

Problem 1. *Lập bảng thống kê kết quả thí nghiệm cho mỗi tổ hợp*

Sphere on 2 Dimensions		
Popsiz	DE	CEM
16	0.0 (0.0)	0.000255 (0.000232)
32	0.0 (0.0)	9.170e-05 (9.159e-05)
64	0.0 (0.0)	4.224e-05 (4.199e-05)
128	2.150e-36 (1.427e-36)	1.941e-05 (2.322e-05)
256	1.345e-16 (1.398e-16)	4.612e-06 (4.150e-06)

Sphere on 10 Dimensions		
Popsiz	DE	CEM
16	6.671e-14 (2.001e-13)	0.122 (0.059)
32	0.0 (0.0)	0.019 (0.005)
64	0.0 (0.0)	0.012 (0.003)
128	8.356e-38 (1.175e-37)	0.006 (0.002)
256	1.079e-17 (8.066e-18)	0.004 (0.001)

Griewank on 2 Dimensions		
Popsiz	DE	CEM
16	0.003 (0.003)	9.381e-05 (0.000105)
32	0.002 (0.003)	3.576e-05 (1.940e-05)
64	0.0 (0.0)	1.208e-05 (8.551e-06)
128	0.008 (0.001)	1.053e-05 (1.317e-05)
256	0.223 (0.053)	2.503e-06 (2.236e-06)

Griewank on 10 Dimensions		
Popsiz	DE	CEM
16	0.003 (0.004)	0.014 (0.008)
32	0.001 (0.003)	0.002 (0.001)
64	0.0 (0.0)	0.001 (0.000)
128	0.004 (0.005)	0.001 (0.000)
256	0.098 (0.046)	0.001 (0.000)

Rosenbrock on 2 Dimensions		
Popsize N	DE	CEM
16	0.168 (0.342)	0.237 (0.451)
32	0.0 (0.0)	0.023 (0.024)
64	0.001 (0.004)	0.002 (0.002)
128	0.457 (0.916)	0.001 (0.000)
256	21.307 (10.625)	0.000 (0.000)

Rosenbrock on 10 Dimensions		
Popsize N	DE	CEM
16	4.997 (2.536)	22.105 (5.623)
32	20.280 (22.786)	7.415 (1.650)
64	49.190 (31.480)	4.241 (1.613)
128	77.162 (8.465)	2.695 (1.112)
256	101.630 (18.564)	1.740 (1.573)

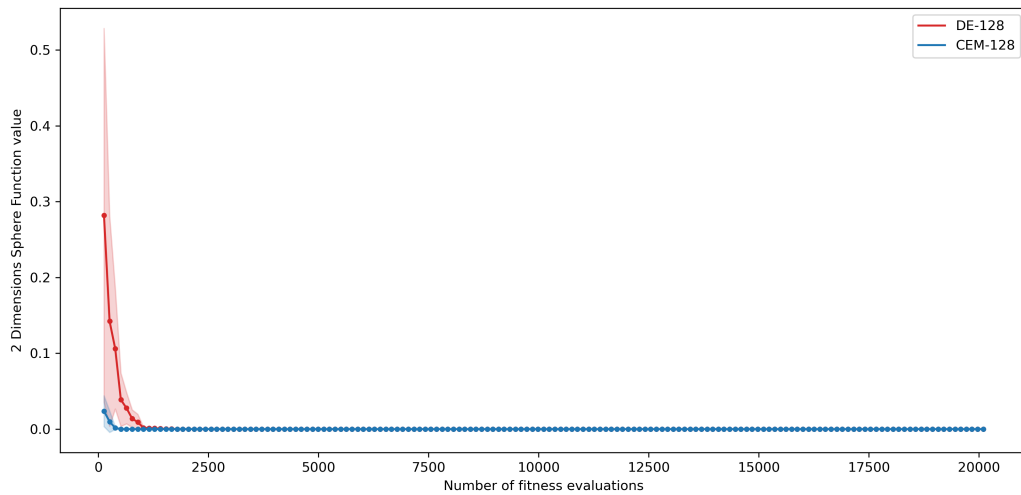
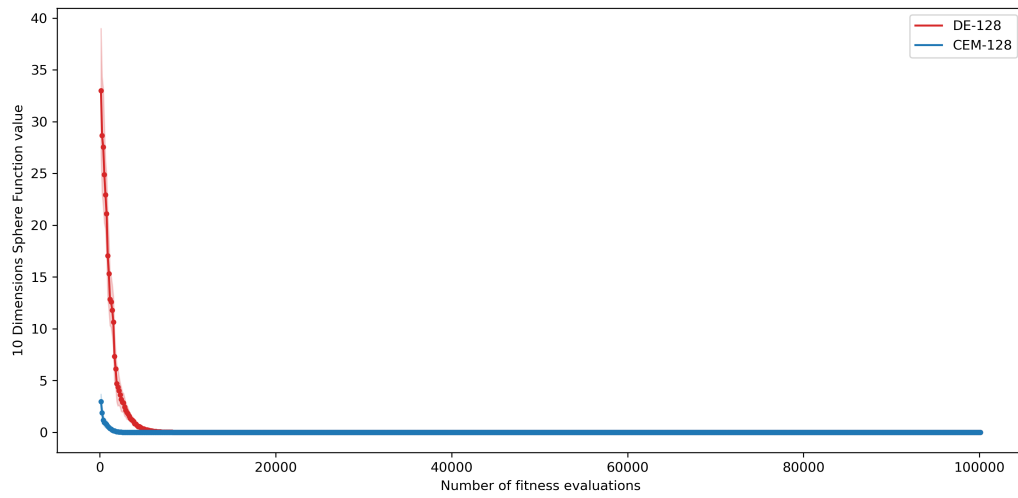
Michalewicz on 2 Dimensions		
Popsize N	DE	CEM
16	-1.801 (0.0)	-1.734 (0.176)
32	-1.801 (0.0)	-1.799 (0.002)
64	-1.801 (0.0)	-1.801 (0.000)
128	-1.801 (0.0)	-1.801 (0.001)
256	-1.801 (0.0)	-1.801 (0.000)

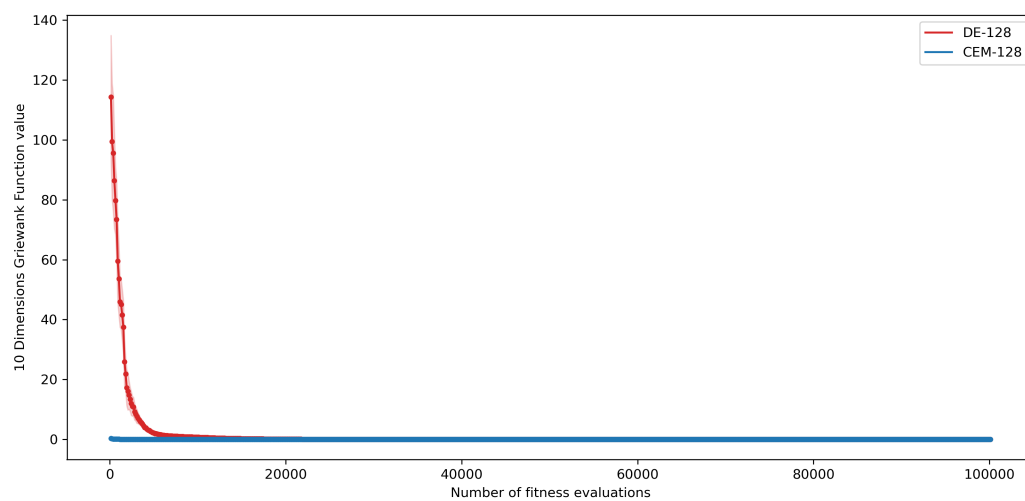
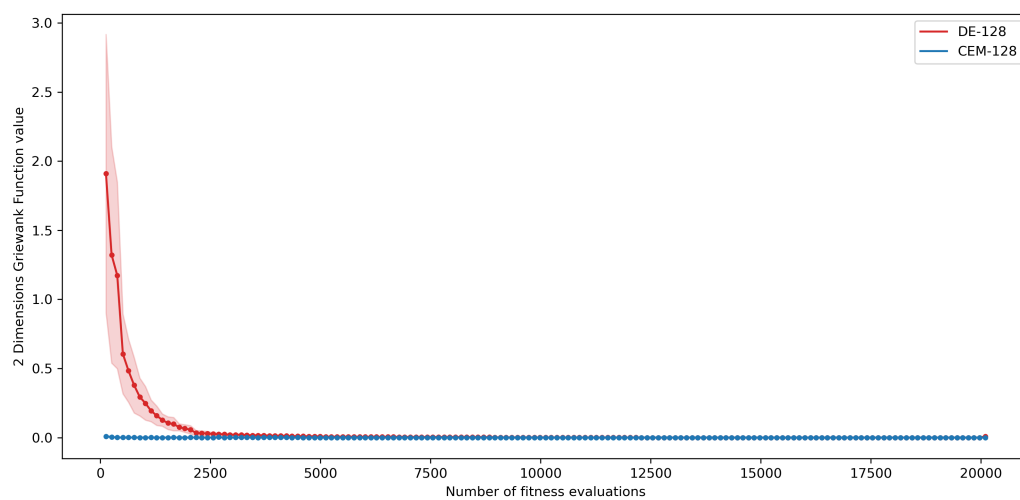
Michalewicz on 10 Dimensions		
Popsize N	DE	CEM
16	-9.577 (0.056)	-2.483 (0.644)
32	-9.655 (0.012)	-4.068 (0.929)
64	-9.660 (0.0)	-7.199 (0.685)
128	-9.660 (0.0)	-8.039 (0.267)
256	-9.660 (0.0)	-8.127 (0.245)

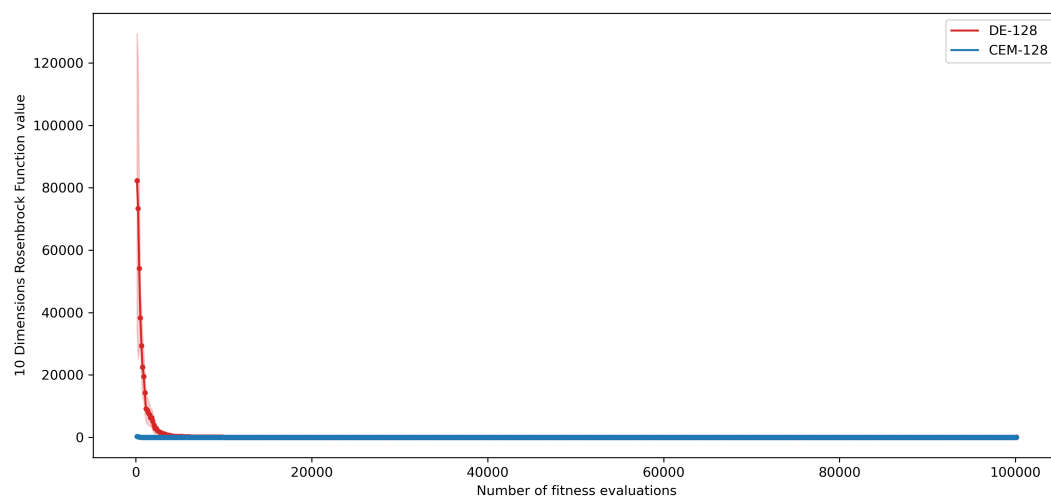
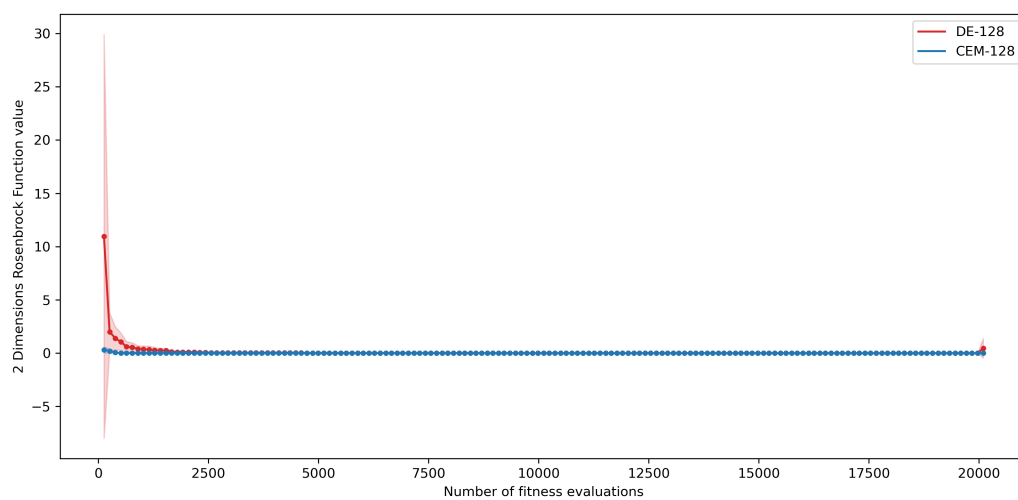
Ackley on 2 Dimensions		
Popsize N	DE	CEM
16	9.537e-07 (0.0)	0.056 (0.039)
32	9.537e-07 (0.0)	0.026 (0.017)
64	9.537e-07 (0.0)	0.014 (0.010)
128	9.537e-07 (0.0)	0.013 (0.009)
256	5.150e-06 (1.144e-06)	0.006 (0.003)

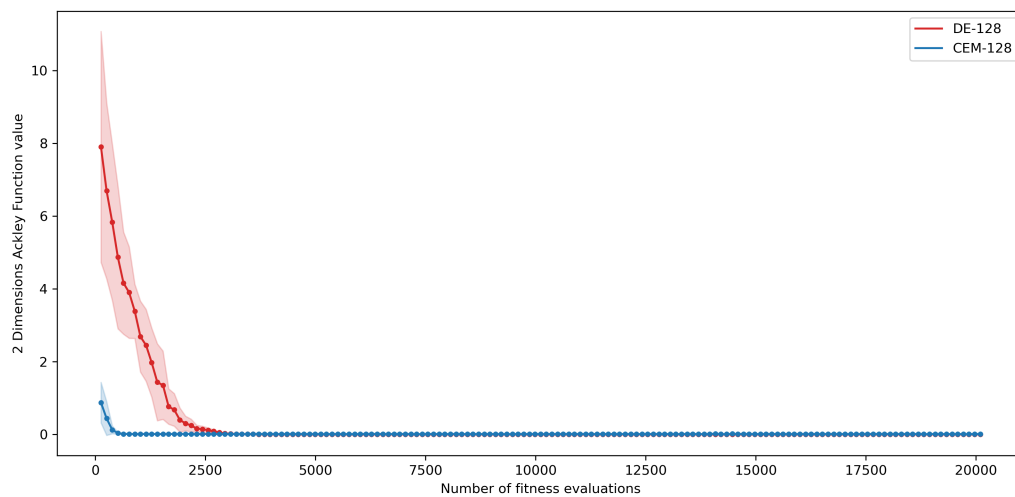
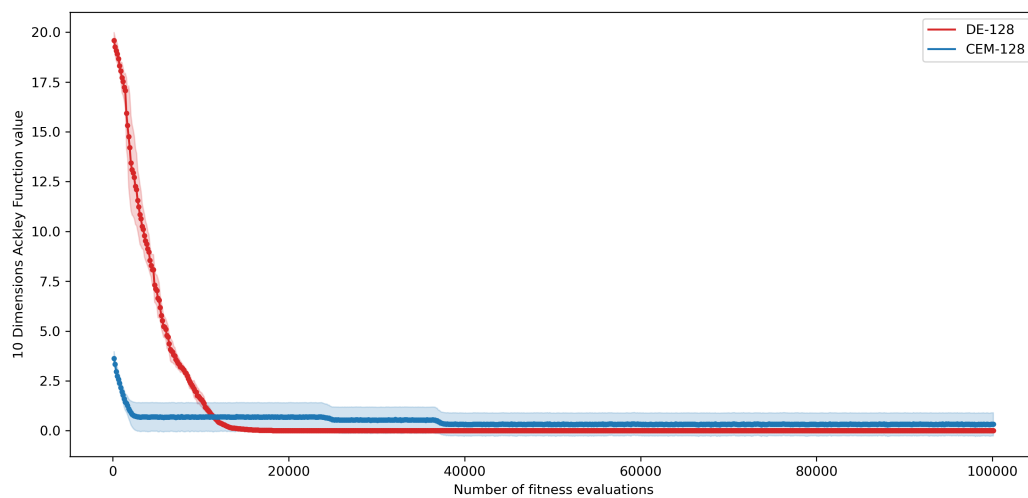
Ackley on 10 Dimensions		
Popsize N	DE	CEM
16	0.116 (0.347)	0.949 (0.335)
32	4.768e-06 (0.0)	0.323 (0.060)
64	5.531e-06 (1.526e-06)	0.644 (0.693)
128	8.583e-06 (0.0)	0.328 (0.576)
256	1.621e-05 (0.0)	0.687 (0.713)

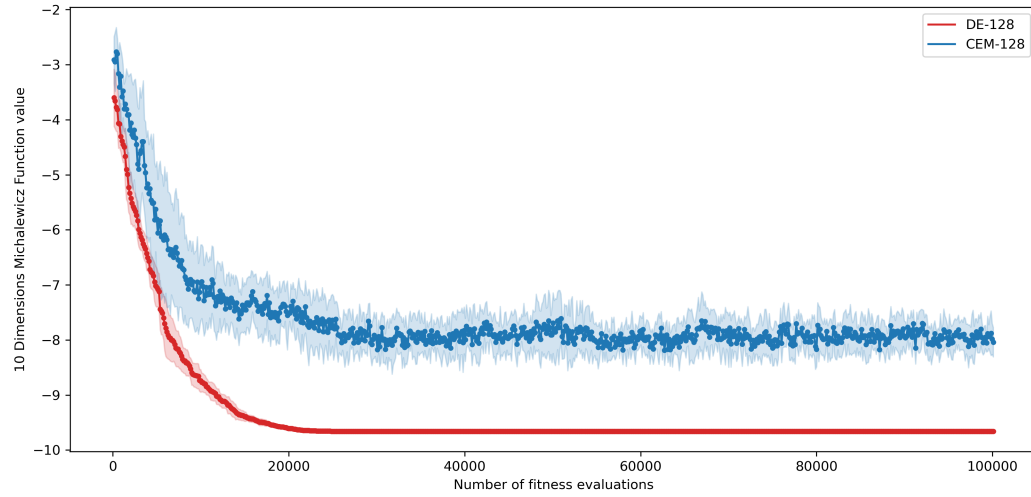
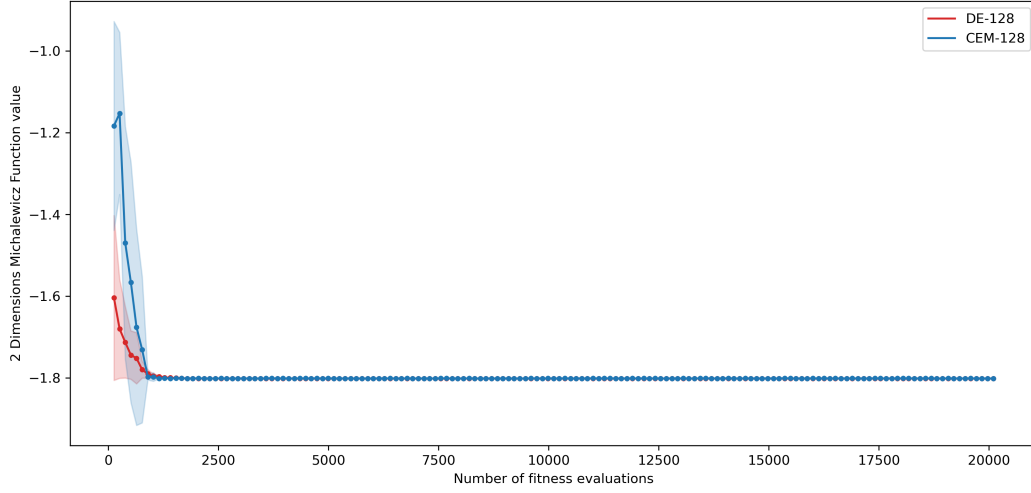
Problem 2. Vẽ các đồ thị hội tụ (convergence graph)











Problem 3. Nhận xét

- From the experimental results and graphs presented, it is evident that the Differential Evolution (DE) algorithm consistently outperforms the Cross Entropy Method (CEM) in terms of returning solutions with superior objective values, closer to the global optima, across various scenarios.
- DE exhibits significantly lower standard deviations compared to CEM in the experiments, as illustrated in the graphs. Additionally, DE demonstrates much faster convergence times.
- Across the Sphere, Ackley, and Rosenbrock functions, both DE and CEM produce satisfactory solutions closely approximating the optimal solutions.

- However, in the Michalewicz and Griewank functions, only DE consistently provides good solutions in both two and ten dimensions. CEM yields relatively poor results, considerably distant from the optimal solutions.

Problem 4. *Resources*

All experimental results and the GIF file are stored here.