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 = 495 #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)
```

```
[[ 1.25854374  6.00496673 -0.80081935 -1.63653239 -5.90776991  2.19084589
   1.69184659 -5.2834609  -0.77973984  3.56849395]
 [ 2.23084456  3.09611376  5.01701021  2.0874062  -5.16332365 -1.42273365
  -1.04396225  6.93925027 -9.35876768 -8.43459904]
 [ 4.69102819  9.88138155 -7.73826089  0.34543733 -5.35028949 -4.44966847
  -3.34784932 -2.55603186  4.43899427  9.08185793]
 [ 9.36851766  5.95287885  4.07355641  9.59290151 -1.55498599  4.80833032
  -6.7427817   8.60564353  3.94862647 -1.56634069]
 [ 3.41190335 -5.01320158 -9.89743295 -3.87440944  9.14247475  4.03988795
  -0.23720503  0.09225919  7.46266585  7.73424011]
 [-0.40132684  2.35851844  8.78183253  4.82088921  9.85156514  1.54809588
  -2.35870911  9.89695848  8.13541952 -0.93450151]
 [ 8.99687731  2.54131602 -8.10051928 -3.56089312 -4.19691749  6.77286244
   3.18384957  1.67901093 -2.08168662  7.22279119]
 [ 2.82114329 -3.71431806  2.56267199  9.51030833 -7.89746924 -5.91139758
  -5.89012647 -0.02026072 -4.43484796 -8.92449722]
 [-8.92430203  7.6012156  -5.19782469  4.79290713  3.59175152  8.6580248
   6.21574871  3.84333007  0.83784332  9.04036757]
 [-6.37040742  5.28847171  8.7024512  -9.58915382  3.00657764 -1.03157378
  -9.31695871  9.43488774 -4.85018763  9.46418245]]
```

```
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)
```

```
 [124.78410593 280.74637114 347.99881016 394.92881247 365.22367093
  376.10680392 298.64435054 350.09142937 411.11000333 535.25610075]
```

```
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)
```

```
 15.032218194692597
```

```
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
```

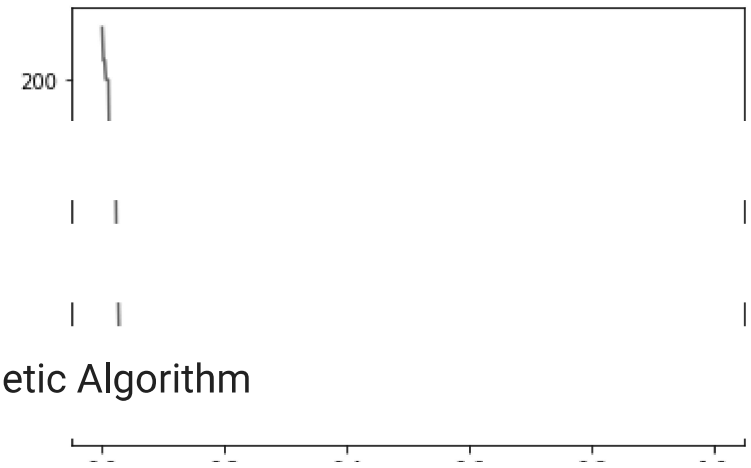
```
  3.91563390e-001 3.91563390e-001 3.91563390e-001 3.91563390e-001
  3.91563390e-001 3.91563390e-001 3.91563390e-001 3.91563390e-001
  3.91563390e-001 3.91563390e-001 3.91563390e-001 3.91563390e-001
  3.91563390e-001 3.91563390e-001 2.25000000e+002 2.25000000e+002
  2.25000000e+002 2.25000000e+002 2.25000000e+002 1.43141213e-153]

 Nilai Optimal :
  [2.29669099e+002 2.10779225e+002 2.10779225e+002 1.99596194e+002
  1.99596194e+002 1.99596194e+002 1.49876667e+002 1.49876667e+002
  1.49876667e+002 1.49876667e+002 1.49876667e+002 1.40179691e+002
  8.55127965e+001 7.45159176e+001 4.01315940e+001 4.01315940e+001
  4.01315940e+001 4.01315940e+001 4.01315940e+001 3.96218667e+001
  3.96218667e+001 3.96218667e+001 2.19345046e+001 2.19345046e+001
  2.19345046e+001 2.19345046e+001 2.19345046e+001 2.19345046e+001
  2.19345046e+001 2.02940520e+001 1.72429667e+001 1.72429667e+001
  1.56688237e+001 1.56688237e+001 1.11193422e+001 1.01214844e+001
  7.25096147e+000 3.95283925e+000 3.95283925e+000 3.95283925e+000
  3.45810327e+000 3.15275394e+000 1.83098485e+000 1.83098485e+000
  1.83098485e+000 1.83098485e+000 1.83098485e+000 1.35915778e+000
  1.31470168e+000 1.13048845e+000 1.13048845e+000 1.13048845e+000
  1.13048845e+000 1.13048845e+000 9.09315763e-001 9.09315763e-001
  9.09315763e-001 7.69522930e-001 7.69522930e-001 7.69522930e-001
  6.87996259e-001 6.49335430e-001 6.48189791e-001 6.08875832e-001
  6.08875832e-001 5.18710464e-001 4.98908265e-001 4.98908265e-001
  4.88678126e-001 4.53025775e-001 4.53025775e-001 4.53025775e-001
  4.53025775e-001 4.53025775e-001 4.51692244e-001 4.25187429e-001
```

```
4.53025775e-001 4.53025775e-001 4.51692244e-001 4.25187429e-001
4.25187429e-001 4.25187429e-001 4.25187429e-001 4.21967653e-001
4.21967653e-001 4.20161659e-001 4.20161659e-001 4.20161659e-001
4.12482100e-001 4.07165505e-001 4.05548909e-001 4.05548909e-001
4.05548909e-001 4.05548909e-001 4.05548909e-001 4.04260237e-001
4.04260237e-001 4.00996995e-001 4.00996995e-001 3.99947037e-001
3.99947037e-001 3.99552391e-001 3.98549389e-001 3.98549389e-001
3.98549389e-001 3.98477790e-001 3.98477790e-001 3.98477790e-001
3.96501906e-001 3.96501906e-001 3.96501906e-001 3.96501906e-001
3.96242195e-001 3.96242195e-001 3.95874523e-001 3.95853586e-001
3.95853586e-001 3.95853586e-001 3.95049637e-001 3.95049637e-001
3.95049637e-001 3.94949118e-001 3.94949118e-001 3.94680765e-001
3.94680765e-001 3.94598856e-001 3.94106362e-001 3.93967726e-001
3.93668263e-001 3.93668263e-001 3.93668263e-001 3.93541330e-001
3.93541330e-001 3.93159496e-001 3.93159496e-001 3.92929619e-001
3.92929619e-001 3.92929619e-001 3.92796933e-001 3.92709599e-001
3.92709599e-001 3.92609678e-001 3.92603582e-001 3.92603582e-001
3.92603582e-001 3.92496087e-001 3.92411368e-001 3.92400995e-001
3.92400995e-001 3.92379227e-001 3.92333683e-001 3.92282903e-001
3.92256597e-001 3.92148863e-001 3.92148863e-001 3.92148863e-001
3.92141295e-001 3.92141295e-001 3.92081993e-001 3.92081993e-001
3.92081993e-001 3.92060777e-001 3.91958022e-001 3.91958022e-001
3.91920818e-001 3.91920818e-001 3.91913330e-001 3.91887973e-001
3.91881820e-001 3.91851374e-001 3.91831678e-001 3.91826280e-001
3.91821983e-001 3.91814582e-001 3.91781606e-001 3.91760502e-001
3.91760154e-001 3.91718448e-001 3.91698640e-001 3.91689446e-001
3.91689446e-001 3.91670250e-001 3.91654849e-001 3.91650896e-001
3.91650896e-001 3.91640925e-001 3.91625882e-001 3.91625882e-001
3.91623556e-001 3.91616844e-001 3.91616817e-001 3.91613392e-001
3.91606157e-001 3.91606157e-001 3.91606157e-001 3.91604876e-001
3.91603547e-001 3.91595652e-001 3.91595580e-001 3.91593937e-001
3.91590336e-001 3.91589211e-001 3.91589211e-001 3.91586633e-001
3.91586633e-001 3.91586519e-001 3.91585927e-001 3.91585927e-001
```

```
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 :  6.253351485484217
Nilai Standard Deviation :  28.59080188472914
Nilai Minimal :  0.3915633902944092
```

```
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])
```

```
     14 [1, 1, 1, 0]
     10 [1, 0, 1, 0]
     0 [0, 0, 0, 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 = 495
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])



#'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])
        #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
        #individual replacement
        if (minFitness < maxFit):
            induk[idx] = anak[idxanak]

        #populasi induk 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, 225, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  371
 [225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  372
 [225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  373
 [225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  374
 [225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  375
 [225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  376
 [225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
 Iterasi:  377
```

```
[225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  378
[225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  379
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Iterasi:  380
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Iterasi:  392
[225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  393
[225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  394
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Iterasi:  395
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Iterasi:  396
[225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  397
[225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  398
[225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 225, 2
Iterasi:  399
```
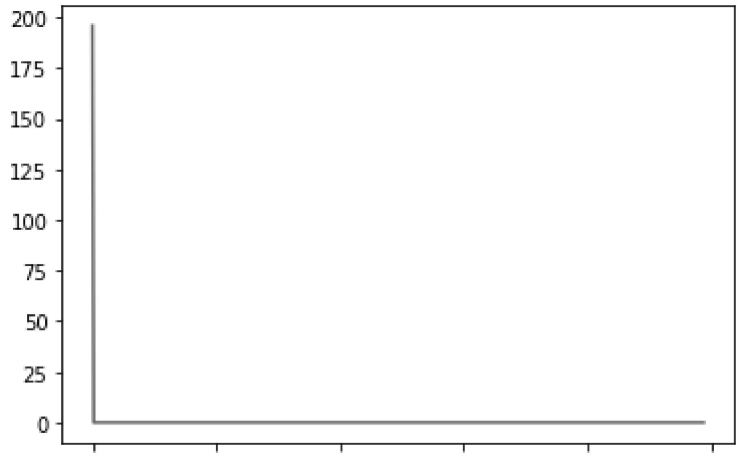

```
print("Nilai Mean : ", st.mean(MaxFitness))
print("Nilai Standard Deviation : ", st.stdev(MaxFitness))
print("Nilai Minimal : ",np.min(MaxFitness))
```

```
Nilai Mean :  0.39595959595959596
Nilai Standard Deviation :  8.809544869519696
Nilai Minimal :  0
```

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

```
[<matplotlib.lines.Line2D at 0x7f1d0763ee50>]
```



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