Metaheuristics - IM5110701
Homework #2
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For the second homework, students are required to **1)** code a population-based algorithm (GA, EA, DE, PSO, etc) to solve one of the following problems, **2)** compare the previously developed single-state algorithm for the first homework with the newer algorithm for the second homework.

Some notes as the following.
1) The problem dimension is $D = [10, 20, 50]$.
2) Precision level for the problem is **1E–6**.
3) In order to have a fair comparison, we set the stopping criteria based on the number of function evaluations. The maximum number of function evaluations is $20000D$.

Things to report:
1) Convergence curves (contains both Algorithm 1 and Algorithm 2).
2) Code (if you are not using Python, please provide the explanation about the coding and on how to run the code).
3) Pseudocode.
4) Your analysis on the performance gap between Algorithm 1 and Algorithm 2.

$$f(\mathbf{x}) = \sum_{i=1}^{D} x_i^2 + (\sum_{i=1}^{D} 0.5ix_i)^2 + (\sum_{i=1}^{D} 0.5ix_i)^4 \tag{1}$$

Bound at $[-5 \leq x_i \leq 10]$. Global minimum solution at $f(\mathbf{x*}) = 0$, where $\mathbf{x*} = (0, ..., 0)$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} x_i^4 \tag{2}$$

Bound at $[-100 \leq x_i \leq 100]$. Global minimum solution at $f(\mathbf{x*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} |x_i|^{i+1} \tag{3}$$

Bound at $[-100 \leq x_i \leq 100]$. Global minimum solution at $f(\mathbf{x*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} ix_i^2 \tag{4}$$

Bound at $[-10 \leq x_i \leq 10]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} x_i^2 \tag{5}$$

Bound at $[-100 \leq x_i \leq 100]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} x_i^2 + 10^6 \sum_{i=2}^{D} x_i^2 \tag{6}$$

Bound at $[-100 \leq x_i \leq 100]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} \left(\sum_{j=1}^{i} x_j \right)^2 \tag{7}$$

Bound at $[-100 \leq x_i \leq 100]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} |x_i| + \prod_{i=1}^{n} |x_i| \tag{8}$$

Bound at $[-10 \leq x_i \leq 10]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} x_i^{10} \tag{9}$$

Bound at $[-10 \leq x_i \leq 10]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \left(\sum_{i=1}^{D} x_i^2 \right)^2 \tag{10}$$

Bound at $[-100 \leq x_i \leq 100]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D-2} (x_{i-1} + 10x_i)^2 + 5\,(x_{i+1} - x_{i+2})^2 + (x_i - 2x_{i+1})^4 + 10\,(x_{i-1} - x_{i+2})^4 \tag{11}$$

Bound at $[-4 \leq x_i \leq 5]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} |x_i sin\,(x_i) + 0.1x_i| \tag{12}$$

Bound at $[-10 \leq x_i \leq 10]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} \left(x_i^2 - 10cos\,(2\pi x_i) + 10\right) \tag{13}$$

Bound at $[-5.12 \leq x_i \leq 5.12]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \sum_{i=1}^{D} x_i^6 (2 + sin\frac{1}{x_i}) \tag{14}$$

Bound at $[-1 \leq x_i \leq 1]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.

$$f(\mathbf{x}) = \frac{1}{4000}(\sum_{i=1}^{D}(x_i - 100)^2) - \prod_{i=1}^{D} cos(\frac{x_i - 100}{\sqrt{i}}) + 1 \tag{15}$$

Bound at $[-600 \leq x_i \leq 600]$. Global minimum solution at $f(\mathbf{x^*}) = 0$.