**PSO Algorithm:**

1. Create a ‘population’ of agents (particles) which is uniformly distributed over X by initiating the parameters as:

# number of variables

# since we're maximizing tensile strength

# number of particles

# max number of iterations

# inertia constant is set to 0.5 for both TS and FS

# cognitive constant

# social constant

2. Calculate TS and FS for full factorial using:

Where, **L** is Layer Thickness, **S** is Feed Rate and **D** is Infill Density from three-level full factorial

Find TSmax and FSmax for the TS and FS calculated.

3. Evaluate each particle’s position considering the multi-objective function (aiming to optimize the fitness value in each iteration):

4. If a particle’s present position is better than its previous best position, update it.

5. Find the best particle (according to the particle’s last best places).

6. Update particles’ velocities.

7. Move particles to their new positions.

8. Go to step 3 until the stopping criteria are satisfied, i.e., maximum iteration has reached.

Diagram

Description automatically generated

*Fig. 1: PSO Flowchart*

**BFO Algorithm:**

1. Initialize the parameters as:

# Ci

# number of elimination-dispersal steps

# number of reproduction steps

# number of chemotaxis steps

# number of swim steps for a given cell

# elimination cofficient

# attraction coefficients

#attraction weight

# repulsion coefficients, set equal to attraction cofficient

#repulsion coefficient

2. Calculate TS and FS for full factorial using:

Where, **L** is Layer Thickness, **S** is Feed Rate and **D** is Infill Density from three-level full factorial

Find TSmax and FSmax for the TS and FS calculated.

3. Evaluate each particle’s position considering the multi-objective function (aiming to optimize the fitness value in each iteration):

4. Initiate chemotaxis tumble/run until number of chemotaxis is less than Nc, go to step 2 if the value is greater than or equal to Nc.

5. If chemotaxis iteration is less than Nc, start reproduction until number of reproductions are less than Nre, go to step 2 if reproduction step is greater than or equal to Nre.

6. Elimination dispersal if the value is less than Ned, go to step 2 if the value is greater than or equal to Ned.

7. Stop when the number of chemotaxis steps are complete.

Diagram

Description automatically generated

*Fig. 2: BFO Flowchart*

**PSO-BFO Hybrid Algorithm:**

1. Initialize the parameters as:

# Ci

# number of elimination-dispersal steps

# number of reproduction steps

# number of chemotaxis steps

# number of swim steps for a given cell

# elimination cofficient

# attraction coefficients

#attraction weight

# repulsion coefficients, set equal to attraction cofficient

#repulsion coefficient

2. Calculate TS and FS for full factorial using:

Where, **L** is Layer Thickness, **S** is Feed Rate and **D** is Infill Density from three-level full factorial

Find TSmax and FSmax for the TS and FS calculated.

3. Evaluate each particle’s position considering the multi-objective function (aiming to optimize the fitness value in each iteration):

4. Initiate chemotaxis tumble/run until number of chemotaxis is less than Nc, go to step 2 if the value is greater than or equal to Nc.

5. If chemotaxis iteration is less than Nc, start reproduction until number of reproductions are less than Nre, go to step 2 if reproduction step is greater than or equal to Nre.

6. For the last chemotaxis, run PSO and update the fitness function accordingly, this is carry forwarded to the next reproduction step.

7. Elimination dispersal if the value is less than Ned, go to step 2 if the value is greater than or equal to Ned.

8. Stop when the number of chemotaxis steps are complete. Diagram

Description automatically generated

*Fig. 3: PSO-BFO Hybrid Flowchart*