1.

Proszę, korzystając z algorytmu roju cząstek znaleźć minimum funkcji

$f(x, y) = x^2 + y^2 - 20(cos\pi x + cos\pi y - 2)$ w przedziale $x, y \in [-10,10]$,

przy założeniu że rozwiązanie jest reprezentowane przez wektor $[xi, yi]$.

Proszę zbadać:

- funkcjonowanie algorytmu dla c1=0, c2=2
- funkcjonowanie algorytmu dla c1=2, c2=0 oraz kilku przypadków pośrednich.
- funkcjonowanie algorytmu dla c1 = c2 = 2,2
- funkcjonowanie dla różnych wartości w.

Za każdym razem należy podać średnie wyniki (wartość funkcji przystosowania) oraz odchylenie standardowe dla 10 wywołań algorytmu i przedstawić przykładowe przebiegi algorytmu na wykresach (dla jednego z wywołań).

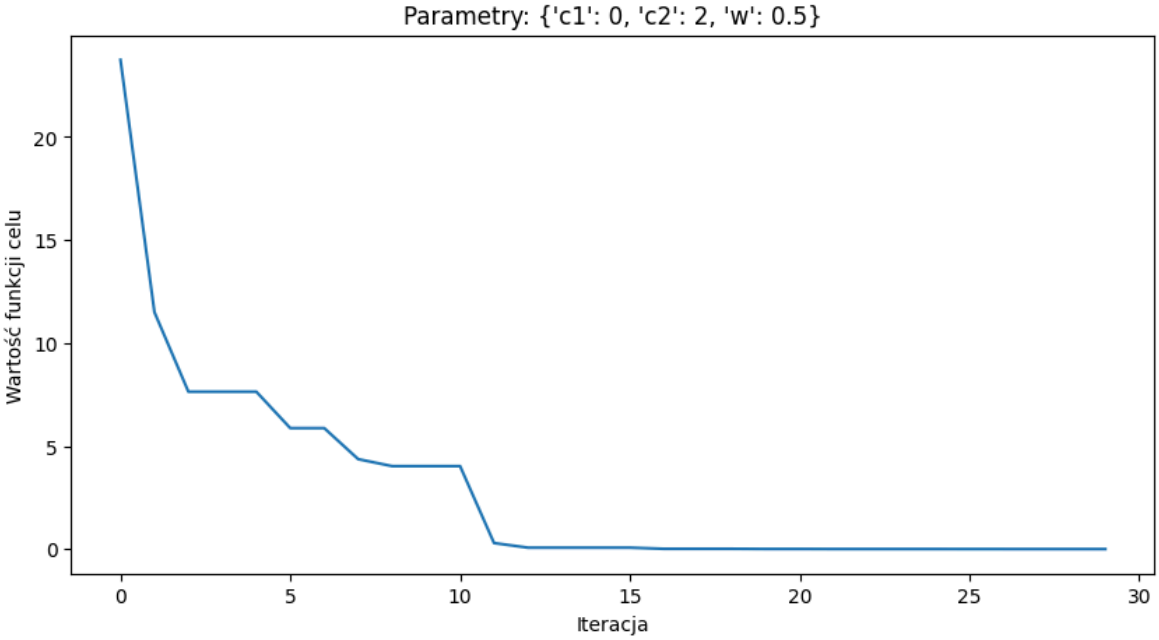
Należy opisać, który wariant sprawdzał się najlepiej.

In [ ]:
```
import numpy as np
import pyswarms as ps
from pyswarms.utils.functions import single_obj as fx
import matplotlib.pyplot as plt

def f(x):
    return x[:, 0]**2 + x[:, 1]**2 - 20 * (np.cos(np.pi * x[:, 0]) + np.cos(np.p
bounds = np.array([[-10, -10], [10, 10]])
params = [
    {'c1': 0, 'c2': 2, 'w': 0.5},
    {'c1': 2, 'c2': 0, 'w': 0.5},
    {'c1': 1, 'c2': 1, 'w': 0.5},
    {'c1': 2, 'c2': 2, 'w': 0.5},
    {'c1': 2, 'c2': 2, 'w': 0.4},
    {'c1': 2, 'c2': 2, 'w': 0.6},
    {'c1': 2, 'c2': 2, 'w': 0.7},
    {'c1': 2, 'c2': 2, 'w': 0.8},
    {'c1': 2, 'c2': 2, 'w': 0.9},
    {'c1': 2, 'c2': 2, 'w': 1.0},
]
for param in params:
    print(f"Testowanie parametrów: {param}")
    results = []
    for _ in range(10):
        optimizer = ps.single.GlobalBestPSO(n_particles=30, dimensions=2, option
        cost, pos = optimizer.optimize(f, iters=30)
        results.append(cost)
    print(f"Średnia wartość funkcji celu: {np.mean(results)}")
    print(f"Odchylenie standardowe wartości funkcji celu: {np.std(results)}")
    plt.figure(figsize=(10, 5))
    plt.plot(optimizer.cost_history)
    plt.title(f'Parametry: {param}')
    plt.xlabel('Iteracja')
```

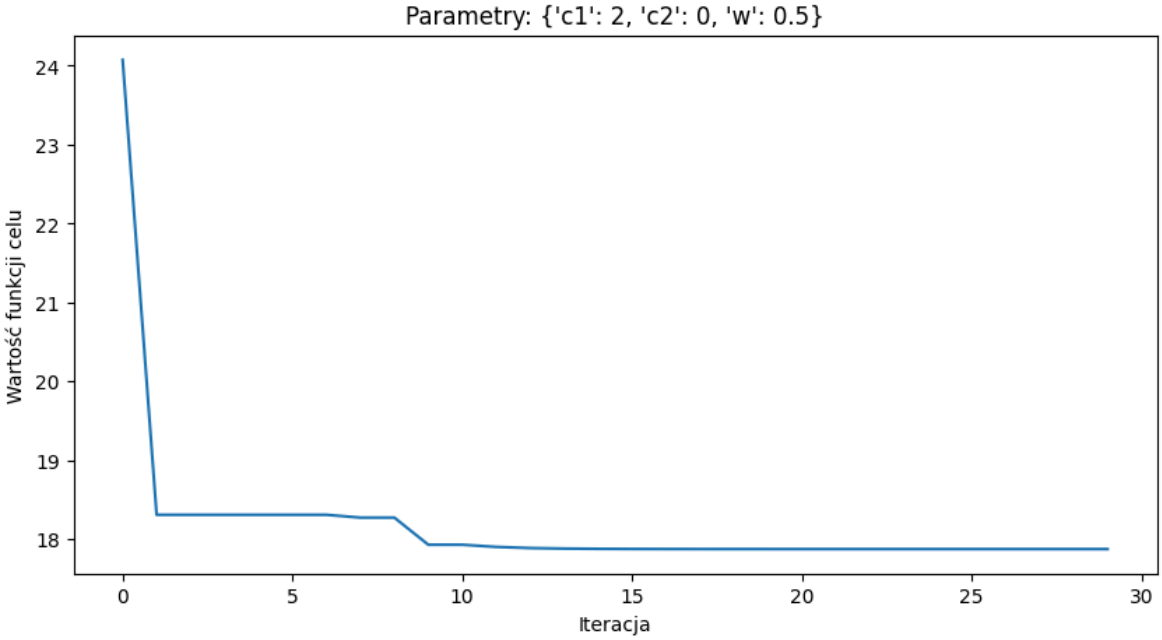
```
    plt.ylabel('Wartość funkcji celu')
    plt.show()
```

```
2024-05-12 10:55:24,715 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
Testowanie parametrów: {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.4e-5
2024-05-12 10:55:24,744 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.3984147388418614e-05, best pos: [-0.00028537 -0.00024255]
2024-05-12 10:55:24,754 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.04e-5
2024-05-12 10:55:24,781 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.0358360863823694e-05, best pos: [0.00041374 0.00018172]
2024-05-12 10:55:24,787 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.96
2024-05-12 10:55:24,817 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.959868600090886, best pos: [1.55283598e-04 1.98004067e+00]
2024-05-12 10:55:24,824 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.96
2024-05-12 10:55:24,850 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.9598697425038156, best pos: [ 3.08057998e-05 -1.97970705e+00]
2024-05-12 10:55:24,857 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.05e-5
2024-05-12 10:55:24,883 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.0517946362006975e-05, best pos: [-0.00022499  0.00039394]
2024-05-12 10:55:24,889 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.47e-5
2024-05-12 10:55:24,917 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.4734374183418233e-05, best pos: [4.89294533e-04 9.32134989e-0
5]
2024-05-12 10:55:24,923 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.08e-5
2024-05-12 10:55:24,953 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.080360943035141e-05, best pos: [ 0.00029962 -0.00034482]
2024-05-12 10:55:24,959 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=7.11e-5
2024-05-12 10:55:24,987 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 7.11485099114671e-05, best pos: [-0.00012124  0.00083604]
2024-05-12 10:55:24,991 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.49e-6
2024-05-12 10:55:25,017 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.4909510255980458e-06, best pos: [6.33985261e-05 1.04573389e-0
4]
2024-05-12 10:55:25,023 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 0, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.92e-5
2024-05-12 10:55:25,050 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.922613570619168e-05, best pos: [-0.00042105 -0.00046495]
Średnia wartość funkcji celu: 0.7919950606629572
Odchylenie standardowe wartości funkcji celu: 1.5839370554133891
```



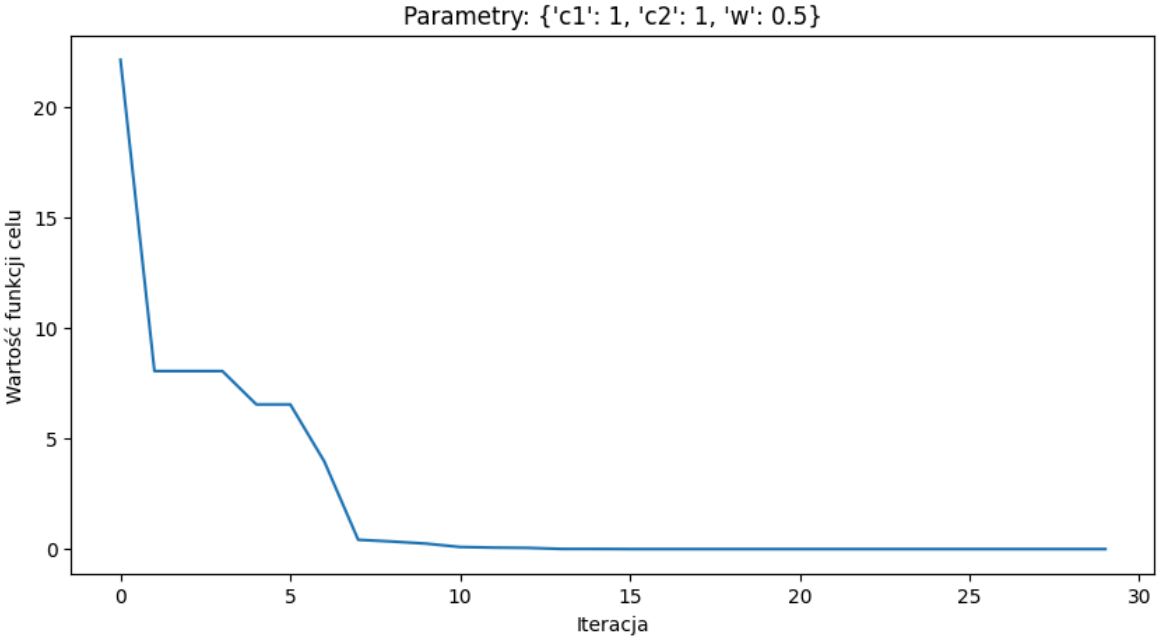

```
2024-05-12 10:55:25,175 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
Testowanie parametrów: {'c1': 2, 'c2': 0, 'w': 0.5}
```

```
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=14.2
2024-05-12 10:55:25,217 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 14.204118262277248, best pos: [-1.9989341   2.23512115]
2024-05-12 10:55:25,225 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=7.2
2024-05-12 10:55:25,264 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 7.201099583115197, best pos: [0.04010295 2.15713168]
2024-05-12 10:55:25,271 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.96
2024-05-12 10:55:25,309 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.9598826471487003, best pos: [-1.97953463e+00  1.59436625e-04]
2024-05-12 10:55:25,317 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.09
2024-05-12 10:55:25,361 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.087870036494264, best pos: [-0.03422479 -1.96924647]
2024-05-12 10:55:25,371 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=32.1
2024-05-12 10:55:25,407 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 32.13102778773929, best pos: [ 3.89170555 -3.9597917 ]
2024-05-12 10:55:25,414 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=5.4
2024-05-12 10:55:25,441 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 5.403666045554601, best pos: [-0.0073433  -1.85847942]
2024-05-12 10:55:25,448 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=14.6
2024-05-12 10:55:25,543 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 14.613561361247406, best pos: [1.80732243 2.17809248]
2024-05-12 10:55:25,552 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=8.05
2024-05-12 10:55:25,590 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 8.051280878519659, best pos: [-1.98295252 -2.0161371 ]
2024-05-12 10:55:25,597 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=16.7
2024-05-12 10:55:25,633 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 16.732634089283234, best pos: [-2.33402315  0.11243541]
2024-05-12 10:55:25,641 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 0, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=17.9
2024-05-12 10:55:25,682 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 17.877878954936435, best pos: [-3.81380199 -0.00867109]
Średnia wartość funkcji celu: 12.426301964631604
Odchylenie standardowe wartości funkcji celu: 8.255033676687216
```



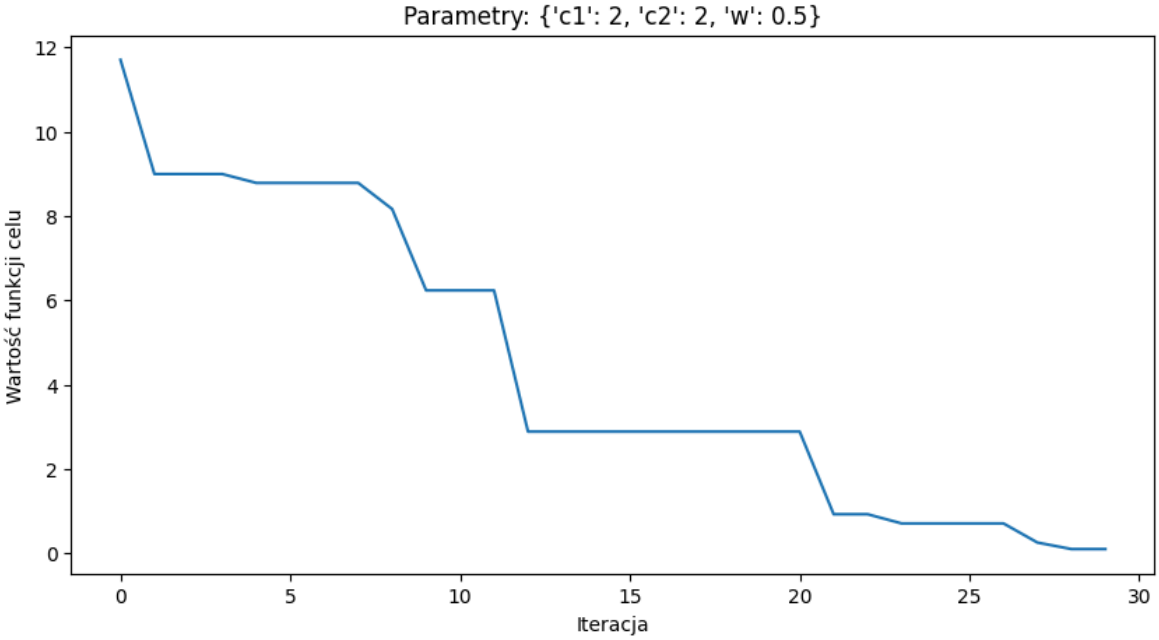

```
2024-05-12 10:55:25,841 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
Testowanie parametrów: {'c1': 1, 'c2': 1, 'w': 0.5}
```

```
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.000167
2024-05-12 10:55:25,908 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0001665315439702658, best pos: [ 0.00032259 -0.00125153]
2024-05-12 10:55:25,918 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=9.13e-6
2024-05-12 10:55:25,973 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 9.131951514100048e-06, best pos: [ 0.00013389 -0.00027143]
2024-05-12 10:55:25,984 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.61e-7
2024-05-12 10:55:26,038 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.6102103192730533e-07, best pos: [3.80894590e-05 3.41666722e-0
5]
2024-05-12 10:55:26,045 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.96
2024-05-12 10:55:26,100 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.9598649674915354, best pos: [ 1.97990024e+00 -1.33606080e-05]
2024-05-12 10:55:26,109 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.64e-7
2024-05-12 10:55:26,164 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.638980319158078e-07, best pos: [-2.94508031e-05 -2.78680368e-0
5]
2024-05-12 10:55:26,172 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.14e-5
2024-05-12 10:55:26,233 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.1374771015417542e-05, best pos: [0.00019879 0.00027309]
2024-05-12 10:55:26,243 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.000422
2024-05-12 10:55:26,296 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0004223104537878542, best pos: [-0.00164817  0.00123269]
2024-05-12 10:55:26,306 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.45e-7
2024-05-12 10:55:26,355 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.4520126451333157e-07, best pos: [-3.08206932e-05 -2.25060981e-
05]
2024-05-12 10:55:26,371 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=6.92e-6
2024-05-12 10:55:26,408 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 6.923622680083817e-06, best pos: [-7.33011681e-05 -2.53128936e-0
4]
2024-05-12 10:55:26,414 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 1, 'c2': 1, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.59e-7
2024-05-12 10:55:26,449 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.59119661502571e-07, best pos: [-3.63560245e-05  3.57398404e-0
5]
Średnia wartość funkcji celu: 0.39604820690744924
Odchylenie standardowe wartości funkcji celu: 1.1879389270985463
```




```
2024-05-12 10:55:26,587 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
Testowanie parametrów: {'c1': 2, 'c2': 2, 'w': 0.5}
```

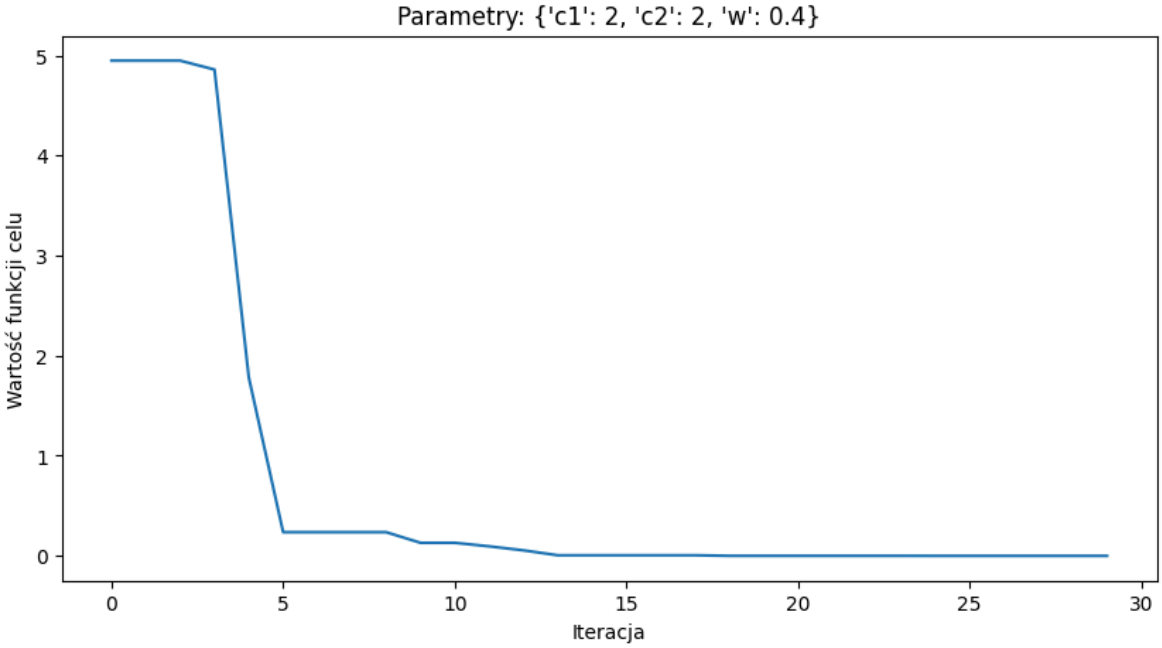
```
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0276
2024-05-12 10:55:26,629 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.027566293008791536, best pos: [ 0.00604658 -0.01549162]
2024-05-12 10:55:26,637 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.00857
2024-05-12 10:55:26,740 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.008571546597317287, best pos: [-0.00373916 -0.00848527]
2024-05-12 10:55:26,745 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0491
2024-05-12 10:55:26,778 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.04905909207388243, best pos: [-0.00674229  0.02113746]
2024-05-12 10:55:26,785 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.00516
2024-05-12 10:55:26,820 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.005158365567729893, best pos: [0.00031077 0.00718655]
2024-05-12 10:55:26,827 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0295
2024-05-12 10:55:26,859 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.029465322219854217, best pos: [0.01509642 0.00822774]
2024-05-12 10:55:26,868 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0046
2024-05-12 10:55:26,922 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.004604961015830097, best pos: [-0.00017068  0.00679431]
2024-05-12 10:55:26,930 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.024
2024-05-12 10:55:26,990 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.02396276664653232, best pos: [-0.00845346  0.0129971 ]
2024-05-12 10:55:27,006 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.000377
2024-05-12 10:55:27,083 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0003773437798562361, best pos: [ 0.00189601 -0.00043599]
2024-05-12 10:55:27,095 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.00442
2024-05-12 10:55:27,145 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.004418670246538337, best pos: [ 0.00628308 -0.00220128]
2024-05-12 10:55:27,151 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.5}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.105
2024-05-12 10:55:27,187 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.10472289970327482, best pos: [ 0.03201086 -0.00515573]
Średnia wartość funkcji celu: 0.025790726085960718
Odchylenie standardowe wartości funkcji celu: 0.030108698865147443
```




```
2024-05-12 10:55:27,355 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
Testowanie parametrów: {'c1': 2, 'c2': 2, 'w': 0.4}
```

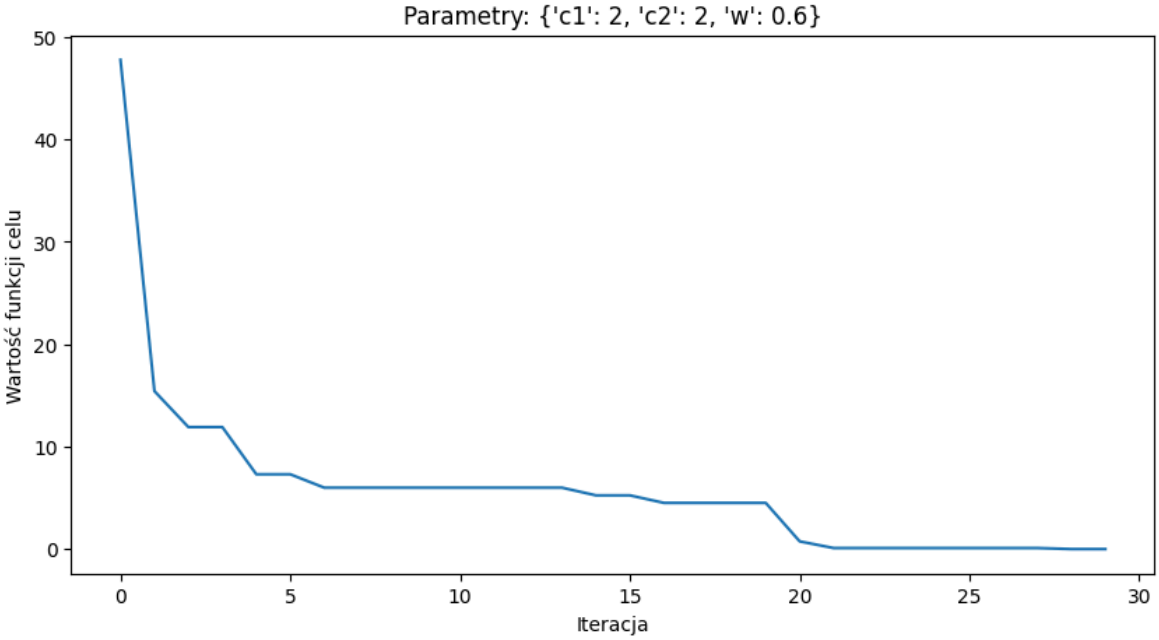
```
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0085
2024-05-12 10:55:27,415 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.008499220675240258, best pos: [-0.00468033 -0.00795924]
2024-05-12 10:55:27,490 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.97
2024-05-12 10:55:27,553 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.966613817694672, best pos: [ 1.97390128 -0.00561134]
2024-05-12 10:55:27,562 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=7.13e-6
2024-05-12 10:55:27,617 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 7.130676222101691e-06, best pos: [ 5.28690687e-05 -2.62162220e-0
4]
2024-05-12 10:55:27,625 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.00119
2024-05-12 10:55:27,668 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0011888275295141174, best pos: [-0.00254887 -0.00232977]
2024-05-12 10:55:27,675 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0347
2024-05-12 10:55:27,715 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0347230675074936, best pos: [ 0.0063279  -0.01755921]
2024-05-12 10:55:27,722 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0333
2024-05-12 10:55:27,753 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0332788856747937, best pos: [0.00938793 0.01567564]
2024-05-12 10:55:27,761 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0132
2024-05-12 10:55:27,797 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.013226816928025015, best pos: [-0.00953989  0.00645523]
2024-05-12 10:55:27,805 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0155
2024-05-12 10:55:27,845 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.015502612355708236, best pos: [-0.0111724   0.00553983]
2024-05-12 10:55:27,851 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.11e-6
2024-05-12 10:55:27,885 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.1104437792193454e-06, best pos: [-9.82134683e-05 -1.07344755e-
04]
2024-05-12 10:55:27,892 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.08e-7
2024-05-12 10:55:28,012 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.080554410305314e-07, best pos: [-4.30514131e-05 -4.73241074e-0
5]
```

Średnia wartość funkcji celu: 0.4073042897540889
Odchylenie standardowe wartości funkcji celu: 1.186501556663484



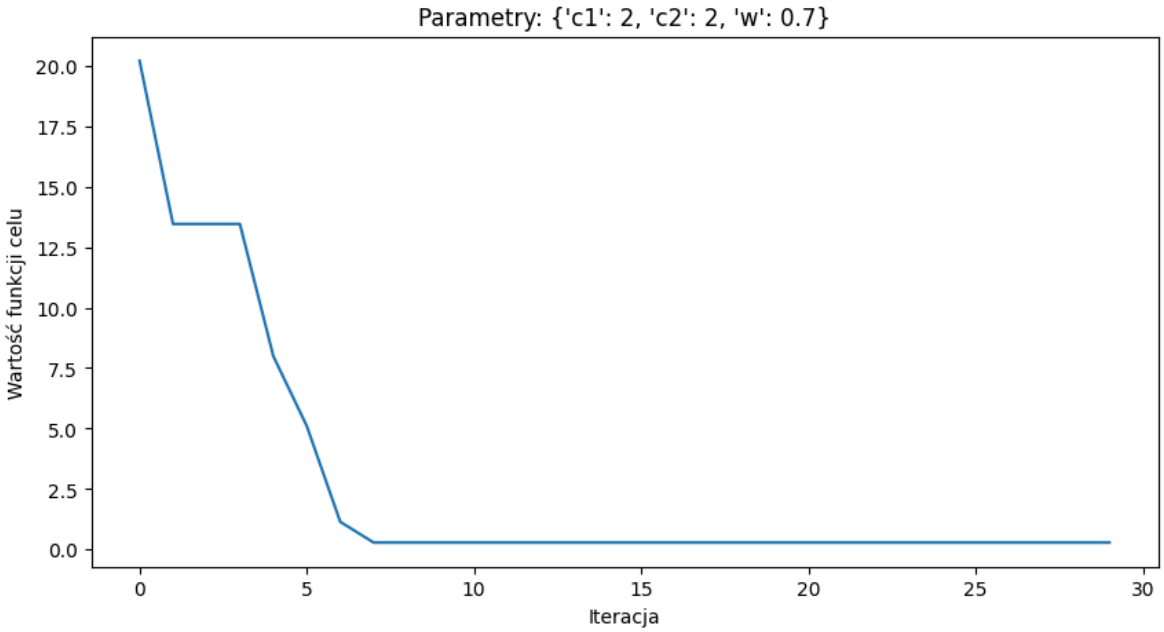

```
2024-05-12 10:55:28,183 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
Testowanie parametrów: {'c1': 2, 'c2': 2, 'w': 0.6}
```

```
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.158
2024-05-12 10:55:28,241 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.1577288011280767, best pos: [0.02052714 0.03408778]
2024-05-12 10:55:28,255 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.03
2024-05-12 10:55:28,300 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.030038558739000232, best pos: [0.00784053 0.01548798]
2024-05-12 10:55:28,308 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.002
2024-05-12 10:55:28,351 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0020006899866777694, best pos: [ 0.00252787 -0.00369837]
2024-05-12 10:55:28,362 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0302
2024-05-12 10:55:28,415 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.03015963549525125, best pos: [-0.0141182   0.01016037]
2024-05-12 10:55:28,425 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0159
2024-05-12 10:55:28,485 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.015939057977165414, best pos: [-0.0012162  -0.01258641]
2024-05-12 10:55:28,495 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.00517
2024-05-12 10:55:28,562 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0051698198078867635, best pos: [-0.00086431 -0.00714919]
2024-05-12 10:55:28,572 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.00293
2024-05-12 10:55:28,641 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.002927521571758808, best pos: [ 0.00528001 -0.00121925]
2024-05-12 10:55:28,653 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.234
2024-05-12 10:55:28,722 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.23401046782766283, best pos: [0.01640214 0.04562668]
2024-05-12 10:55:28,733 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.96
2024-05-12 10:55:28,794 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.9616782255870424, best pos: [-0.00357968  1.97760505]
2024-05-12 10:55:28,805 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.6}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.00594
2024-05-12 10:55:28,861 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0059384036949074286, best pos: [-0.0044131   0.00633177]
Średnia wartość funkcji celu: 0.444559118181543
Odchylenie standardowe wartości funkcji celu: 1.1747487424243959
```



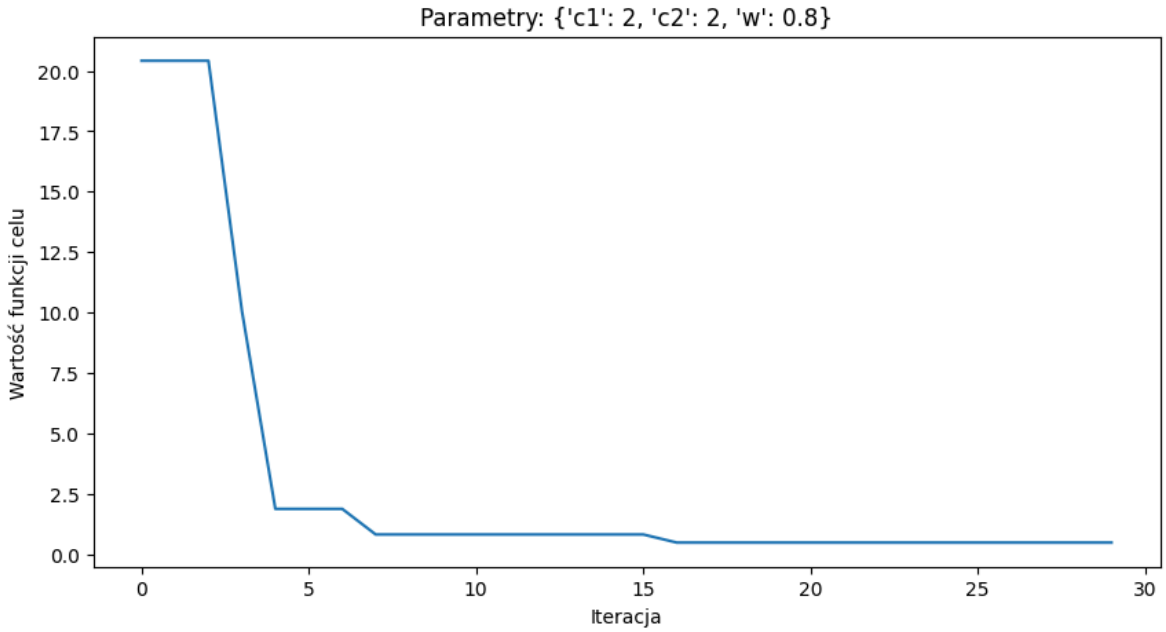

```
Testowanie parametrów: {'c1': 2, 'c2': 2, 'w': 0.7}
```

```
2024-05-12 10:55:29,051 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.16
2024-05-12 10:55:29,097 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.1567963746949275, best pos: [ 0.1480301 -0.0104393]
2024-05-12 10:55:29,104 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0454
2024-05-12 10:55:29,151 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.045435206066243 98, best pos: [ 0.0115739  -0.01794105]
2024-05-12 10:55:29,159 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.2
2024-05-12 10:55:29,194 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.20125598067906, best pos: [ 2.02571688 -0.01805461]
2024-05-12 10:55:29,200 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.96
2024-05-12 10:55:29,234 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.9637583653074153, best pos: [ 1.977596  -0.0057998]
2024-05-12 10:55:29,241 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.347
2024-05-12 10:55:29,276 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.34651007566809233, best pos: [-0.01651773  0.05666814]
2024-05-12 10:55:29,282 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.336
2024-05-12 10:55:29,317 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.33578306061669283, best pos: [ 0.05623727 -0.01461539]
2024-05-12 10:55:29,323 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.606
2024-05-12 10:55:29,429 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.6064820581146776, best pos: [-0.07755055  0.00993087]
2024-05-12 10:55:29,435 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.000977
2024-05-12 10:55:29,470 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.0009771077763438803, best pos: [ 0.00312702 -0.00015063]
2024-05-12 10:55:29,475 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.81
2024-05-12 10:55:29,512 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.8108554137308877, best pos: [-0.02448899 -0.13349694]
2024-05-12 10:55:29,517 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.7}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.293
2024-05-12 10:55:29,555 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.29262196012519814, best pos: [0.05424036 0.00040673]
Średnia wartość funkcji celu: 1.376047560277954
Odchylenie standardowe wartości funkcji celu: 1.5180963128534264
```



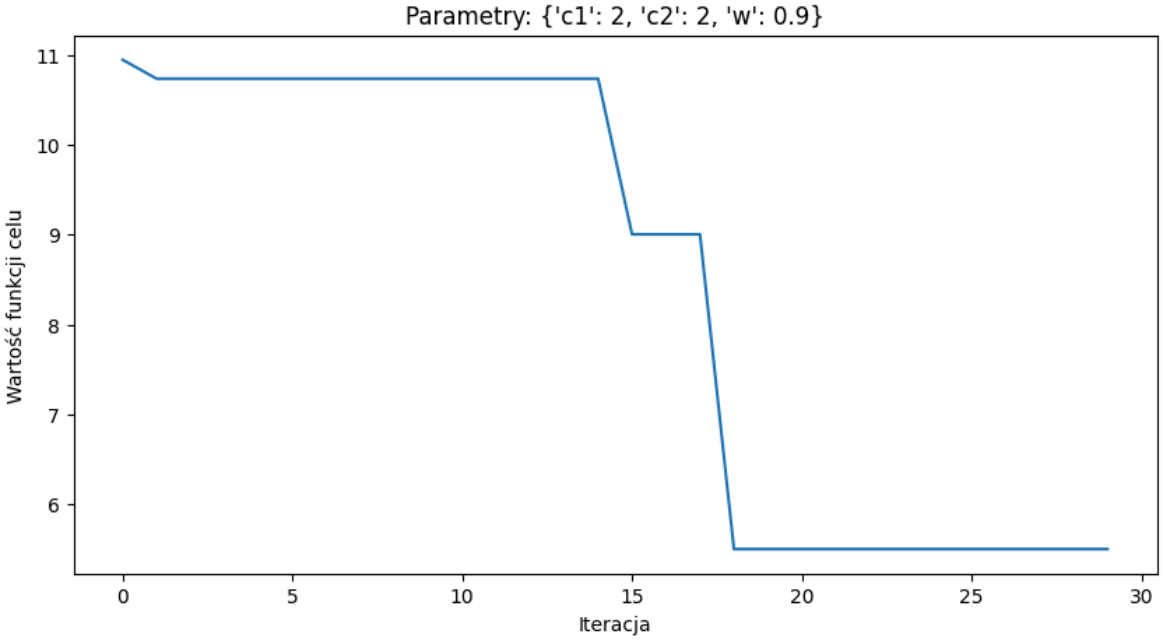

```
2024-05-12 10:55:29,695 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
Testowanie parametrów: {'c1': 2, 'c2': 2, 'w': 0.8}
```

```
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.16
2024-05-12 10:55:29,740 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.1602978812475751, best pos: [0.00313751 0.04000132]
2024-05-12 10:55:29,746 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.21
2024-05-12 10:55:29,781 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.2083356661995266, best pos: [-0.17759421 -0.03800994]
2024-05-12 10:55:29,792 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0282
2024-05-12 10:55:29,831 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.02820161761130296, best pos: [-0.01424906 -0.00893751]
2024-05-12 10:55:29,838 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.104
2024-05-12 10:55:29,880 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.10404537073022532, best pos: [-0.03093002 -0.00936542]
2024-05-12 10:55:29,889 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0727
2024-05-12 10:55:29,939 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.07265790980555042, best pos: [0.02561423 0.00854754]
2024-05-12 10:55:29,948 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=6.58
2024-05-12 10:55:29,992 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 6.580591501894349, best pos: [-2.14308682  0.00297359]
2024-05-12 10:55:29,997 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.00999
2024-05-12 10:55:30,034 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.009988587472653467, best pos: [-0.00956526  0.0029501 ]
2024-05-12 10:55:30,039 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.13
2024-05-12 10:55:30,075 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.1272408833446597, best pos: [ 0.03477156 -0.17587206]
2024-05-12 10:55:30,081 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.575
2024-05-12 10:55:30,117 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.5754075995382391, best pos: [-0.07144124  0.0262551 ]
2024-05-12 10:55:30,123 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.8}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.474
2024-05-12 10:55:30,159 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.4736389959808145, best pos: [-0.06194078  0.03044405]
Średnia wartość funkcji celu: 1.4340406013824896
Odchylenie standardowe wartości funkcji celu: 2.0835219285895623
```



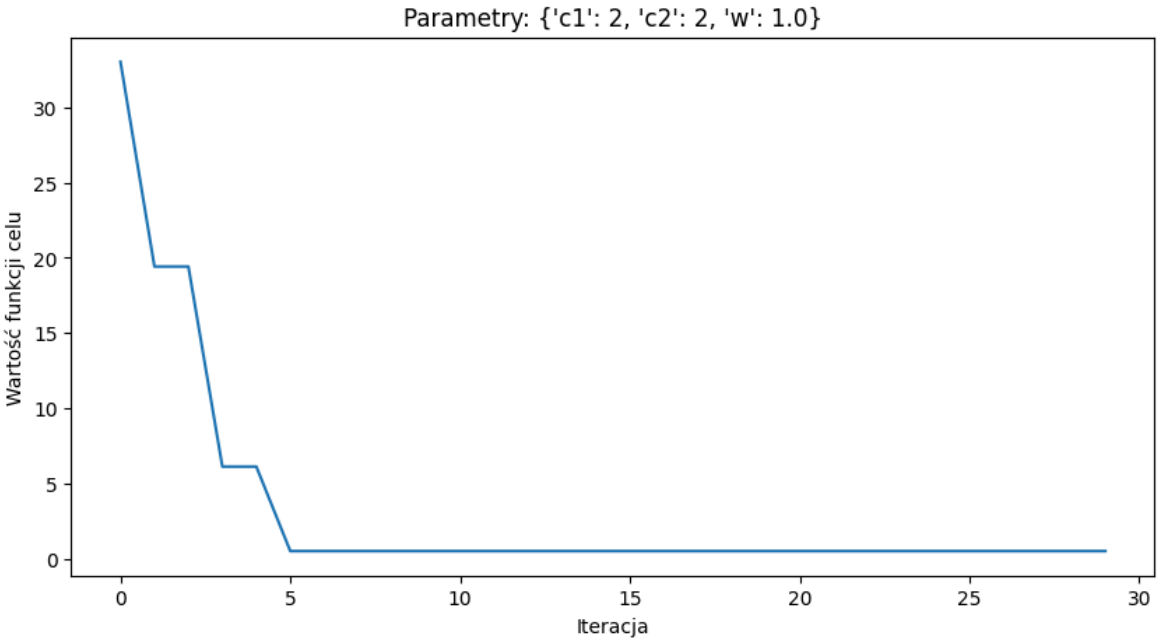

```
2024-05-12 10:55:30,303 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
Testowanie parametrów: {'c1': 2, 'c2': 2, 'w': 0.9}
```

```
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.52
2024-05-12 10:55:30,342 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.5227199011123767, best pos: [0.12377753 0.01195506]
2024-05-12 10:55:30,348 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.58
2024-05-12 10:55:30,378 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.5798433460667307, best pos: [-0.18789506  0.04010314]
2024-05-12 10:55:30,384 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.03
2024-05-12 10:55:30,415 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.0327542674392323, best pos: [-0.00336224 -0.10215723]
2024-05-12 10:55:30,421 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.66
2024-05-12 10:55:30,453 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.656691770585767, best pos: [0.03996019 2.05343236]
2024-05-12 10:55:30,460 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.21
2024-05-12 10:55:30,490 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.208451866152156, best pos: [ 0.19882596 -0.06284699]
2024-05-12 10:55:30,496 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.844
2024-05-12 10:55:30,572 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.8443697233978023, best pos: [0.09224419 0.00438595]
2024-05-12 10:55:30,581 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.89
2024-05-12 10:55:30,614 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.8864956596942584, best pos: [-0.12848647  0.05138166]
2024-05-12 10:55:30,619 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=5.44
2024-05-12 10:55:30,652 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 5.444936104320023, best pos: [-2.09967902  0.02527135]
2024-05-12 10:55:30,658 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.4
2024-05-12 10:55:30,689 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.395402528792439, best pos: [ 0.05847307 -1.94888286]
2024-05-12 10:55:30,695 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.9}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=5.5
2024-05-12 10:55:30,729 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 5.50183815694184, best pos: [-2.08454416 -0.06769752]
Średnia wartość funkcji celu: 3.3073503324502624
Odchylenie standardowe wartości funkcji celu: 1.7239391107625597
```




```
2024-05-12 10:55:30,851 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
Testowanie parametrów: {'c1': 2, 'c2': 2, 'w': 1.0}
```

```
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=3.54
2024-05-12 10:55:30,889 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 3.538265355117432, best pos: [ 0.18613025 -0.04260192]
2024-05-12 10:55:30,895 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.55
2024-05-12 10:55:30,927 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.545578559344453, best pos: [0.06978315 2.01194634]
2024-05-12 10:55:30,932 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.16
2024-05-12 10:55:30,964 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.160474283487639, best pos: [ 0.0442131  -1.97213648]
2024-05-12 10:55:30,971 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1.25
2024-05-12 10:55:31,003 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.2514196983215737, best pos: [0.02785157 0.10904964]
2024-05-12 10:55:31,008 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=2.72
2024-05-12 10:55:31,045 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 2.7225108908250886, best pos: [ 0.09956524 -0.13315054]
2024-05-12 10:55:31,052 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.433
2024-05-12 10:55:31,083 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.4330657004842911, best pos: [-0.06518236 -0.01047894]
2024-05-12 10:55:31,090 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=1
2024-05-12 10:55:31,122 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 1.0045853211927973, best pos: [0.06685438 0.07516083]
2024-05-12 10:55:31,127 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=4.24
2024-05-12 10:55:31,159 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 4.244999379119386, best pos: [ 0.07286264 -0.19617358]
2024-05-12 10:55:31,164 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=6.28
2024-05-12 10:55:31,197 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 6.284781426058256, best pos: [-1.82817685  0.03149269]
2024-05-12 10:55:31,202 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 1.0}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.498
2024-05-12 10:55:31,233 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.4984853744287958, best pos: [-0.07014446  0.00997469]
Średnia wartość funkcji celu: 2.8684165988379715
Odchylenie standardowe wartości funkcji celu: 1.9014429765874392
```



Wnioski: Dla c1=0 i c2=2, algorytm skupia się na ulepszaniu obecnych rozwiązań, ignorując eksplorację. Dla c1=2 i c2=0, algorytm skupia się na eksploracji, ignorując ulepszanie obecnych rozwiązań. Wartość w kontroluje prędkość cząstek, więc wpływa na balans między eksploracją a eksploatacją. Algorytm najlepiej sprawdził się dla c1 i c2 = 2 i w = 0.4.

2.

Uzyskany najlepszy wynik proszę w miarę możliwości porównać z algorytmem genetycznym – dedykowanym dla optymalizacji tej samej funkcji. Zakładamy użycie takiej samej liczby epok dla obu algorytmów. Należy porównać czas działania obydwu algorytmów.

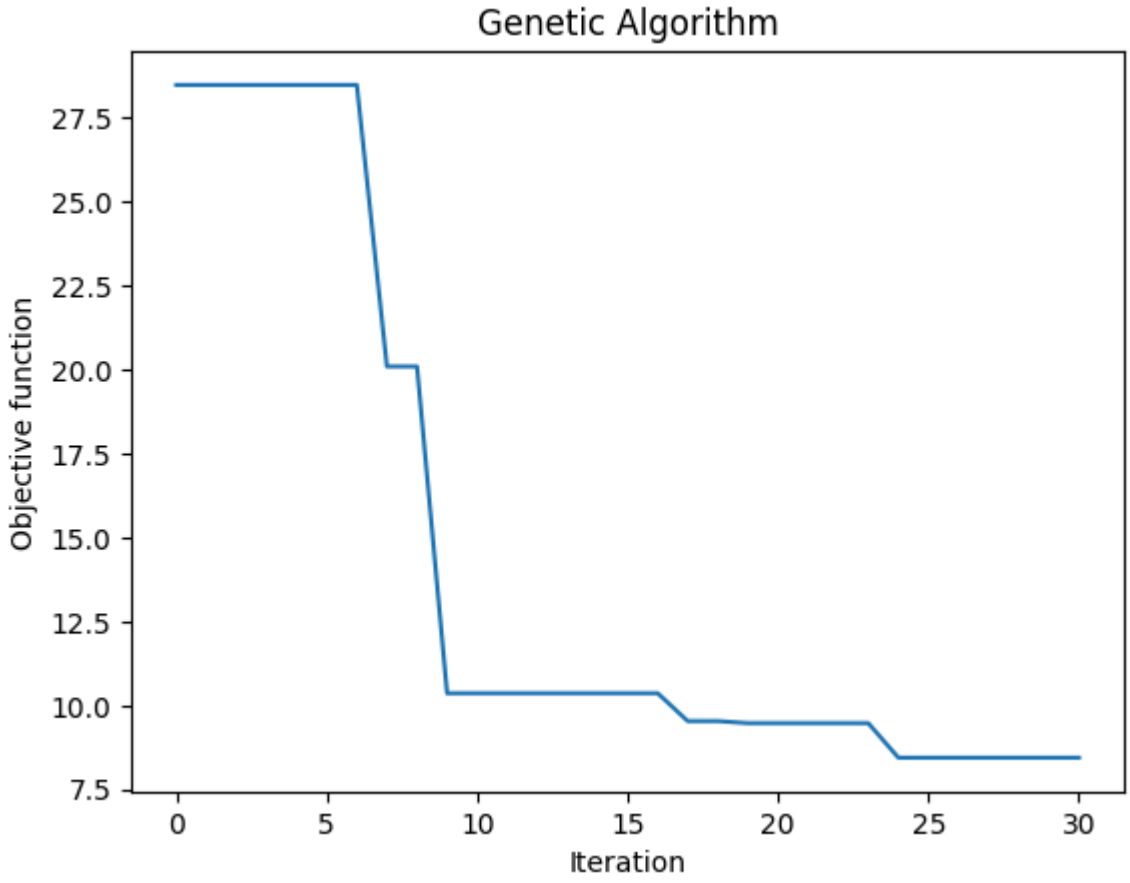
In [ ]:
```
import time
import numpy as np
from geneticalgorithm import geneticalgorithm as ga
import pyswarms as ps

def f(X):
    x = X.reshape(-1, 2)
    return x[:, 0]**2 + x[:, 1]**2 - 20 * (np.cos(np.pi * x[:, 0]) + np.cos(np.p
bounds = np.array([[-10, -10], [10, 10]])
start_time = time.time()
options = {'c1': 2, 'c2': 2, 'w': 0.4}
optimizer = ps.single.GlobalBestPSO(n_particles=30, dimensions=2, options=option
cost, pos = optimizer.optimize(f, iters=30)
pso_time = time.time() - start_time
print (f"\nKoszt PSO: {cost}")
print (f"Pozycja PSO: {pos}")
print (f"Czas PSO: {pso_time}")
# Measure the time taken by the genetic algorithm
start_time = time.time()
algorithm_parameters = {'max_num_iteration': 30, 'population_size': 30, 'parents
model = ga(function=f, dimension=2, variable_type='real', variable_boundaries=np
model.run()
ga_time = time.time() - start_time
```

```
print(f"\nKoszt GA: {model.output_dict['function']}")
print(f"Pozycja GA: {model.output_dict['variable']}")
print(f"Czas GA: {ga_time}")
```

```
2024-05-12 10:55:14,615 - pyswarms.single.global_best - INFO - Optimize for 30 it
ers with {'c1': 2, 'c2': 2, 'w': 0.4}
pyswarms.single.global_best: 100%|██████████|30/30, best_cost=0.0115
2024-05-12 10:55:14,662 - pyswarms.single.global_best - INFO - Optimization finis
hed | best cost: 0.011538709857014929, best pos: [-0.00676451 -0.00836576]
Koszt PSO: 0.011538709857014929
Pozycja PSO: [-0.00676451 -0.00836576]
Czas PSO: 0.052605628967285156
 The best solution found:
 [1.96822358 1.9080549 ]

 Objective function:
 8.442733648920946
```




```
Koszt GA: 8.442733648920946
Pozycja GA: [1.96822358 1.9080549 ]
Czas GA: 0.3962836265563965
```

Wnioski: Czas działania algorytmu PSO jest krótszy niż algorytmu genetycznego. PSO może być lepsze dla problemów, które wymagają szybkiego zbiegania, podczas gdy GA może być lepsze dla problemów, które wymagają intensywnej eksploracji przestrzeni rozwiązań.