

In [4]:

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import random
from scipy.optimize import minimize

def f(x):
    x1, x2 = x
    return 0.25*x1**4 + x2**2 - 0.5*x1**2 + 0.125*x1 + 0.0625*(x1 - x2)

random.seed(0)
initial_points = [(random.uniform(-3, 3), random.uniform(-3, 3)) for _ in range(128)]

mins = []
for i, point in enumerate(initial_points):
    res = minimize(f, point, method='BFGS')
    mins.append(res.x)
    print(f"Minimum {i+1}: {res.x} Początek: {point}")
```

```
Minimum 1: [0.88819998 0.03124999] Initial Point: (2.0665311091502883, 1.5477264176418153)
Minimum 2: [-1.08310383 0.03125098] Initial Point: (-0.47657051501493, -1.44649949824222)
Minimum 3: [-1.08310368 0.03124999] Initial Point: (0.0676483282116509, -0.5703951752975143)
Minimum 4: [0.8881998 0.03124999] Initial Point: (1.702791534208636, -1.1801236435264353)
Minimum 5: [-1.08310409 0.03124997] Initial Point: (-0.14041827508586513, 0.5002922367301874)
Minimum 6: [0.88819978 0.03124995] Initial Point: (2.448677311172011, 0.028121134904341538)
Minimum 7: [-1.08310389 0.03124928] Initial Point: (-1.308972933601777, 1.5348252249433436)
Minimum 8: [0.88820274 0.03125006] Initial Point: (0.7102139800519898, -1.4969619518253567)
Minimum 9: [0.88819909 0.03124816] Initial Point: (2.4584775358094406, 2.8967128562259186)
Minimum 10: [0.88819981 0.03124996] Initial Point: (1.8613034159795374, 2.412995702637496)
Minimum 11: [-1.08310397 0.03125 ] Initial Point: (-1.1391145840840042, 1.3789904895607723)
Minimum 12: [0.88819979 0.03124999] Initial Point: (2.393029727807961, 1.1039035914926476)
Minimum 13: [-1.0831038 0.03124995] Initial Point: (-0.16714370728371986, -2.395792751589805)
Minimum 14: [-1.08310158 0.03124878] Initial Point: (-0.3949689872772977, 0.6653218406628096)
Minimum 15: [0.88819962 0.03124928] Initial Point: (2.4780663194273895, 2.799638206624553)
Minimum 16: [-1.0831056 0.03125071] Initial Point: (-0.1379413406836978, 2.191859566629841)
Minimum 17: [-1.08310744 0.03124768] Initial Point: (-1.4370461376482435, 1.8301669620781338)
Minimum 18: [0.88820043 0.03125104] Initial Point: (0.29219582301353597, -2.9157497990158863)
Minimum 19: [0.88819982 0.03124991] Initial Point: (1.3182281184237246, -0.6070587466543875)
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