wmoFSS - New Proposal

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wmoFSS - Main idea

- Utilize **reference points** in the **objective space** to guide the search
- Split the fishes into clusters according to the distance to the lines λ determined by the reference points and the **ideal point**
- **W-dominance:** inside the same cluster, sort the fishes according to the *aggregated weight*. The heaviest fish will be W non-dominated
- The W non-dominated fishes of each cluster are the *leaders* of the fishes in the same cluster and will lead the searching process

wmoFSS - Feeding operator

- Each fish has a **vector** of weights, one weight regarding one objective
- The component j of the weight vector of fish i is updated according to:

$$W_{i,j}(t+1) = 1 + \left(\frac{W_{scale} - 1}{F_{j,max} - F_{j,min}}\right)(F_{i,j} - F_{j,min})$$

- The aggregation function is the penalty-based boundary intersection (PBI):

$$\overline{W}_i = \frac{1}{d_{i,1} + \theta d_{i,2}}$$

where $d_{i,1} = \frac{||W_i^T \lambda_i||}{||\lambda_i||}$ and $d_{i,2} = ||W_i - d_{i,1}\frac{\lambda_i}{||\lambda_i||}||$

wmoFSS - Individual movement

Keeps the idea of original FSS, i.e. the fish will move only if the new position is better than the old:

- If the new solution dominates the old one:

$$x_i(t+1) = x_i + rand(-1,1)step_{ind}(t)$$

- If both solutions are indifferent, choose one randomly

wmoFSS - Collective-instinctive movement

Only the fishes of the same cluster will influence each other:

$$x_i(t+1) = x_i(t) + L\left(\frac{\sum_{k\in N_i} \Delta x_k \overline{W_k}}{\sum_{k\in Ni} \overline{W}_k}\right)$$

- L = 0 if the fish is a leader
- L = 1 if the fish has a leader
- N_i is the cluster of fish i

wmoFSS - Collective-volitive movement

The barycenter of the cluster instead of the entire school is calculated according to:

$$B_i(t) = \frac{\sum_{k \in N_i} x_k \overline{W}_k}{\sum_{k \in Ni} \overline{W}_k}$$

- N_i is the cluster of fish i
- l is the leader of the cluster of fish i

Pseudocode

```
Create reference points
Initialize fishes
while Stopping condition is not met do
    for Each fish on the school do
        Run individual movement operator
        Run feeding operator
        Run clustering operator
        Sort each cluster based on w-dominance
        Leaders definition
        Run collective-instinctive movement operator
        Run collective-volitive movement operator
    end for
end while
Sort each cluster based on Pareto-dominance
return Pareto front
```