

**UJIAN TENGAH SEMESTER** Nama

Matakuliah : Teknik Optimalisasi  
Waktu : Take Home Test  
Dosen : Hendry, PhD  
Sifat : Open Book

**PETUNJUK Pengerjaan :**

- Berdoalah sebelum Anda mulai mengerjakan.
- Kerjakanlah soal berikut ini dengan cermat dan teliti !

Selesaikan permasalahan kontinu berikut menggunakan metode algoritma genetik dan differential evolution. Mahasiswa bisa mengembangkan dari metode dasar yang sudah dipelajari dalam materi mata kuliah.

No	Nama Fungsi	Formula fungsi objektif	Ukuran Dimensi	Search Space
1	Sphere function	$f_a = \sum_{i=1}^n x_i^2$	10	$[-10, 10]^n$
2	Schewel's function 2.22	$f_b = \sum_{i=1}^n  x_i  + \prod_{i=1}^n  x_i $	10	$[-10, 10]^n$
3	Generalized Rosenbrock function	$f_c = \sum_{i=1}^{n-1} [100(x_{i+1} - x_i^2)^2 + (x_i - 1)^2]$	10	$[-30, 30]^n$
4	Rastrigin's function	$f_d = \sum_{i=1}^n [x_i^2 - 10\cos(2\pi x_i) + 10]$	10	$[-5.12, 5.12]^n$

Lakukan eksperimen dengan kriteria

1. jumlah maksimum evaluasi fungsi objective adalah 1.000.

Contoh :

- a. misal populasinya 10, dan setiap iterasi menghasilkan 10 solusi baru, maka jumlah maksimum iterasi untuk kasus tersebut adalah  $\text{max\_it} = (1000-P)/10 = (1000-10)/10 = 99$
- b. misal populasinya 10, dan setiap iterasi menghasilkan 2 solusi baru, maka jumlah maksimum iterasi untuk kasus tersebut adalah  $\text{max\_it} = (1000-P)/2 = (1000-10)/2 = 495$
2. Setiap fungsi di run 30 kali, kemudian tentukan nilai terbaik, nilai rata-rata dan standar deviasinya

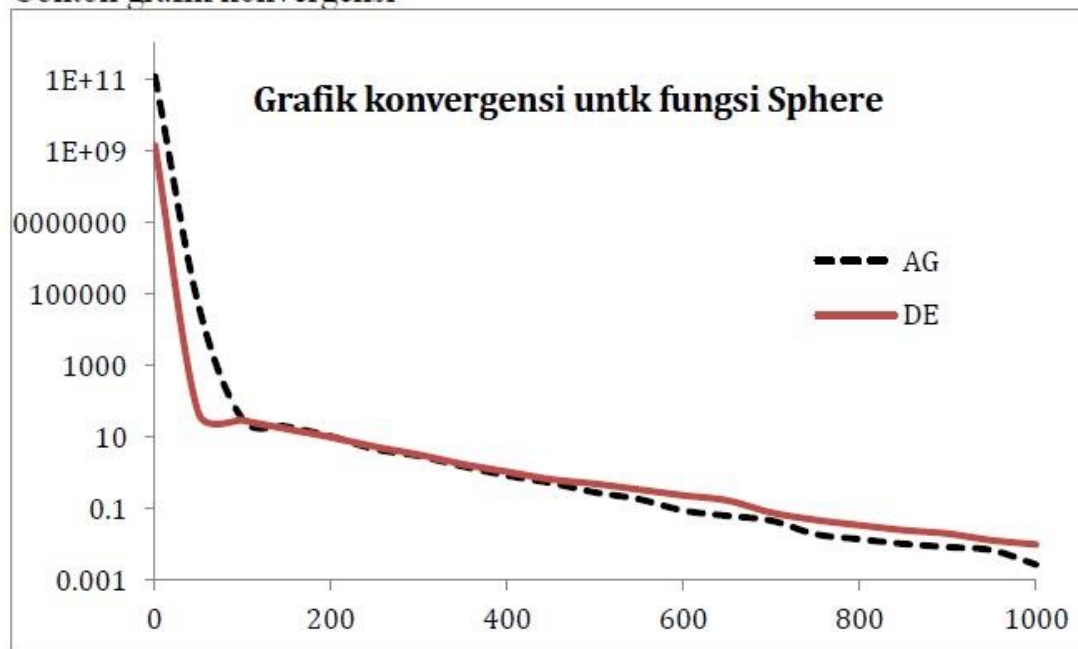
Hasil eksperimen kemudian dituliskan dalam bentuk laporan yang berisi:

1. Penjelasan metode metaheuristik yang dipakai untuk menyelesaikan permasalahan diatas. (representasi penyelesaian, tuning parameter, dll)
2. Hasil Experimen dan Analisisnya

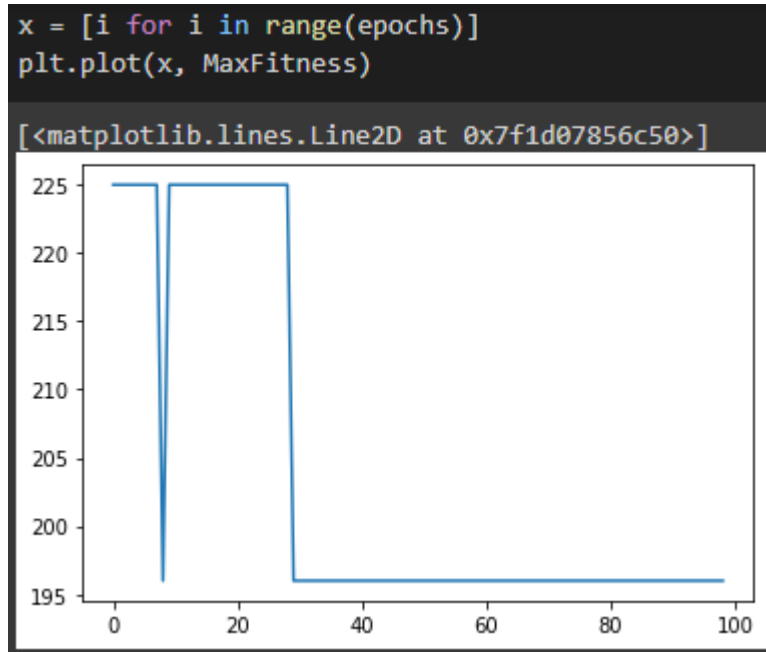
Fungsi	Algoritma genetik			Differential evolution		
	mean	stdev	min	mean	stdev	min
1 Sphere	3.29E-11	9.42E-11	1.61E-14	1.67E-09	2.70E-09	6.52E-11
2 Schewel's	1.23E-06	7.97E-07	1.53E-07	1.80E-05	1.57E-05	3.95E-06
3 Rosenbrock	3.89E+02	1.47E+02	1.44E+02	6.83E_02	2.64E+02	2.89E+02
4 Rastrigin's	1.25E+01	3.08E+00	7.02E+00	1.14E+01	3.86E+00	4.47E+00

Contoh menampilkan hasil dalam bentuk tabel

Contoh grafik konvergensi







B. Poin B

Dari hasil percobaan codingan menggunakan Algoritma Genetika dengan  $\text{max\_it} = (1000-P)/2 = (1000-10)/2 = 495$  serta nilai yang diketahui:

i = 1
epochs = 495
minFit = -10
maxFit = 10

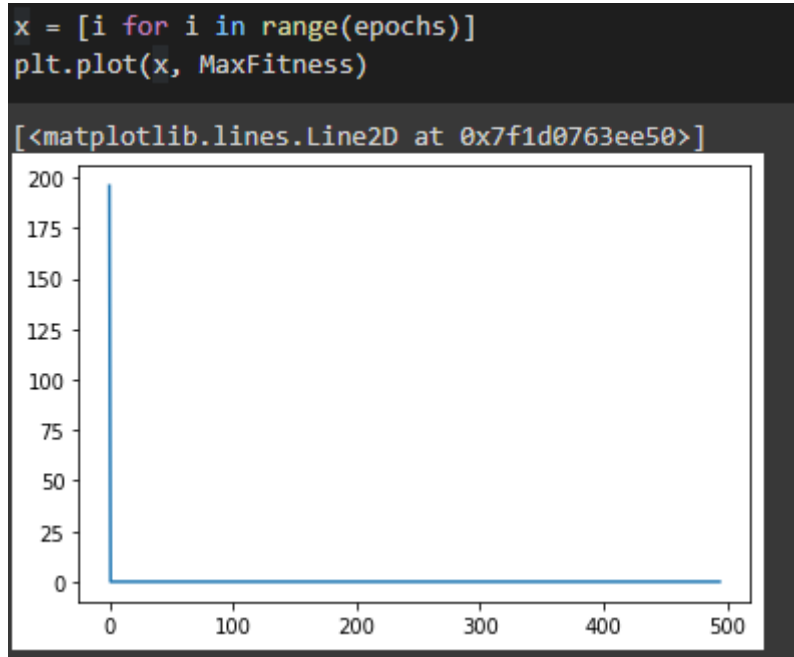
Menghasilkan Populasi:

```
[ 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]]
```

Serta fungsi di run sebanyak 30 kali menghasilkan:

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

Hasil Grafik:



### 1.2. Schewel's Function 2.22

### A. Poin A

Dari hasil percobaan codingan menggunakan Algoritma Genetika dengan  $\text{max\_it} = (1000-P)/10 = (1000-10)/10 = 99$  serta nilai yang diketahui:

i = 1
epochs = 99
minFit = -10
maxFit = 10

### Menghasilkan Populasi:

[illegible]

Serta fungsi di run sebanyak 30 kali menghasilkan:

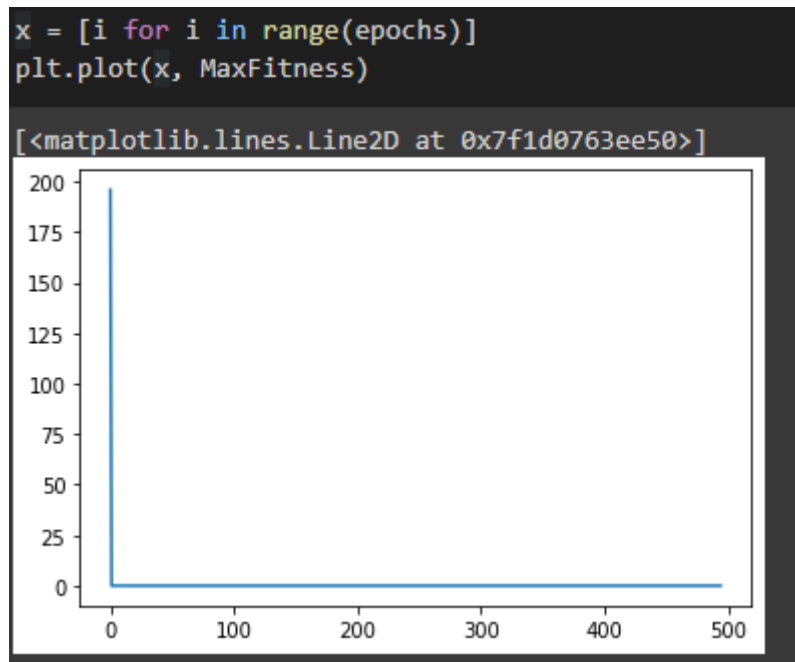
<b>Nilai Mean</b>	: 24
<b>Nilai Standard Deviation</b>	: 0
<b>Nilai Minimal</b>	: 24

Hasil Grafik:



Nilai Mean : 29  
Nilai Standard Deviation : 0  
Nilai Minimal : 22

Hasil Grafik:



### 1.3. Generalize rosenbrock Function

#### A. Poin A

Dari hasil percobaan codingan menggunakan Algoritma Genetika dengan  $\text{max\_it} = (1000-P)/10 = (1000-10)/10 = 99$  serta nilai yang diketahui:

$i = 1$

epochs = 99

minFit = -30

maxFit = 3x0

Menghasilkan Populasi:





epochs = 495
minFit = -30
maxFit = 30

epochs = 495
minFit = -30
maxFit = 30

epochs = 495
minFit = -30
maxFit = 30

### Menghasilkan Populasi:

[illegible]

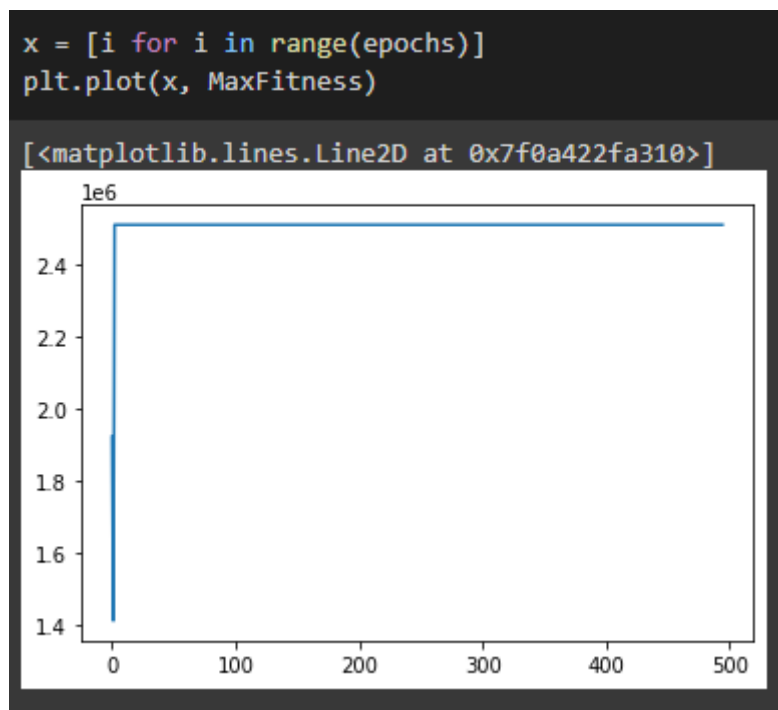
Serta fungsi di run sebanyak 30 kali menghasilkan:

**Nilai Mean** : 2509012

**Nilai Standard Deviation** : 55969.79841843277

**Nilai Minimal** : 1413821

Hasil Grafik:



### 1.4. Rastrigin's Function

### A. Poin A

Dari hasil percobaan codingan menggunakan Algoritma Genetika dengan  $\text{max\_it} = (1000 - P) / 10 = (1000 - 10) / 10 = 99$  serta nilai yang diketahui:

i = 1
epochs = 99
minFit = -5.12
maxFit = 5.12

### Menghasilkan Populasi:

[illegible]

Serta fungsi di run sebanyak 30 kali menghasilkan:

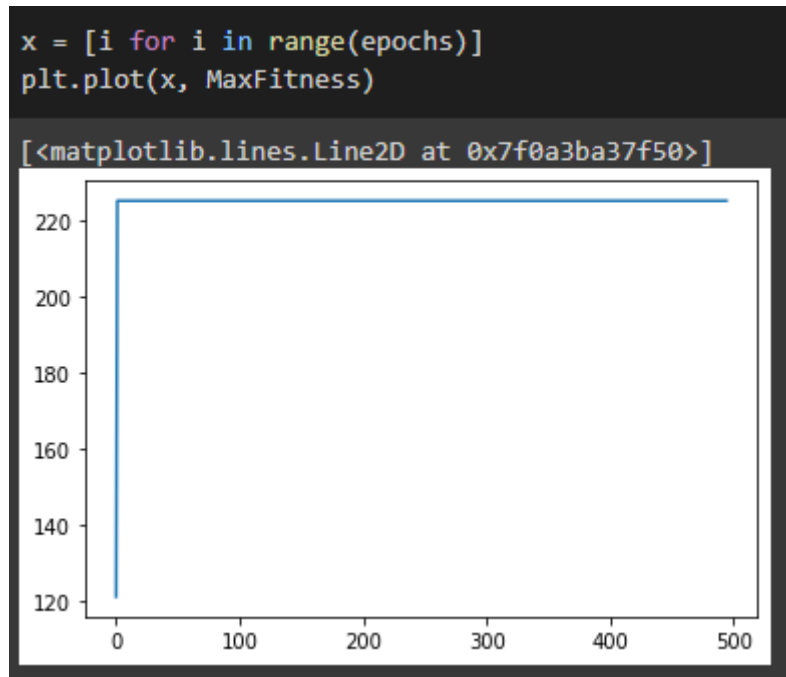
**Nilai Mean** : 143.1919191919192  
**Nilai Standard Deviation** : 8.040302522073697  
**Nilai Minimal** : 64.0

Hasil Grafik:



**Nilai Standard Deviation** : 4.674452379745145  
**Nilai Minimal** : 121.0

Hasil Grafik:



## 2. Differential Evolution

### 2.1. Sphere Function

#### A. Poin A

Dari hasil percobaan codingan menggunakan Defferential Evolution dengan  $\text{max\_it} = (1000-P)/10 = (1000-10)/10 = 99$  serta nilai yang diketahui:

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

Menghasilkan Populasi:

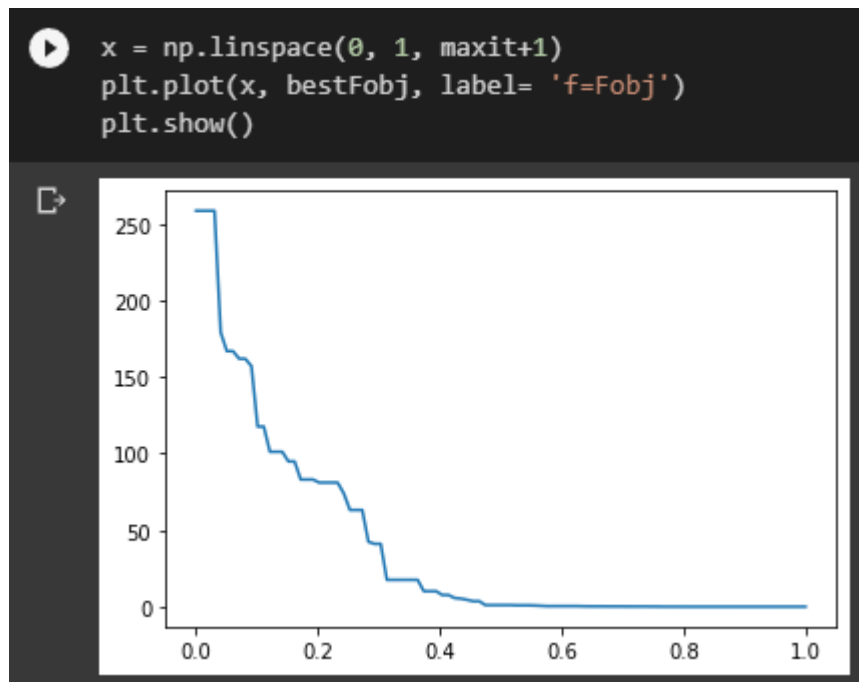
[ 5.69622364 -9.77272772 -8.23100607 -6.47651935 -7.01127811 2.86234108
9.15963831 -8.82896704 -6.82454823 -8.44254531]

[-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 ]

Serta fungsi di run sebanyak 30 kali menghasilkan:

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

Hasil Grafik:



#### B. Poin B

Dari hasil percobaan codingan menggunakan Algoritma Genetika dengan  $\text{max\_it} = (1000-P)/2 = (1000-10)/2 = 495$  serta nilai yang diketahui:

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

Menghasilkan Populasi:

[ 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

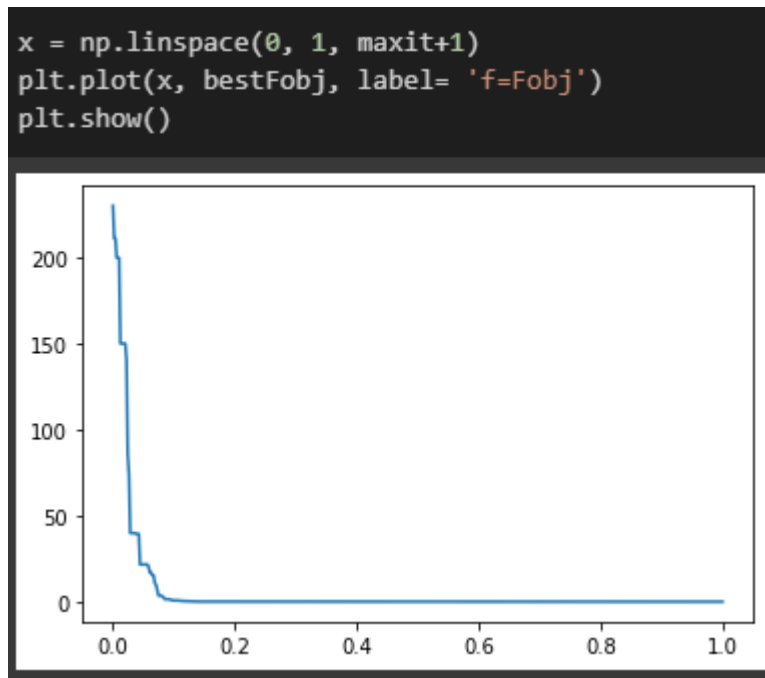
-3.34784932 -2.55603186 4.43899427 9.08185793]
[ 9.36851766 5.95287885 4.07355641 9.59290151 -1.55498599 4.80833032
-6.7427817 8.60564353 3.94862647 -1.56634069]
[ 3.41190335 -5.01320158 -9.89743295 -3.87440944 9.14247475 4.03988795
-0.23720503 0.09225919 7.46266585 7.73424011]
[-0.40132684 2.35851844 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]

Serta fungsi di run sebanyak 30 kali menghasilkan:

**Nilai Mean** : 6.253351485484217  
**Nilai Standard Deviation** : 28.59080188472914  
**Nilai Minimal** : 0.3915633902944092

Hasil Grafik:





## 2.2. Schewel's Function 2.22

### A. Poin A

Dari hasil percobaan codingan menggunakan Defferential Evolution dengan  $\text{max\_it} = (1000-P)/10 = (1000-10)/10 = 99$  serta nilai yang diketahui:

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

Menghasilkan Populasi:

[-7.60150902 2.39583676 3.2683578 -3.14154693 -4.28265303 -1.5768425
4.82188716 -3.60759683 -8.80893321 -1.59421434]
[ 2.61109487 -7.20880547 7.05810423 -1.40019624 9.41536103 9.18794912
2.04349291 8.84909036 -4.18218125 -6.46676852]
[-8.54349277 0.45874522 -1.36669332 0.97355784 -3.59369362 -1.63170636

-0.20612024 2.02489683 9.32521902 5.61500509]
[ 9.33583352 2.53643434 -4.18710696 8.77198854 -8.11729087 -3.5368533
0.78400984 4.21304702 2.2370119 -6.72486315]
[-1.8115141 1.97487091 -8.69973273 -0.77904277 9.69633998 1.35760893
-3.51025469 5.61318042 -2.65392451 -3.72278878]
[ 5.0170669 8.68295548 -8.83323428 -3.93366733 0.59113996 -4.40024356
-7.49738274 -4.65143857 4.07595081 -2.68152885]
[ 9.06168264 -6.72211694 1.72863966 7.0072561 -0.6778801 -1.0370398
9.17727341 -9.16964738 -0.77560448 7.66325911]
[-9.46453123 4.6550682 4.93639552 7.47631702 -2.64677153 9.55215065
-2.34689303 2.18793289 8.4342208 3.12784339]
[ 2.18139596 -4.4741004 4.12284846 -8.403091 6.32390902 -6.76765416
-1.67651325 -9.08123829 7.51278439 -1.9393268 ]
[-2.96780188 -6.65101491 3.25417874 9.41692218 -5.76880906 9.49608055
-7.36273648 0.61565673 5.79480816 7.56061276]

Fungsi Objective :

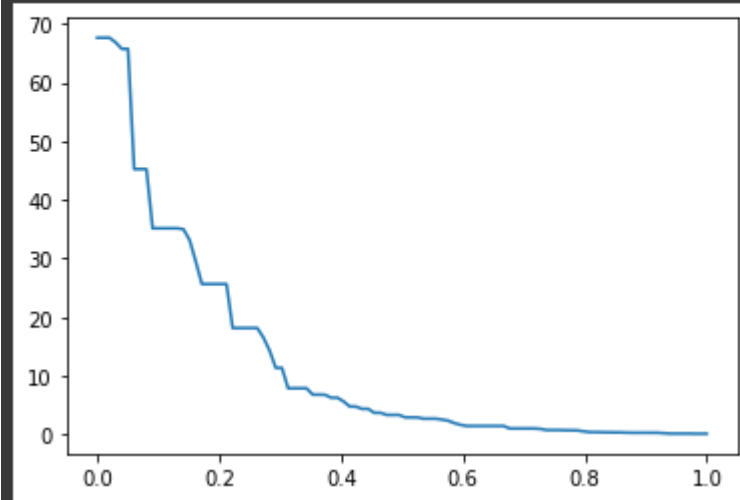
[ 74.58637252 67.63652563 96.74014386 115.51225131  
105.84099923 90.98413482 134.37920041 102.0135241  
72.53778865 118.2703168 ]

Serta fungsi di run sebanyak 30 kali menghasilkan:

**Nilai Mean** : 12.37812068453818  
**Nilai Standard Deviation** : 18.368908455434536  
**Nilai Minimal** : 0.09755504747058841

Hasil Grafik:

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



#### B. Poin B

Dari hasil percobaan codingan menggunakan Algoritma Genetika dengan  $\text{max\_it} = (1000-P)/2 = (1000-10)/2 = 495$  serta nilai yang diketahui:

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

Menghasilkan Populasi:

[-4.04301875 0.53884136 8.00538886 -3.18897556 -7.86131553 - 1.33503336]
[-1.82652845 -2.3703909 -6.09920286 5.43886746]
[ 3.26844945 -2.57427516 -4.52919619 -4.28008403 0.0772137 - 5.11631276]
[-1.26177483 -3.16590835 1.52185851 -5.34046065]
[ 3.93840673 5.98670356 -5.01539932 1.44669619 -9.52649048 9.85866649]
[ 8.69204064 8.47641365 6.29342124 3.17994647]

[ 4.59670209 2.72171256 -4.17595002 6.65078724 0.04273397 -0.24894272
-2.05950487 -2.38839401 -5.87268808 -6.56585697]
[ 3.16352711 -0.80191217 8.34511496 2.21464723 5.55000968 0.68912663
6.6629669 -2.61657411 6.27443675 -4.8049696 ]
[-8.81458304 -1.41652709 0.85303005 -5.8910459 -8.86689798 2.17723232
-6.81872751 -5.33849818 8.44511107 -8.05558786]
[-3.38133462 4.02782274 2.52367092 -4.38898674 5.03965094 3.28683238
-6.32539395 6.36993378 -3.74536687 -7.49984454]
[-3.11465176 -3.81676883 6.8295952 1.09234056 2.97402781 2.2807242
1.27052054 1.4797594 2.26163101 -2.16090941]
[ 2.17601568 7.8755492 9.59599919 0.12987194 4.05252536 -0.51013306
3.92332676 1.74298907 4.46762636 -0.60371282]
[ 8.50170775 -4.45343165 -2.78230591 3.12361584 4.53377593 8.03079509
9.04568654 3.90613225 -2.63956582 8.6829121 ]

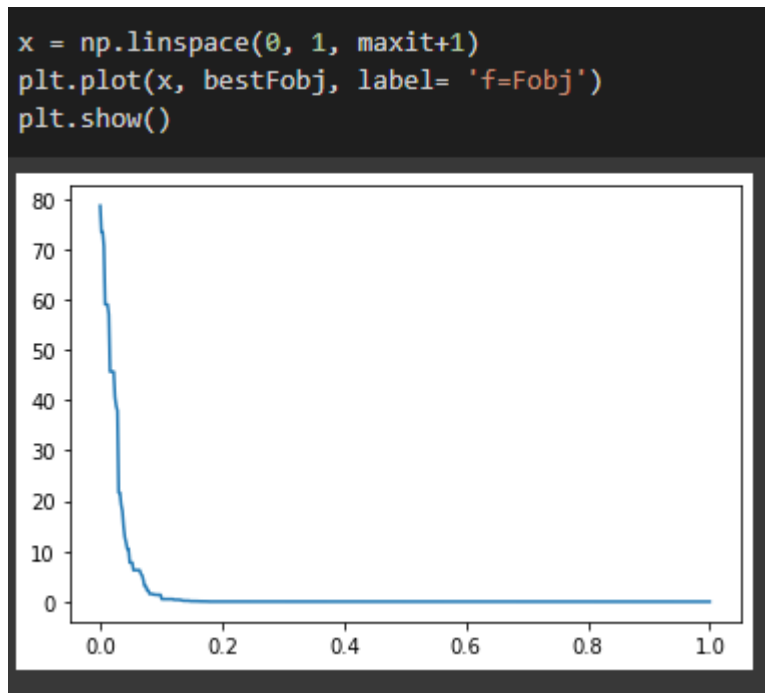
Fungsi Objektif:

[ 81.41512616 62.27106726 124.82836952 70.64654504  
82.24657027 113.354482 93.17767495 54.56185742  
70.15549886 111.39985777]

Serta fungsi di run sebanyak 30 kali menghasilkan:

**Nilai Mean** : 2.1820240155997133  
**Nilai Standard Deviation** : 9.959848743443919  
**Nilai Minimal** : 5.620433788795094e-15

Hasil Grafik:



### 2.3. Generalize rosenbrock Function

#### A. Poin A

Dari hasil percobaan codingan menggunakan Defferential Evolution dengan  $\text{max\_it} = (1000-P)/10 = (1000-10)/10 = 99$  serta nilai yang diketahui:

D = 10 # Dimensi dari permasalahan
maxit = 99 #Max iterasi
ukuranPopulasi = 10
LB = -30 #Batas Bawah
UB = 30 #Batas Atas
CR = 0.9
F = 0.5

Menghasilkan Populasi:

[-4.31989349 -6.02052172 -29.5944793 -16.05092933 17.32842641
27.09911361 19.61629467 15.80666967 -1.44566903 -15.57844307]
[-19.66339459 21.15936886 15.88259604 -15.84049668 -11.50072269
-6.32702278 25.97403914 -7.66430191 20.79945561 5.19040482]
[-4.4608596 -24.99790406 27.86278004 12.16987262 -22.31485918
9.62225434 20.0708507 -11.07587077 20.36860179 -9.18549819]
[-26.09522786 16.28695527 -1.27574002 16.70712843 -28.08497075

-28.99156568 12.68388522 4.38982582 19.16753501 7.94150965]
[ 26.14859167 -11.94087323 27.51315127 3.42793625 -25.35915512
21.43179972 14.28349115 3.73670237 14.40532017 -19.34638537]
[ -2.05596653 -6.35502848 12.41003877 -23.75985261 22.009279
-7.22870203 15.48147474 -13.0578926 -0.1819396 -6.7545737 ]
[ -6.6042105 3.03539158 -1.25727846 2.68786527 -10.90488097
-25.6389763 6.11014714 16.92081144 -0.94923841 -8.1950749 ]
[ 19.13849986 -11.07323146 27.64585637 -7.27243905 19.2814311
6.80544275 25.74049504 22.41729553 -28.04585842 -26.84749239]
[-12.46969618 13.48106911 -24.08536713 19.27557991 -25.67674258
-17.30789429 -20.2444812 13.84886958 -14.4622641 -20.69932867]
[ 26.1300471 -9.62219131 -17.85807845 -11.32324955 -11.91313974
-3.69262528 18.52933747 -16.20897858 -23.83022307 -1.300887 ]

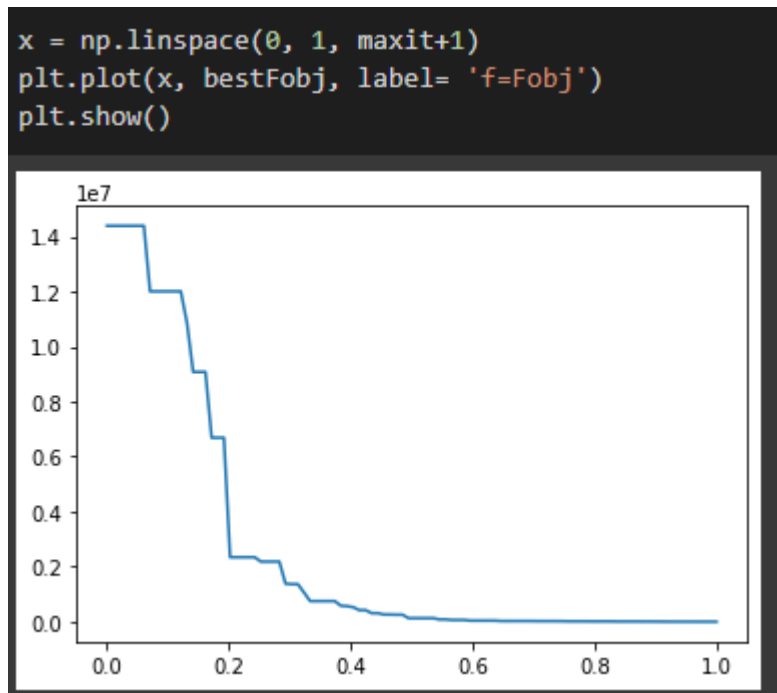
Fungsi Objective :

[30645533.79752161 27147336.29914287 31672437.71651385  
33938339.16500393 35455031.36859612 17121019.4301655  
11661807.45655456 44141965.41514488 32530557.45484405  
24119803.95882684]

Serta fungsi di run sebanyak 30 kali menghasilkan:

**Nilai Mean** : 2661784.5095996186  
**Nilai Standard Deviation** : 4672830.927810584  
**Nilai Minimal** : 1994.4194605694136

Hasil Grafik:



#### B. Poin B

Dari hasil percobaan codingan menggunakan Algoritma Genetika dengan  $\text{max\_it} = (1000-P)/2 = (1000-10)/2 = 495$  serta nilai yang diketahui:

D = 10 # Dimensi dari permasalahan
maxit = 495 #Max iterasi
ukuranPopulasi = 10
LB = -30 #Batas Bawah
UB = 30 #Batas Atas
CR = 0.9
F = 0.5

Menghasilkan Populasi:

[-7.61081227 16.75428072 13.21043827 9.38809217 25.82375783
-5.97266 16.72879063 13.07785531 9.79193829 6.31141543]
[ 14.11978806 20.20459763 26.02100856 18.28858776 22.17751602
8.0744026 -1.65119132 22.81829131 -10.81018187 7.66739252]
[-15.10608193 0.97648733 2.78299542 20.21540426 -22.63091213
-0.22592397 -17.87334542 -8.32939924 7.02288728 -26.12762238]
[ -7.15930251 17.81181178 -26.86173356 20.98898672 14.43410529

17.60415444 14.01785515 1.76782069 20.82162597 -2.22402291]
[-25.67739085 29.91880602 18.05535191 5.13380508 -18.54210928
-1.38544472 0.03642762 -19.30382664 23.95611823 -25.43411657]
[ 10.7763051 -8.35561497 6.11354222 -26.7781645 -14.38960392
-23.84762208 -11.61579588 -8.19720304 -25.1864147 -6.95201705]
[-4.62853907 27.95150174 14.55237837 23.55990911 3.19809128
29.5817369 -23.35268425 -19.60324441 15.03486828 28.29263551]
[-8.1061652 -20.93191898 -2.15838804 -18.47794075 19.48967109
27.08795231 5.98748489 22.23064494 22.13023058 25.32642625]
[-3.8058883 -9.50922113 -28.02666694 13.71607392 3.55230585
12.0658694 -23.06839754 6.16264274 26.01362888 27.60170642]
[-25.99298495 0.94112291 -3.11709472 -23.00655264 -21.68642299
-6.54808417 -20.21544157 -29.37906683 -7.21067292 23.19687774]

Fungsi Objektif:

[20560275.41139579 30795754.29945384 21260650.63404217  
27847314.01302745 37536067.18847232 23447942.13629209  
45209389.36433864 37066993.34578882 32400777.01344717  
33057531.1409331 ]

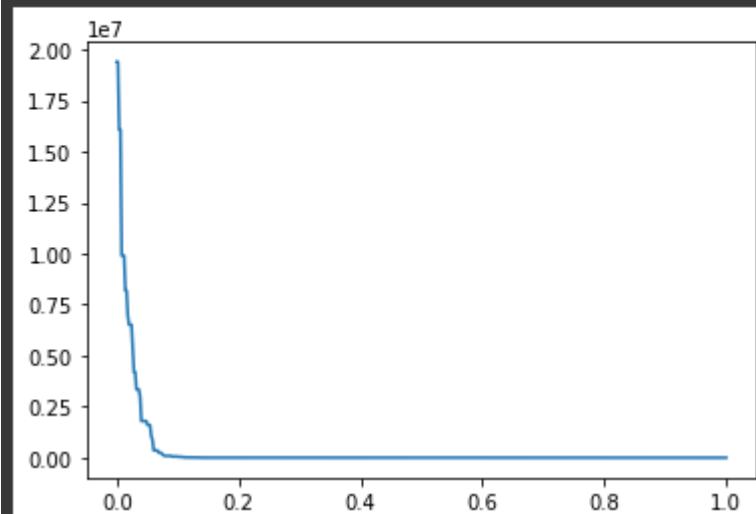
Serta fungsi di run sebanyak 30 kali menghasilkan:

**Nilai Mean** : 382855.90483743796  
**Nilai Standard Deviation** : 1976442.722855424  
**Nilai Minimal** : 40.40093858396244

Hasil Grafik:



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



## 2.4. Rastrigin's Function

### A. Poin A

Dari hasil percobaan codingan menggunakan Defferential Evolution dengan  $\text{max\_it} = (1000-P)/10 = (1000-10)/10 = 99$  serta nilai yang diketahui:

D = 10 # Dimensi dari permasalahan
maxit = 99 #Max iterasi
ukuranPopulasi = 10
LB = -5.12 #Batas Bawah
UB = 5.12 #Batas Atas
CR = 0.9
F = 0.5

Menghasilkan Populasi:

[-2.15754919 -3.50031577 -2.70433695 -1.06363627 -0.42612007 4.00825165
2.13396615 0.3162541 -4.69803543 -0.92078303]
[ 3.43997084 1.40887612 0.50470684 -3.3083668 -1.21082204 - 3.39203186
2.66504885 -1.51843372 0.18723296 1.22455745]
[ 3.51651352 0.57799963 0.69904877 -2.80522963 -3.2493769 - 2.04398902

0.80243709 -0.18547343 -3.32317425 -2.48133956]
[ 2.89309994 4.09039297 -1.39674521 -5.08050672 -1.3607342 -3.75167291
-3.43667007 -4.37002884 -5.10198188 -0.58850435]
[ 0.65755065 -3.81896762 -2.87322127 2.57811342 1.42285133 -2.65074536
-3.35207745 2.71946112 -1.5467619 -5.02033034]
[ 3.21162776 3.98093537 -0.27248704 3.81855068 4.69266979 4.7656973
-3.53666827 0.11320444 1.35384729 -2.97585924]
[-0.37417792 0.33108811 -4.55107447 -2.41535253 2.43892343 -1.64717123
5.01907706 -2.92151459 -1.46160153 -4.9858677 ]
[ 3.1969741 4.64249687 -1.72233152 0.34318446 -4.63895299 3.23263126
1.86182636 -1.23399887 4.95800155 -0.6537128 ]
[ 3.75374981 2.20813773 1.51968391 -3.95211108 2.44692879 -2.78184265
-2.63105429 -1.20877899 -2.20183148 -2.3766895 ]
[ 4.86347726 3.8190673 2.95832359 -2.7419668 -1.63198534 -0.55755049
-0.20698455 -2.79328086 -1.6632247 1.61285433]

Fungsi Objective :

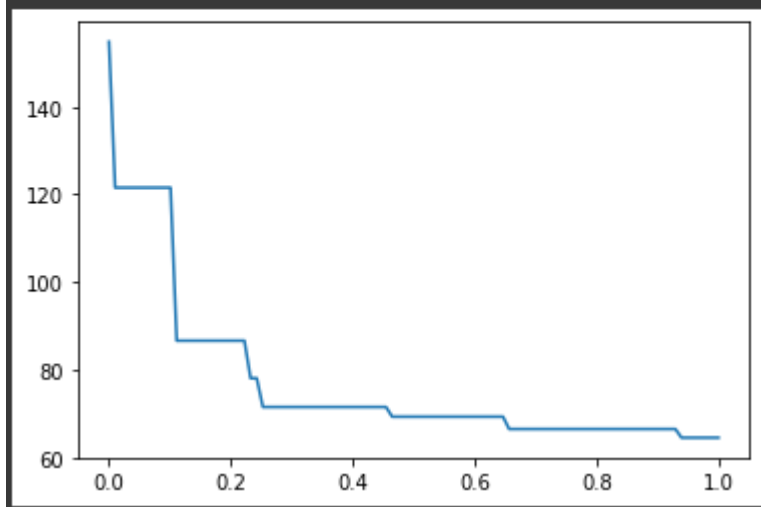
[158.061709            195.15231719    169.71779216    231.88462337  
210.5453206           194.56450994    222.5051991       200.96710363  
182.90166477 174.3225815 ]

Serta fungsi di run sebanyak 30 kali menghasilkan:

**Nilai Mean** : 76.98217421933484  
**Nilai Standard Deviation** : 18.245435904923628  
**Nilai Minimal** : 64.5119213263452

Hasil Grafik:

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



#### B. Poin B

Dari hasil percobaan codingan menggunakan Algoritma Genetika dengan  $\text{max\_it} = (1000-P)/2 = (1000-10)/2 = 495$  serta nilai yang diketahui:

D = 10 # Dimensi dari permasalahan
maxit = 495 #Max iterasi
ukuranPopulasi = 10
LB = -5.12 #Batas Bawah
UB = 5.12 #Batas Atas
CR = 0.9
F = 0.5

Menghasilkan Populasi:

[-3.2624089 -1.49039916 -3.23395392 -3.45809705 2.79498964 -2.55798858
2.43109578 -3.84155635 3.38225337 -3.1593795 ]
[-4.96577034 3.67998815 -3.00965051 -4.14117572 3.37125551 -4.72333636
2.25790292 -2.40802317 -2.55694828 -4.96389869]
[-3.74524393 -3.03583626 -2.59040671 -2.92361815 -1.90616482 -1.56325007
1.65395186 -0.11823577 0.73703835 -1.4717998 ]

[ 4.450193 3.39059319 4.85541336 1.35805933 -4.79226438 -0.23229507
-3.00187602 -4.69191832 -4.59975205 -1.38296498]
[-2.38084244 3.92483052 4.12030404 0.15784405 -3.22627593.35222084
-0.22299671 4.98344965 4.77082471 -1.21258905]
[-1.13971517 -1.14247076 -3.89817727 -1.92857946 0.48916429 -0.79525553
-4.18576982 1.35591617 2.48063094 3.50613934]
[ 3.73048957 -1.57626963 3.5442358 4.3315732 0.58517554 -0.23831071
-2.79218961 -0.90566567 2.36991679 -0.2613543 ]
[-3.46049838 -4.78393875 4.95038207 -2.13505006 0.01010492 -4.59807786
3.39433049 0.18658997 -3.07106186 2.2230482 ]
[ 3.66678713 1.12027553 3.01558764 -2.21370538 3.725167723.74591907
-0.44044049 -1.8811086 -1.88492058 -1.534121 ]
[ 0.8941392 -1.71348102 4.10344458 -3.38960115 2.45283715 -3.46624229
-3.87680107 2.09612014 -0.1872964 0.23995961]

Fungsi Objektif:

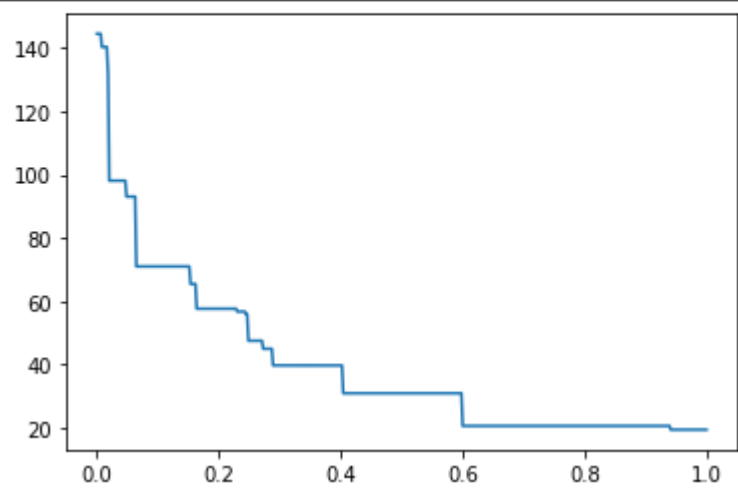
[223.32125038 235.41434 150.02347486 256.55879554  
183.74504968 159.86023523 191.55072537 193.91827206  
157.79950107 163.23389168]

Serta fungsi di run sebanyak 30 kali menghasilkan:

**Nilai Mean** : 39.66523750432544  
**Nilai Standard Deviation** : 25.229802589630165  
**Nilai Minimal** : 19.470490042715884

Hasil Grafik:

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



### Summary Tabel

Poin 1 dengan percobaan iterasi 99

Fungsi	Algoritma Genetik			Differential Evolution		
	Mean	Stdev	Min	Mean	Stdev	Min
<b>Sphere</b>	204.2020202020202	13.127304305382667	196	39.045273875157235	65.73583350532162	0.00294986216248811
<b>Schewel's 2.22</b>	24	0	24	12.37812068453818	18.368908455434536	0.09755504747058841
<b>Generalize rosenbrock</b>	2501324	110413.45438396536	1413821	2661784.5095996186	4672830.927810584	1994.4194605694136
<b>Rastrigin's</b>	143.1919191919192	8.040302522073697	64.0	76.98217421933484	18.245435904923628	64.5119213263452

Poin 2 dengan percobaan iterasi 495

Fungsi	Algoritma Genetik			Differential Evolution		
	Mean	Stdev	Min	Mean	Stdev	Min
<b>Sphere</b>	0.39595959595959596	8.809544869519696	0	6.253351485484217	28.59080188472914	0.3915633902944092
<b>Schewel's 2.22</b>	29	0	22	2.1820240155997133	9.959848743443919	5.620433788795094e-15
<b>Generalize rosenbrock</b>	2509012	55969.79841843277	1413821	382855.90483743796	1976442.722855424	40.40093858396244
<b>Rastrigin's</b>	224.789898989899	4.674452379745145	121.0	39.66523750432544	25.229802589630165	19.470490042715884