

```

!pip install pygad
import pygad
import numpy
import numpy as np
import matplotlib.pyplot as plt

def func_3D(x,y):
    wynik = 20 * np.exp(-0.2 * np.sqrt(0.5 * (x*x + y*y))) + np.exp(0.5 * (np.cos(2*np.pi*x) + np.cos(2*np.pi*y))) - 20;
    return wynik

x = np.linspace(-4, 4, 100)
y = np.linspace(-4, 4, 100)
X, Y = np.meshgrid(x, y)
Z = func_3D(X,Y)
plt.rcParams["figure.figsize"] = (6,6)
fig = plt.figure()
ax = fig.add_subplot(projection='3d')
surface = ax.plot_surface(X, Y, Z, cmap='coolwarm')
plt.show()

```

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def fitness_function(ga_instance, solution, solution_idx):
    return func_3D(solution[0],solution[1])

last_fitness = 0
def on_generation(ga_instance):
    global last_fitness
    print(f"Generation = {ga_instance.generations_completed}")
    print(f"Fitness = {ga_instance.best_solution(pop_fitness=ga_instance.last_generation_fitness)[1]}")
    print(f"Change = {ga_instance.best_solution(pop_fitness=ga_instance.last_generation_fitness)[1] - last_fitness}")
    print()
    last_fitness = ga_instance.best_solution(pop_fitness=ga_instance.last_generation_fitness)[1]

ga_instance = pygad.GA(
    num_generations=100,
    num_parents_mating=100,
    sol_per_pop=1000,
    num_genes=2,
    init_range_low=-4,
    init_range_high=4,
    fitness_func=fitness_function,
    crossover_type="single_point",
    parent_selection_type = "rws",
    mutation_type = "random",
    mutation_percent_genes=10,
    on_generation=on_generation,
    mutation_by_replacement=True,
    random_mutation_min_val=-4,
    random_mutation_max_val=4,
)

print(ga_instance.population)

ga_instance.run()

solution, solution_fitness, solution_idx = ga_instance.best_solution()
print(f"Argumenty najlepszego rozw : {solution}")
print(f"Wartosc dla najlepszego rozw: {solution_fitness}")

def wykres_populacji(ga_instance):
    x = np.linspace(-4, 4, 100)
    y = np.linspace(-4, 4, 100)
    X, Y = np.meshgrid(x, y)
    Z = func_3D(X,Y)
    plt.contour(X, Y, Z, cmap='coolwarm')
    plt.plot(ga_instance.population[:,0], ga_instance.population[:,1], 'bo')
    plt.show()

```

```
wykres_populacji(ga_instance)
```

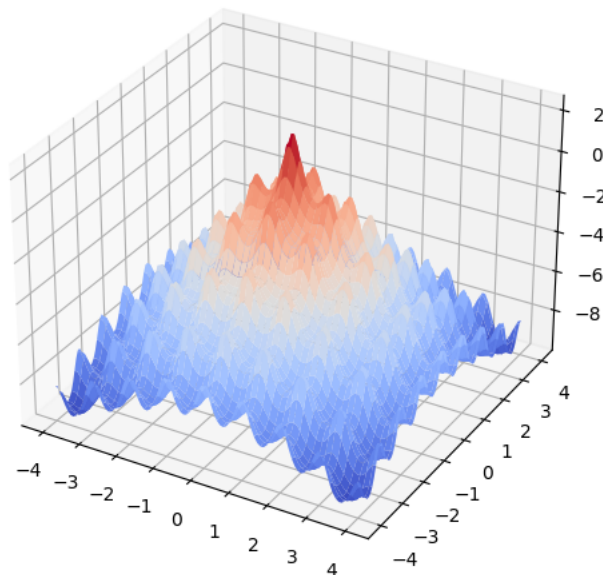


Collecting pygad

Downloading pygad-3.2.0-py3-none-any.whl (80 kB)

80.8/80.8 kB 1.4 MB/s eta 0:00:00

```
Requirement already satisfied: cloudpickle in /usr/local/lib/python3.10/dist-packages (from pygad) (2.2.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (from pygad) (3.7.1)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from pygad) (1.23.5)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pygad) (1.2.0)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pygad) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pygad) (4.47.2)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pygad) (1.4.5)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pygad) (23.2)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pygad) (9.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pygad) (3.1.1)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.10/dist-packages (from matplotlib->pygad) (2.8.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.7->matplotlib->pygad) (1.16.0)
Installing collected packages: pygad
Successfully installed pygad-3.2.0
```



```
/usr/local/lib/python3.10/dist-packages/pygad/pygad.py:748: UserWarning: The percentage of genes to mutate (mutation_percent_genes=10) r
If you do not want to mutate any gene, please set mutation_type=None.
```

```
warnings.warn(f"The percentage of genes to mutate (mutation_percent_genes={mutation_percent_genes}) resulted in selecting ({mutation_n
```

```
[[ 3.81783332 -2.84078543]
 [-3.10780394 -2.8042903 ]
 [ 1.91343551  3.1444426 ]
 ...
 [ 0.94342258 -3.97841894]
 [ 3.75412227  2.80236917]
 [-2.34201444 -1.98740116]]
```

```
Generation = 1
Fitness =2.3106462021531513
Change =2.3106462021531513
```

```
Generation = 2
Fitness =2.3106462021531513
Change =0.0
```

```
Generation = 3
Fitness =2.3106462021531513
Change =0.0
```

```
Generation = 4
Fitness =2.3106462021531513
Change =0.0
```

```
Generation = 5
Fitness =2.3106462021531513
Change =0.0
```

```
Generation = 6
Fitness =2.3106462021531513
Change =0.0
```

```
Generation = 7
Fitness =2.3106462021531513
Change =0.0
```

```
Generation = 8
Fitness =2.3106462021531513
Change =0.0
```