Course on Optimization University of Mauritius, January 2023
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Exercise session 3 and 4: derivative free optimization, metaheuristics

Question 1.

1. What happens in simulated annealing when the cost function J is replaced by the cost function $4J$, respectively $J + 3$? Answer the same question in the case of an evolution strategy.

2. Compare an evolution strategy ES(1+1) and a simulated annealing.

Question 2.

The stochastic ranking algorithm, described below, allows to rank λ individiuals in a constrained optimzation problem solved with an evolution strategy.

```
1   I_j = j ∀ j ∈ {1, ..., λ}
2   for i = 1 to λ do
3       for j = 1 to λ − 1 do
4           sample u ∈ U(0, 1) (uniform random number generator)
5           if (φ(x_{I_j}) = φ(x_{I_{j+1}}) = 0) or (u < P_f) then
6               if f(x_{I_j}) > f(x_{I_{j+1}}) then
7                   swap(I_j, I_{j+1})
8               fi
9           else
10              if φ(x_{I_j}) > φ(x_{I_{j+1}}) then
11                  swap(I_j, I_{j+1})
12              fi
13          fi
14      od
15      if no swap done break fi
    od
```

Fig. 2. Stochastic ranking procedure, $P_f = 0.45$.

Here, f is the cost function to minimize, Φ the penalty function and P_f is a parameter.

1. What happens when $P_f = 0$, respectively 1?

2. Write a Python script that uses the stochastic ranking for λ individus, a function f and a given penalty Φ.