Swarm Aggregation: Triangular Pattern Formation

(Assignment 01)

Course: RME-5105

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March 10, 2022

1 Problem Description

There are six swarm robots in two dimensional space. We have to model these swarms alike the pattern showed in Figure 1.
These are the equations that we have to follow:

$$
\begin{aligned}
x_i(t+1) &= x_i(t) + v_i(t+1) && (1)\\
v_i(t+1) &= wv_i(t) + f_i \\
f_i &= \sum_{j=1, j\neq i}^{M} f_i(i,j) && \text{(i=1,...,M)}
\end{aligned}
$$

Assuming $w = 0$ we define f_i such that:

$$f_i(i,j) = -(x_i - x_j)(a_{ij} - b_{ij}exp(-\frac{||x_i - x_j||^2}{c_ij}) \tag{2}$$

Here, a_{ij}, b_{ij}, c_{ij} is the constant for (i,j) pair. The equilibrium condition for $f_i(i,j)$ is:

$$\delta_{i,j} = \sqrt{c_{i,j} In \frac{b_{i,j}}{a_{i,j}}} \tag{3}$$

Here, $\delta_{i,j}$ is the comfortable distance between (i,j) pairs.
We consider equilateral traingle with length of $0.05, 0.025$ for the outermost and innermost triangle respectively.

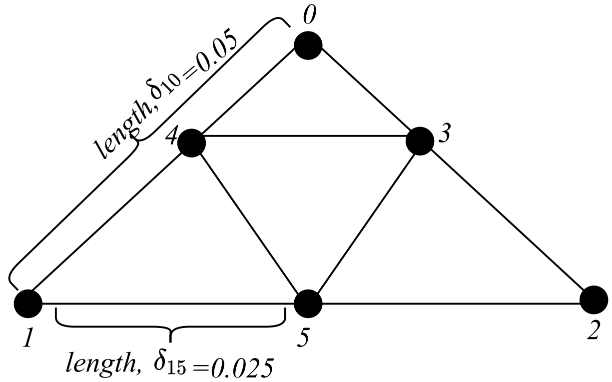

Figure 1: Triangular pattern of six swarms

2 Algorithm

Algorithm 1: Triangle formation using swarm aggregation

Data: Given distance between points d_{ij}
Result: Get formation of triangle based on those points
Function `tri`$_f ormation(N : int, d_{ij} : distance)$**:**

```
begin
for i ∈ 1, ..., N                                  // initialize the individuals
 do
   v_i ← 0;                                        // initialize velocity and position
   xi ←choose a random point of Ω ∈ ℝ²;
end
Define the attraction/repulsion parameters between each pair d_ij;
Assume a_ij, c_ij parameters                       // set parameters
;
d_ij = δ_ij;
compute b_ij based on using this equation δ_ij = sqrt(c_ij.ln(b_ij/a_ij));
repeat                                             // update the swarm
t ← t + 1;
for i ∈ 1, ..., N do
   v_i(t + 1) ← w.v_i(t) + f_i;                    // Define f_i functions in Equations 1 and 2
   x_i(t + 1) ← x_i(t) + v_i(t);
end
until termination criterion is fulfilled;
return x_i;                                        // return the best point found
End Function
```

3 Snap Shots

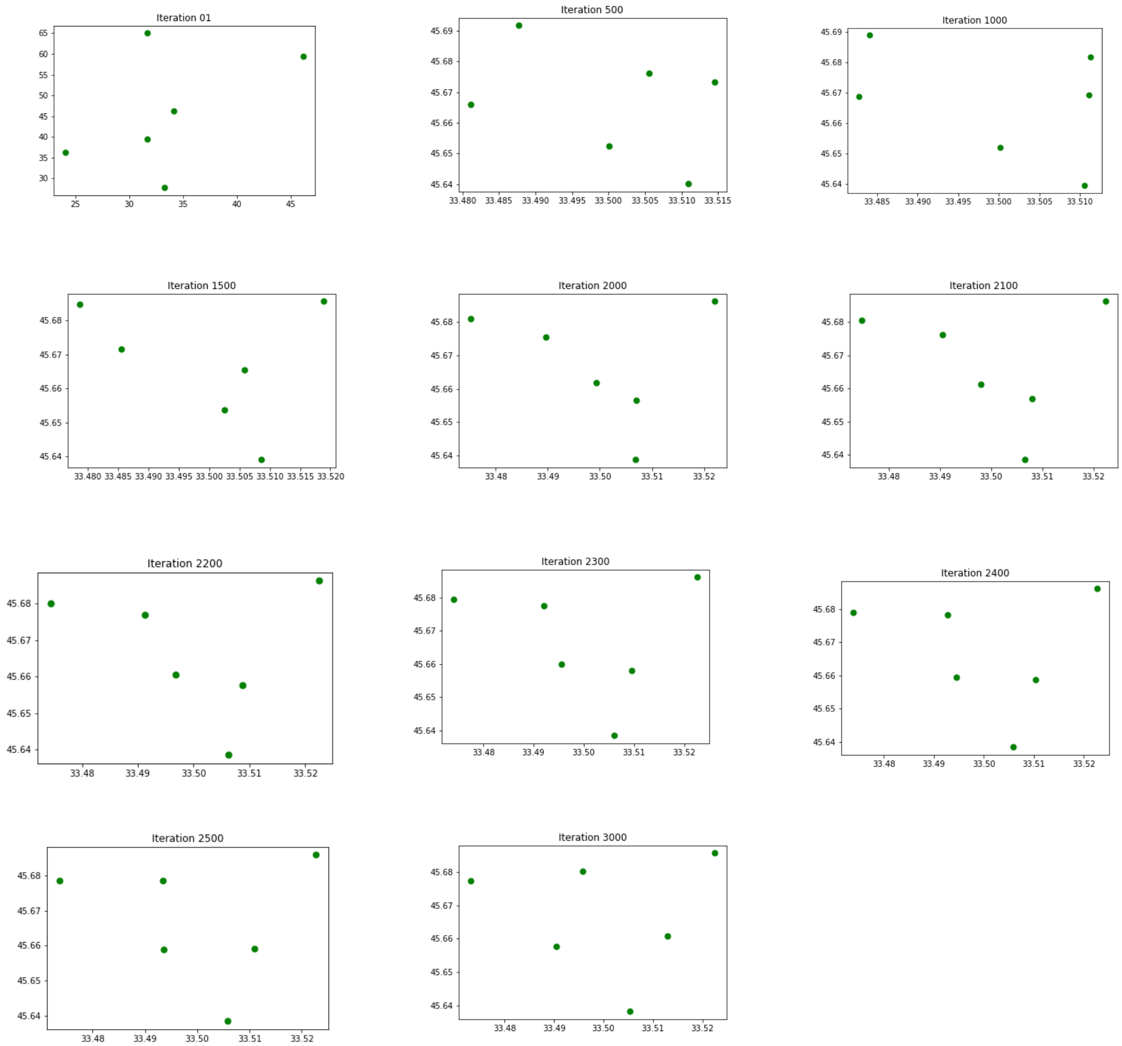

Figure 2: Triangular pattern formation: plotting