Background & Purpose

• Initialization techniques are always considered as “computational-resource-free”
• Not true under computational expensive environment where single FE costs a lot
• Optimally allocate the limited computational resources becomes important

Optimal Computational Resource Allocation Problem (OCRAP):

Under given amount of computational resources ($R$), objective function of the base problem ($f$), initialization technique ($\text{IniT}$) and optimization algorithm ($\text{OA}$), to find an resource allocation scheme ($\text{RA} = \text{IniR}/(\text{IniR} + \text{OptR})$) where $\text{IniR}$ and $\text{OptR}$ are the resources consumed by $\text{IniT}$ and $\text{OA}$ so that either the optimal solution ($y=y^*$) of the objective function ($y=f(x)$) is achieved with the least total resources ($\text{IniR} + \text{OptR} < R$) or the best suboptimal solution ($y\neq y^*$) is achieved when resources are used up ($\text{IniR} + \text{OptR} = R$).

Computational resource is defined as number of FE used under computational expensive environment. Due to the extreme long time required by FE, other calculations are negligible.

Problem Formulation:

• General version:

$$\min_{\text{IniT, OA, f}} \{ (\text{IniR} + \text{OptR}), [y - y^*] \} = F(RA)$$

s.t. $\text{IniR} + \text{OptR} \leq R$

$\text{IniR} > 0$

$\text{OptR} > 0$

• Simulation version:

$$\min_{\text{IniT, OA, f}} \{ (\text{IniFE} + \text{OptFE}), [y - y^*] \} = F(RA)$$

s.t. $\text{IniFE} + \text{OptFE} \leq \text{TotalFE}$

$\text{IniFE} > 0$

$\text{OptFE} > 0$

Simulation cases

Initialization techniques:

• Pseudo Random Number Generator (PRNG)
• Opposition-Based Learning (OBL) [1]
• Quasi-Opposition-Based Learning (QOBL) [2]
• Quadratic Interpolation (QI) [3]

Optimization algorithms:

• Differential Evolution (DE) [4]
• Chemical Reaction Optimization (CRO) [5]

Benchmark functions:

• CEC14 computational expensive problem set

Metrics:

• Without $\text{IniR}$ considered (traditional way)
• Considering $\text{IniR}$
• Solve the OCRAP

Simulation results

• Notations & settings:

  • M1: without considering $\text{IniR}$
  • M2: $\text{IniR}$ considered
  • $M3 = r_{\text{ini}} / r_{\text{rand}}$, the ratio between results from using $\text{IniT}$ and using PRNG.

  M3<1 means $\text{IniT}$ better

  M3>1 means PRNG better

  • $D=10, 30 & 100$; MaxFE($R$)=50*D; No. of run=50

  • Comparison between $\text{IniR}$ considered and not considered:

Some curves

• Using QI with DE to test different RA ratios

• Comparing QI, OBL under different RA

Conclusion

• Formulate and solve the optimal computational resource allocation problem
• Define the computational resource under the expensive environment
• Conduct simulations analyze performances from different initialization techniques

Reference


