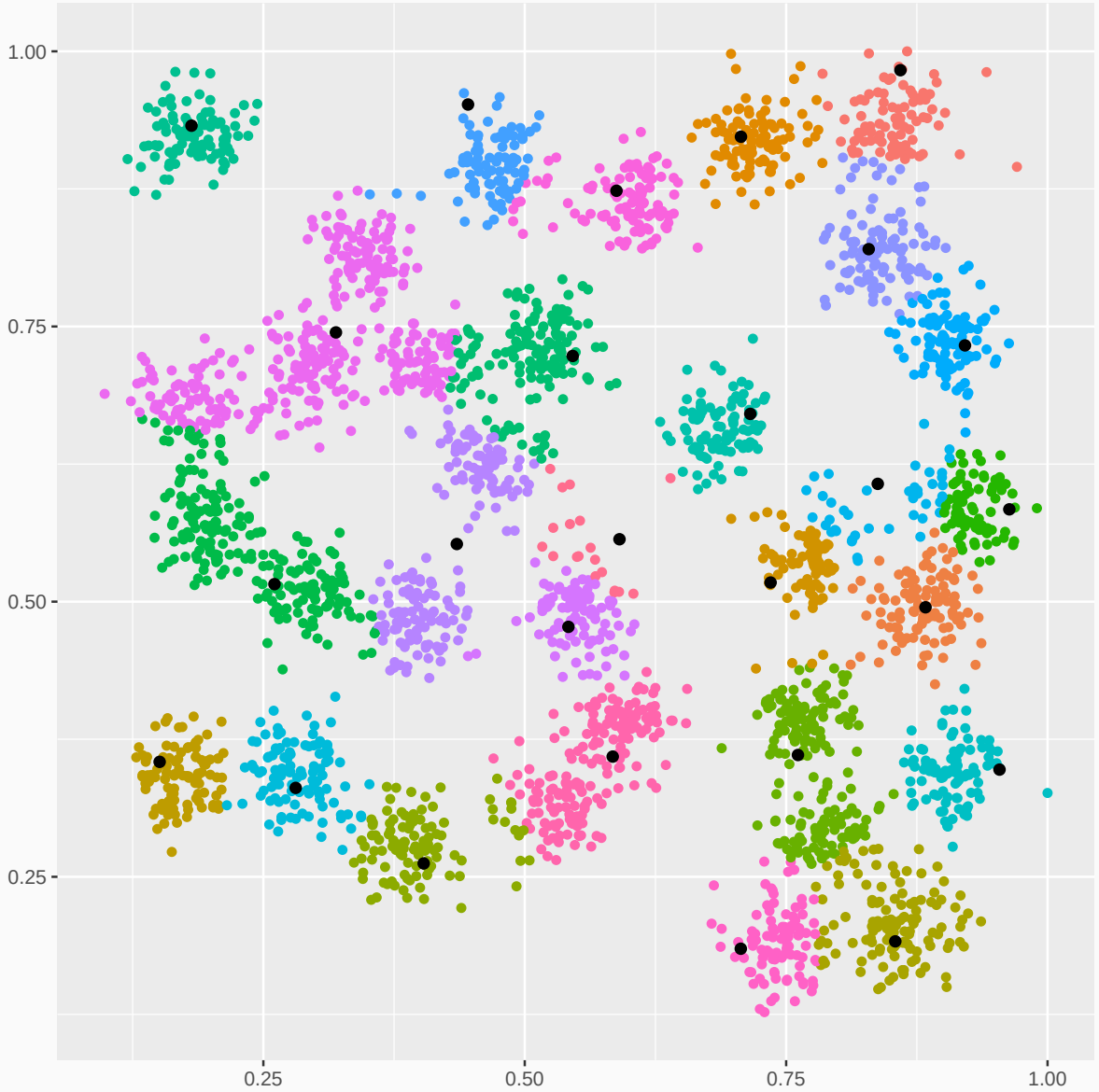
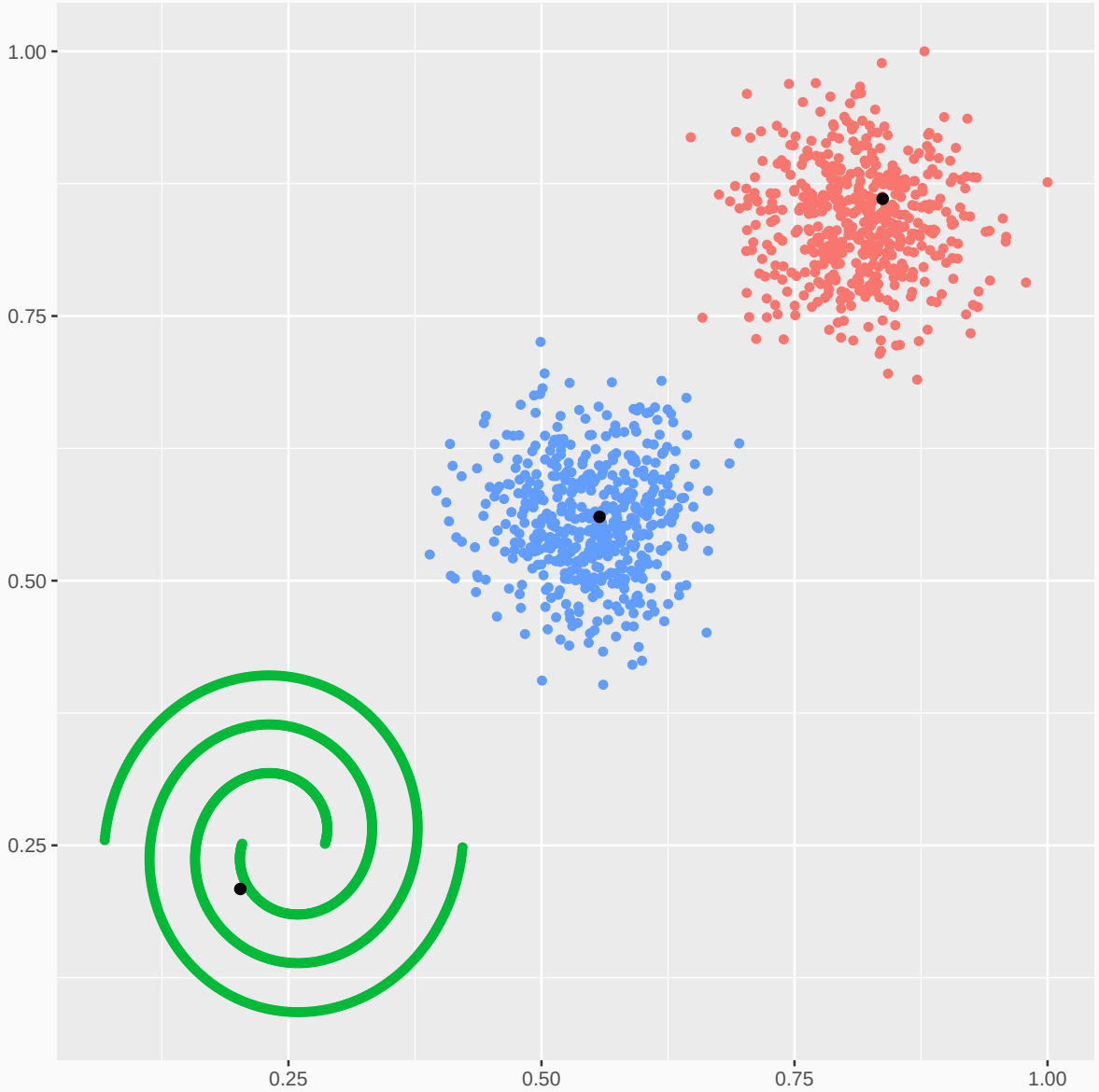
Minimum cluster size is relaxed to $\frac{n}{10k}$ if the algorithm reaches the first two condition

Result 1



Result 2



References i

Kumar, S., Sharma, V. K., & Kumari, R. (2014). Randomized memetic artificial bee colony algorithm. arXiv preprint arXiv:1408.0102.