Defferential Evolution (Sphere Func.)

```
import numpy as np
import random
from array import *
import matplotlib.pyplot as plt
import statistics as st
import math


D = 10 # Dimensi dari permasalahan
maxit = 99 #Max iterasi
ukuranPopulasi = 10
LB = -10 #Batas Bawah
UB = 10 #Batas Atas
CR = 0.9
F = 0.5
```

```
import random
def initPopulasi(ukuranPopulasi, D, UB, LB): #Inisialisasi setiap baris kolom
    P = np.empty((ukuranPopulasi,D))
    for i in range(ukuranPopulasi):
        for j in range(D):
            P[i][j]= (random.random()*(UB-LB))+LB
    return P

P = initPopulasi(ukuranPopulasi, D, UB, LB)
print(P)
```

```
[[ 5.69622364 -9.77272772 -8.23100607 -6.47651935 -7.01127811  2.86234108
   9.15963831 -8.82896704 -6.82454823 -8.44254531]
 [-8.50629736  6.44187377  2.43136056 -5.28877532  1.70407556  6.15200632
  -0.80228779 -1.23550781 -1.64848515 -0.67735818]
 [ 3.96002675 -2.56211483 -1.17381326  4.28349931 -1.97867226  2.51688329
   7.15746641 -4.11080985  2.21996604 -7.81933746]
 [ 2.66710187  4.31371608 -3.87726489  5.30822543  8.99155279 -2.91639314
   7.78476023  4.32537916  0.38064641  4.77324052]
 [ 4.96449287 -3.61168306  9.56688097  3.48700723  5.9448273   2.48740972
   9.05995896 -1.06552936  6.83874003  8.77041278]
 [-4.85051854 -7.43523641 -6.37721882 -8.45204101  9.24913917 -0.03213903
  -5.86917081 -9.92411394 -6.26045077  9.69013618]
 [-0.34018508  8.72744673 -4.44127703 -8.22533886 -2.42806967  8.74088018
  -3.05250204 -7.61924065  5.51878122  1.66888765]
 [ 0.78397727 -5.63639414 -4.88399924 -3.32307591 -4.88506801  2.59119844
   5.51257767 -1.91504583 -1.91480962  6.93258055]
 [-9.02182498  8.99499721 -5.34738778  4.37025215 -4.30535137  5.39403455
   2.56665363  7.14115949 -4.09935427 -4.58248127]
 [-1.9732305   7.363828    6.77122162 -6.75696552 -6.86499639 -2.38402261
  -5.90980649  0.24289997 -6.75298643  5.1915824 ]]
```

```
def funcSphere(populasi):
```

```
    ukuran = populasi.shape
    ukuranPopulasi = ukuran[0]
    dimensi = ukuran[1]

    Fobj = np.empty(ukuranPopulasi)

    for i in range (ukuranPopulasi):
        d = 0
        for j in range (dimensi):
            d = d + populasi[i][j]**2
            # d = d + np.sum(np.abs(populasi[i][j])) + np.product(np.abs(populasi[i][j]))
            # d = d + np.sum(100*(populasi[i][j]+1)-(populasi[i][j]))**2 + (populasi[i][j]
            # d =  d + np.sum( (populasi[i][j]**2) - (10*math.cos(2*math.pi*populasi[i][j]
        Fobj[i] = d
    return Fobj

Fobj = funcSphere(P)
print(Fobj)
```

```
 [574.69961469 193.83500895 186.42066406 260.52550295 389.8097685
  542.49098258 346.57643084 183.64112218 353.01632961 309.97753267]
```

```
def crossOver(populasi,F,j):
    ukuran = populasi.shape
    ukuranPopulasi = ukuran[0]
    Dimensi = ukuran[1]

    r1 = random.randint(0, ukuranPopulasi-1)
    r2 = random.randint(0, ukuranPopulasi-1)
    r3 = random.randint(0, ukuranPopulasi-1)

    while r1 == r2:
        r2 = (r2 + 1)%ukuranPopulasi

    while r3 == r1 or r3 == r2:
        r3 = (r3 + 1)%ukuranPopulasi

    v = P[r3][j] + F*(P[r1][j] - P[r2][j])
    return v

v = crossOver(P,F,1)
print(v)
```

```
 0.23808210577046385
```

```
P = initPopulasi(ukuranPopulasi, D, UB, LB)
print("Inisialisasi Populasi :\n",P)
print(P)

Fobj = funcSphere(P)
print(Fobj)
```

```
print("\nFungsi Objective :\n",Fobj)

U = np.empty((1,D))
bestFobj = np.empty((maxit+1))
bestFobj[0] = Fobj.min()

for it in range(maxit):
    for i in range(ukuranPopulasi):
        for j in range(D):
            U[0][j] = P[i][j]

        jrand=random.randint(0,D)

        for j in range(D):
            if random.random() < CR or j == jrand:
                v = crossOver(P,F,j)
                U[0][j] = v

        FobjU = funcSphere(U)

        if FobjU < Fobj[i]:
            Fobj[i] = FobjU
            for j in range(D):
                P[i][j] = U[0][j]

    bestFobj[it+1] = Fobj.min()

    print("\nNilai Optimal : \n",bestFobj)

    for i in range(30):
        bestFobj
```

```
  7.64587745e+00 7.64587745e+00 5.67610107e+00 5.28473509e+00
  4.53707649e+00 3.58652646e+00 3.58652646e+00 1.06292963e+00
  1.06292963e+00 1.06292963e+00 1.06292963e+00 1.06292963e+00
  9.12842930e-01 9.12842930e-01 9.12842930e-01 7.81364918e-01
  5.88571546e-01 3.86149953e-01 3.86149953e-01 3.86149953e-01
  3.86149953e-01 3.86149953e-01 3.86149953e-01 2.79320565e-01
  2.35460975e-01 2.35460975e-01 2.31905451e-01 1.95616440e-01
  1.95616440e-01 1.95616440e-01 1.49883717e-01 1.49883717e-01
  1.49883717e-01 1.26493585e-01 1.02858042e-01 8.93648664e-02
  3.19110875e-02 3.19110875e-02 3.19110875e-02 1.75648542e-02
  1.75648542e-02 1.75648542e-02 1.75648542e-02 1.75648542e-02
  1.75648542e-02 1.75648542e-02 1.75648542e-02 1.75648542e-02
  1.07193586e-02 1.07193586e-02 1.07193586e-02 1.07193586e-02
  9.60403792e-03 5.60006056e-03 5.15511046e-03 3.32847529e-03
  3.32847529e-03 2.94986216e-03 4.01274509e+00 9.68362150e+00]

 Nilai Optimal :
  [2.58455405e+02 2.58455405e+02 2.58455405e+02 2.58455405e+02
  1.79098417e+02 1.66839068e+02 1.66839068e+02 1.61870264e+02
  1.61870264e+02 1.57014684e+02 1.17593958e+02 1.17593958e+02
  1.01152373e+02 1.01152373e+02 1.01152373e+02 9.48490093e+01
  9.48490093e+01 8.30231256e+01 8.30231256e+01 8.30231256e+01
  8.10216226e+01 8.10216226e+01 8.10216226e+01 8.10216226e+01
  7.39386141e+01 6.31351088e+01 6.31351088e+01 6.31351088e+01
  4.23278480e+01 4.10339568e+01 4.10339568e+01 1.75357761e+01
  1.75357761e+01 1.75282522e+01 1.75282522e+01 1.75282522e+01
```

```
 1.75357761e+01 1.75282523e+01 1.75282523e+01 1.75282523e+01
 1.75282523e+01 1.01260533e+01 1.01260533e+01 1.01260533e+01
 7.64587745e+00 7.64587745e+00 5.67610107e+00 5.28473509e+00
 4.53707649e+00 3.58652646e+00 3.58652646e+00 1.06292963e+00
 1.06292963e+00 1.06292963e+00 1.06292963e+00 1.06292963e+00
 9.12842930e-01 9.12842930e-01 9.12842930e-01 7.81364918e-01
 5.88571546e-01 3.86149953e-01 3.86149953e-01 3.86149953e-01
 3.86149953e-01 3.86149953e-01 3.86149953e-01 2.79320565e-01
 2.35460975e-01 2.35460975e-01 2.31905451e-01 1.95616440e-01
 1.95616440e-01 1.95616440e-01 1.49883717e-01 1.49883717e-01
 1.49883717e-01 1.26493585e-01 1.02858042e-01 8.93648664e-02
 3.19110875e-02 3.19110875e-02 3.19110875e-02 1.75648542e-02
 1.75648542e-02 1.75648542e-02 1.75648542e-02 1.75648542e-02
 1.75648542e-02 1.75648542e-02 1.75648542e-02 1.75648542e-02
 1.07193586e-02 1.07193586e-02 1.07193586e-02 1.07193586e-02
 9.60403792e-03 5.60006056e-03 5.15511046e-03 3.32847529e-03
 3.32847529e-03 2.94986216e-03 2.94986216e-03 9.68362150e+00]

Nilai Optimal :
 [2.58455405e+02 2.58455405e+02 2.58455405e+02 2.58455405e+02
 1.79098417e+02 1.66839068e+02 1.66839068e+02 1.61870264e+02
 1.61870264e+02 1.57014684e+02 1.17593958e+02 1.17593958e+02
 1.01152373e+02 1.01152373e+02 1.01152373e+02 9.48490093e+01
 9.48490093e+01 8.30231256e+01 8.30231256e+01 8.30231256e+01
 8.10216226e+01 8.10216226e+01 8.10216226e+01 8.10216226e+01
 7.39386141e+01 6.31351088e+01 6.31351088e+01 6.31351088e+01
 4.23278480e+01 4.10339568e+01 4.10339568e+01 1.75357761e+01
 1.75357761e+01 1.75282523e+01 1.75282523e+01 1.75282523e+01
 1.75282523e+01 1.01260533e+01 1.01260533e+01 1.01260533e+01
 7.64587745e+00 7.64587745e+00 5.67610107e+00 5.28473509e+00
 4.53707649e+00 3.58652646e+00 3.58652646e+00 1.06292963e+00
 1.06292963e+00 1.06292963e+00 1.06292963e+00 1.06292963e+00
 9.12842930e-01 9.12842930e-01 9.12842930e-01 7.81364918e-01
```

```
import statistics as st
print("Nilai Mean : ",st.mean(bestFobj))
print("Nilai Standard Deviation : ",st.stdev(bestFobj))
print("Nilai Minimal : ",np.min(bestFobj))
```

```
Nilai Mean :  39.045273875157235
Nilai Standard Deviation :  65.73583350532162
Nilai Minimal :  0.00294986216248811
```

```
x = np.linspace(0, 1, maxit+1)
plt.plot(x, bestFobj, label= 'f=Fobj')
plt.show()
```

Genetic Algorithm

```
import numpy as np
import random
from array import *
import matplotlib.pyplot as plt
import statistics as st
import math


N = 3
rows, cols = (N, 4)
induk = [[0 for i in range(cols)] for j in range(rows)]
print (induk)

N_Anak = 6
rows, cols = (N_Anak, 4)
anak = [[0 for i in range(cols)] for j in range(rows)]
print(anak)
```

```
[[0, 0, 0, 0], [0, 0, 0, 0], [0, 0, 0, 0]]
[[0, 0, 0, 0], [0, 0, 0, 0], [0, 0, 0, 0], [0, 0, 0, 0], [0, 0, 0, 0], [0, 0, 0, 0]]
```

```
#Inisialiasi Parameter
Pc = 0.9
Pm = 0.1

for i in range(N):
    a = random.randint(0, 15)
    induk[i] = [int (x) for x in '{:04b}'.format(a)]
    print(a, induk[i])
```

```
15 [1, 1, 1, 1]
0 [0, 0, 0, 0]
6 [0, 1, 1, 0]
```

```
#Function cross over
def crossover(ind1=[], ind2=[]):
    anak1 = [0, 0, 0, 0]
    anak2 = [0, 0, 0, 0]
```

```
    anak1[0] = ind1[0]
    anak1[1] = ind1[1]
    anak1[2] = ind2[2]
    anak1[3] = ind2[3]

    anak2[0] = ind2[0]
    anak2[1] = ind2[1]
    anak2[2] = ind1[2]
    anak2[3] = ind1[3]

    return anak1, anak2



#Function  mutasi
def mutasi(ind=[]):
    ind[1] = 1 - ind[1]
    return ind



#Function hitung Int
def hitungInt(ind = []):
    a = ind[3] * 1
    a = a + ind[2] * 2
    a = a + ind[1] * 4
    a = a + ind[0] * 8
    return a



#Buat function untuk melakukan hitung fitness
def hitungFitness(ind = []):
    a = hitungInt(ind)
    y = a**2 #sphere
    #y = np.sum(np.abs(a)) + np.product(np.abs(a)) #schwefel 2.22
    #y = np.sum(100*(a+1)-(a))**2 + (a-1)**2 #Generalize rosenbrock
    # y = np.sum( (a**2) - (10*math.cos(2*math.pi*a)) + 10 ) #rastrigins

    return y


i = 1
epochs = 99
MaxFitness = [0 for i in range(epochs)]
angkaFitness = [0 for i in range(epochs)]

#nilai fitness induk
for j in range(N):
    if (hitungFitness(induk[j])>MaxFitness[0]):
        MaxFitness[0] = hitungFitness(induk[j])



#Melakukan perulangan sampai 'epochs' kali
```

```
    for i in range(30):
      while i < epochs:
        print("Iterasi: ", i+1)
        #Reproduksi
        a = random.random()
        if (a<Pc):
            #Cross over
            anak[0], anak[1] = crossover(induk[0], induk[1])
            anak[2], anak[3] = crossover(induk[0], induk[2])
            anak[4], anak[5] = crossover(induk[1], induk[2])
        else:
            #Mutasi
            for j in range(N):
                induk [j] = mutasi(induk[j])
        # ---------------------------------- end reproduksi
        #Elistism
        minFitness = 10
        idx = 0
        idxanak = 0
        #Cari minFitness (induk terburuk)
        for j in range(len(induk)):
            #print(minFitness, hitungFitness(induk[j]))
            if (hitungFitness(induk[j])<minFitness):
                minFitness = hitungFitness(induk[j])
                idx = j

        #cari maxFit (Anak terbaik)
        maxFit = -10
        for j in range(len(anak)):
            if (hitungFitness(anak[j])>maxFit):
                maxFit = hitungFitness(anak[j])
                idxanak = j
        #Bandingkan individual replacement
        if (minFitness < maxFit):
            induk[idx] = anak[idxanak]

        #dari populasi induk yang baru mana yang paling baik
        for j in range(N):
            if (hitungFitness(induk[j])>MaxFitness[i]):
                MaxFitness[i] = hitungFitness(induk[j])
        i+=1

        print(MaxFitness)
```

```
 [225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  37
 [225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  38
 [225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  39
 [225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  40
 [225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  41
 [225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  42
```

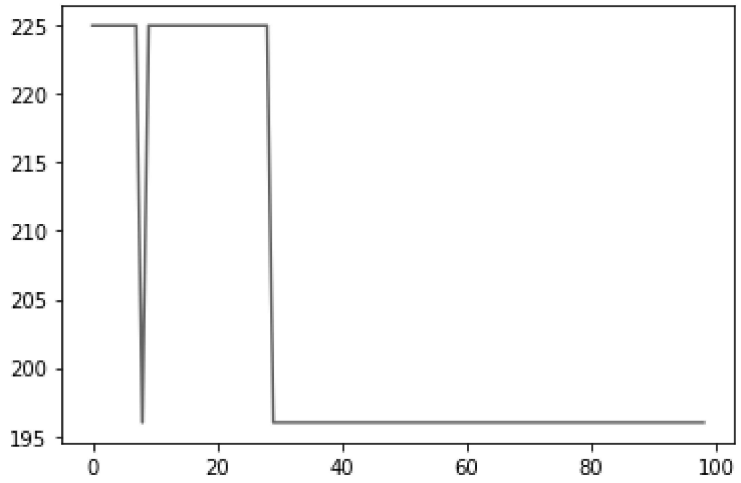
```
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  43
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  44
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  45
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  46
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  47
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  48
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  49
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  50
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  51
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  52
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  53
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  54
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  55
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  56
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  57
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  58
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  59
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  60
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  61
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  62
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  63
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  64
[225, 225, 225, 225, 225, 225, 225, 225, 196, 225, 225, 225, 225, 225, 225, 225, 2
```

```
print("Nilai Mean : ", st.mean(MaxFitness))
print("Nilai Standard Deviation : ", st.stdev(MaxFitness))
print("Nilai Minimal : ",np.min(MaxFitness))
```

```
Nilai Mean :  204.2020202020202
Nilai Standard Deviation :  13.127304305382667
Nilai Minimal :  196
```

```
x = [i for i in range(epochs)]
plt.plot(x, MaxFitness)
```

```
[<matplotlib.lines.Line2D at 0x7f1d07856c50>]
```



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