

1. Synergy Factor F – Inspired by SMA's Oscillatory Behavior

- Implemented a **linearly decreasing function for the synergy factor F**, which allows the algorithm to transition smoothly from broad exploration to fine exploitation.
- Avoids premature local optimum
- Broadens the search space
- **Influence** : SMA uses oscillatory behavior to cover a range of solutions; starts the puffins with large search movements, allowing them to explore diverse areas. Over time, this linear decrease fine-tunes their movements, honing in on optimal solutions with precision.
- $F_{max} = 0.5$ to 0.1

2. Behavioral Conversion Factor B – Inspired by GTO's Cooling Effect

- a **non-linear exponential decrease**, inspired by the cooling schedule used in GTO.
- **Impact**: This non-linear decay encourages a faster shift from exploration to exploitation,. Puffins make big exploratory moves early on, then settle into focused, detailed search patterns, enhancing their ability to converge on high-quality solutions.

3. Dynamic Step Size – Inversely Proportional to Iterations

- **step size inversely proportional to the number of iterations**, introduced an adaptable search pattern where puffins make large steps in early iterations and smaller, more precise steps as they close in on the target.
- **Impact**: This dynamic step size, inspired by adaptive strategies in SMA and GTO, balances exploration and exploitation over the course of the algorithm. Early on, it drives broader exploration, and as the algorithm refines its search, the smaller steps allow for a detailed focus on promising regions of the search space.

4. Chaotic Initialization Using the Logistic Map – Inspired by PSO

- **chaotic initialization using the Logistic map**.
- Logistic map is a mathematical function.
This chaotic map sets each puffin's starting position in a diverse, structured manner across the search space.
- **Impact**: This use of chaos theory reduces the risk of puffins clustering in a single area, which enhances the initial exploration phase.
- Even, unique position, easy to balance as mathematically designed.