



Universidad autónoma de baja California

Ingeniería en computación

Inteligencia artificial

Meta 3.1 optimizacion función de rosenbrock

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a- Resultados para 10 variables con un rango de búsqueda de [-10,10]

Levenberg-Marquardt:

```
: 1
Iter 0: f(x) = 2.0068e+06 | ||grad|| = 5.1939e+05 | gama = 1.0000e-03 | ||x_norm|| = 2.3160e+01
Converged at iteration 4
n=10 performance final =7.55e-17
solucion : [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]
10 variables range [-10,10]
```

Variable Learning Rate Gradient Descent (GDX):

```
: 1
Iter 0: f(x) = 6.1480e+05 |delta_f| = 2.3534e+05 lr = 1.00e-03
Iter 1000: f(x) = 7.5050e+00 |delta_f| = 1.8316e+02 lr = 5.60e-09
Iter 2000: f(x) = 2.8582e+00 |delta_f| = 1.4249e+00 lr = 1.26e-04
Iter 3000: f(x) = 2.1320e+00 |delta_f| = 2.8406e+01 lr = 1.85e-04
Iter 4000: f(x) = 1.8006e+00 |delta_f| = 6.9247e-01 lr = 2.50e-03
Iter 5000: f(x) = 1.5166e+00 |delta_f| = 5.9967e-01 lr = 7.51e-03
Iter 6000: f(x) = 1.3282e+00 |delta_f| = 5.5878e-01 lr = 7.83e-04
Iter 7000: f(x) = 1.1204e+00 |delta_f| = 2.1758e+00 lr = 4.41e-05
Iter 8000: f(x) = 1.5959e+00 |delta_f| = 6.5491e+01 lr = 1.07e-06
Iter 9000: f(x) = 1.3416e+00 |delta_f| = 6.0404e+01 lr = 1.35e-07
Iter 10000: f(x) = 9.5935e-01 |delta_f| = 4.6692e+01 lr = 3.99e-07
Iter 11000: f(x) = 4.0433e-01 |delta_f| = 9.5636e+00 lr = 1.37e-05
Iter 12000: f(x) = 2.7993e-01 |delta_f| = 3.2951e-01 lr = 1.55e-03
Iter 13000: f(x) = 2.6864e-01 |delta_f| = 1.9676e+01 lr = 2.30e-06
Iter 14000: f(x) = 1.2572e-01 |delta_f| = 1.2870e+01 lr = 6.68e-07
Iter 15000: f(x) = 2.2355e-02 |delta_f| = 1.5097e+00 lr = 6.27e-06
Iter 16000: f(x) = 6.3878e-03 |delta_f| = 6.7116e-02 lr = 1.76e-02
Iter 17000: f(x) = 2.1675e-03 |delta_f| = 1.3851e+00 lr = 5.26e-06
Iter 18000: f(x) = 1.8598e-04 |delta_f| = 1.7711e-01 lr = 1.30e-06
Iter 19000: f(x) = 3.9954e-05 |delta_f| = 1.9360e-01 lr = 3.16e-07
Iter 20000: f(x) = 7.5267e-06 |delta_f| = 8.0392e-02 lr = 3.69e-06
Iter 21000: f(x) = 7.4246e-07 |delta_f| = 2.1422e-02 lr = 2.27e-05
Iter 22000: f(x) = 7.8582e-08 |delta_f| = 6.8619e-03 lr = 8.14e-08
Iter 23000: f(x) = 1.2981e-08 |delta_f| = 3.1738e-04 lr = 1.30e-04
Iter 24000: f(x) = 2.8633e-09 |delta_f| = 1.6258e-03 lr = 2.23e-07
Iter 25000: f(x) = 3.0747e-10 |delta_f| = 1.5671e-05 lr = 1.59e-02
Iter 26000: f(x) = 4.1890e-11 |delta_f| = 5.3991e-05 lr = 9.09e-05
Iter 27000: f(x) = 4.5828e-12 |delta_f| = 1.0901e-05 lr = 4.82e-03
Iter 28000: f(x) = 1.8452e-12 |delta_f| = 4.1532e-05 lr = 3.12e-07
Iter 29000: f(x) = 2.0841e-13 |delta_f| = 1.3776e-05 lr = 1.12e-07
Iter 30000: f(x) = 1.3858e-14 |delta_f| = 1.2111e-06 lr = 3.33e-05
Iter 31000: f(x) = 3.2150e-15 |delta_f| = 2.9569e-07 lr = 1.10e-04
Iter 32000: f(x) = 6.7787e-16 |delta_f| = 7.9241e-07 lr = 4.25e-07
norma gradiente < 1.0e-08
n=10 performance final = 1.2460e-16
solution: [[1.00000001]
[1.00000002]
```

```
n=10 performance final = 1.2460e-16  
solution: [[1.00000001]  
[1.00000002]  
[1. ]  
[1. ]  
[1. ]  
[1. ]  
[1. ]  
[1. ]  
[1. ]  
[1. ]]
```

- b- Función de Rosenbrock para n par, dado aleatoriamente un punto inicial en el rango de $[-10,10]$ para cada variable y $n = 100$

Levenberg-Marquardt:

[illegible]

Variable Learning Rate Gradient Descent (GDX):

```
Iter 0: f(x) = 1.1093e+07 |delta_f| = 1.1317e+06 lr = 1.00e-03
Iter 1000: f(x) = 3.6500e+02 |delta_f| = 1.6058e+03 lr = 1.32e-07
Iter 2000: f(x) = 3.0195e+02 |delta_f| = 1.3484e+03 lr = 1.14e-06
Iter 3000: f(x) = 3.0475e+02 |delta_f| = 1.4207e+03 lr = 2.80e-07
Iter 4000: f(x) = 2.9376e+02 |delta_f| = 1.5597e+03 lr = 1.39e-07
Iter 5000: f(x) = 2.1658e+02 |delta_f| = 9.8062e+02 lr = 1.63e-07
Iter 6000: f(x) = 1.4334e+02 |delta_f| = 5.6027e+00 lr = 1.44e-03
Iter 7000: f(x) = 1.6291e+02 |delta_f| = 6.8849e+02 lr = 5.15e-06
Iter 8000: f(x) = 2.1545e+02 |delta_f| = 1.0842e+03 lr = 1.39e-07
Iter 9000: f(x) = 1.1237e+02 |delta_f| = 5.6249e+00 lr = 9.73e-04
Iter 10000: f(x) = 1.0197e+02 |delta_f| = 7.3684e+00 lr = 8.76e-05
Iter 11000: f(x) = 9.3363e+01 |delta_f| = 3.0933e+01 lr = 3.35e-05
Iter 12000: f(x) = 8.4294e+01 |delta_f| = 1.4050e+01 lr = 5.87e-05
Iter 13000: f(x) = 7.4661e+01 |delta_f| = 5.3166e+00 lr = 2.64e-04
Iter 14000: f(x) = 6.3965e+01 |delta_f| = 4.1342e+01 lr = 2.09e-05
Iter 15000: f(x) = 5.9105e+01 |delta_f| = 3.0834e+02 lr = 8.39e-06
Iter 16000: f(x) = 6.8596e+01 |delta_f| = 5.5697e+02 lr = 9.64e-07
Iter 17000: f(x) = 4.8509e+01 |delta_f| = 4.5169e+02 lr = 1.33e-08
Iter 18000: f(x) = 1.9365e+01 |delta_f| = 3.9631e+00 lr = 7.89e-03
Iter 19000: f(x) = 1.4691e+01 |delta_f| = 2.7264e+00 lr = 1.82e-03
Iter 20000: f(x) = 1.2484e+01 |delta_f| = 8.4265e+01 lr = 1.51e-05
Iter 21000: f(x) = 9.1116e+00 |delta_f| = 3.8742e+00 lr = 5.88e-05
Iter 22000: f(x) = 9.0645e+00 |delta_f| = 1.6783e+02 lr = 3.10e-06
Iter 23000: f(x) = 4.2050e+00 |delta_f| = 1.3321e+00 lr = 1.23e-02
Iter 24000: f(x) = 3.5007e+00 |delta_f| = 1.0381e+00 lr = 7.39e-03
Iter 25000: f(x) = 2.9195e+00 |delta_f| = 9.3811e-01 lr = 2.56e-04
Iter 26000: f(x) = 2.3500e+00 |delta_f| = 4.2310e+00 lr = 6.51e-05
Iter 27000: f(x) = 3.2100e+00 |delta_f| = 9.5576e+01 lr = 4.44e-07
Iter 28000: f(x) = 1.3729e+00 |delta_f| = 7.4313e+00 lr = 4.74e-03
Iter 29000: f(x) = 9.7376e-01 |delta_f| = 6.6821e+00 lr = 2.55e-03
Iter 30000: f(x) = 7.2536e-01 |delta_f| = 5.6156e-01 lr = 4.91e-04
Iter 31000: f(x) = 8.0236e-01 |delta_f| = 3.9277e+01 lr = 4.01e-07
Iter 32000: f(x) = 2.7685e-01 |delta_f| = 3.6800e-01 lr = 2.85e-03
Iter 33000: f(x) = 1.4527e-01 |delta_f| = 9.5253e+00 lr = 2.57e-05
Iter 34000: f(x) = 6.6119e-02 |delta_f| = 8.7754e+00 lr = 4.01e-08
Iter 35000: f(x) = 1.3741e-02 |delta_f| = 1.2249e-01 lr = 3.52e-04
Iter 36000: f(x) = 2.3242e-03 |delta_f| = 7.1616e-02 lr = 5.18e-02
Iter 37000: f(x) = 6.9038e-04 |delta_f| = 4.4122e-01 lr = 5.39e-05
Iter 38000: f(x) = 7.7478e-05 |delta_f| = 7.8768e-03 lr = 5.12e-02
Iter 39000: f(x) = 1.3096e-05 |delta_f| = 9.4703e-02 lr = 4.48e-07
```



```
Iter 0: f(x) = 9.7902e+07 |delta_f| = 3.3458e+06 lr = 1.00e-03
Iter 10000: f(x) = 1.5261e+03 |delta_f| = 3.5779e+03 lr = 8.19e-08
Iter 20000: f(x) = 1.8872e+02 |delta_f| = 1.0005e+03 lr = 5.33e-09
Iter 30000: f(x) = 1.2028e+01 |delta_f| = 1.0936e+02 lr = 1.08e-08
Iter 40000: f(x) = 3.1596e-05 |delta_f| = 5.0186e-03 lr = 1.67e-02
Iter 50000: f(x) = 5.9825e-14 |delta_f| = 2.5611e-07 lr = 2.96e-04
norma gradiente < 1.0e-08
n=1000 performance final = 1.2349e-16
solution: [[1.00000000e+00]
```

```
[1.]
```

- d- Función de Rosenbrock para n par, dado aleatoriamente un punto inicial en el rango de [-100,100] para cada variable y n = 1000

```

Iter 0: f(x) = 9.7593e+11 | ||grad|| = 3.3391e+09 | gama = 1.0000e-03 | ||x_norm|| = 1.8004e+03
Converged at iteration 5
n=1000 performance final =1.22e-11
solucion : [1. 0.99999999 1. 1. 1. 1.
1. 1. 1. 0.99999999 1. 1.
1. 1. 1. 0.99999999 0.99999996 1.
1. 0.99999999 1. 0.99999999 1. 1.
1. 1. 1. 0.99999999 1. 1.
1. 0.99999999 1. 1. 1. 1.
1. 1. 0.99999999 0.99999998 1. 0.99999998
1. 1. 1. 0.99999999 1. 1.
1. 1. 1. 1. 0.99999999 0.99999997
1. 1. 1. 1. 1. 1.
0.99999999 0.99999995 0.99999999 0.99999996 1. 1.
1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1.
1. 0.99999997 0.99999999 0.99999998 1. 1.
1. 1. 1. 0.99999998 1. 0.99999999
1. 1. 1. 1. 0.99999999 0.99999993
1. 1. 1. 1. ]
.....
[1. 1. 0.99999999 0.99999989 1. 1.
1. 1. 1. 1. 1. 1.
1. 1. 0.99999999 0.99999998 1. 0.99999999
1. 1. 1. 1. 1. 0.99999999
1. 1. 1. 0.99999999 1. 1.
1. 1. 1. 0.99999999 1. 1.
1. 1. 1. 1. 1. 1.
0.99999999 0.99999998 0.99999999 0.99999991 1. 1.
1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1.
0.99999999 0.99999998 0.99999999 0.99999996 1. 1.
1. 0.99999999 1. 0.99999999 1. 0.99999999
1. 1. 0.99999999 0.99999999 1. 1.
1. 1. 1. 0.99999999 1. 1.
1. 1. 1. 1. 1. 1.
1. 0.99999999 1. 1. 1. 1.
0.99999999 0.99999992 1. 1. ]

```

Variable Learning Rate Gradient Descent (GDX):

En esta opción el algoritmo tardó mucho y al parecer no encontró satisfactoriamente el resultado:

```

... 1 - 10 variables - rango [-10,10]
     2 - 100 variables - rango [-10,10]
     3 - 1000 variables - rango [-10,10]
     4 - 1000 variables - rango [-100,100]
     5 - salir
     : 4
Iter 0: f(x) = 9.1828e+11 |delta_f| = 3.2034e+09 lr = 1.00e-05
Iter 10000: f(x) = 1.2253e+04 |delta_f| = 4.2025e+03 lr = 8.11e-05
Iter 20000: f(x) = 1.2012e+04 |delta_f| = 1.1705e+02 lr = 9.25e-06
Iter 30000: f(x) = 1.1910e+04 |delta_f| = 1.1828e+02 lr = 8.81e-06
Iter 40000: f(x) = 1.1817e+04 |delta_f| = 8.0766e+01 lr = 1.34e-05
Iter 50000: f(x) = 1.4974e+04 |delta_f| = 2.2028e+04 lr = 4.68e-07
Iter 60000: f(x) = 1.1640e+04 |delta_f| = 4.7756e+02 lr = 1.89e-06
Iter 70000: f(x) = 1.9347e+04 |delta_f| = 3.6533e+04 lr = 5.32e-09
Iter 80000: f(x) = 2.0554e+04 |delta_f| = 3.9494e+04 lr = 1.79e-08
Iter 90000: f(x) = 1.6122e+04 |delta_f| = 2.8100e+04 lr = 2.83e-07
Iter 100000: f(x) = 1.1311e+04 |delta_f| = 2.6875e+01 lr = 2.78e-05
Iter 110000: f(x) = 1.1226e+04 |delta_f| = 1.0594e+02 lr = 8.64e-06
Iter 120000: f(x) = 2.0165e+04 |delta_f| = 3.9093e+04 lr = 8.47e-09

```



```

*** Iter 920000: f(x) = 8.8091e+03 |delta_f| = 2.1642e+04 lr = 2.82e-09
Iter 930000: f(x) = 4.8373e+03 |delta_f| = 1.2001e+03 lr = 3.09e-06
Iter 940000: f(x) = 4.9741e+03 |delta_f| = 4.8386e+03 lr = 1.33e-07
Iter 950000: f(x) = 4.6834e+03 |delta_f| = 1.3583e+01 lr = 1.91e-05
Iter 960000: f(x) = 4.6113e+03 |delta_f| = 1.2595e+01 lr = 3.38e-04
Iter 970000: f(x) = 4.5418e+03 |delta_f| = 2.8710e+02 lr = 5.41e-06
Iter 980000: f(x) = 7.0417e+03 |delta_f| = 1.7097e+04 lr = 2.65e-07
Iter 990000: f(x) = 4.5187e+03 |delta_f| = 3.5705e+03 lr = 1.76e-04
Iter 1000000: f(x) = 4.3310e+03 |delta_f| = 1.2128e+01 lr = 2.96e-04
n=1000 performance final = 4.3310e+03
solution: [[ 0.99999993]
 [ 0.99999985]
 [ 0.99999993]
 [ 0.99999985]
 [-4.12410601]
 [17.01437278]
 [ 0.99999993]
 [ 0.99999985]
 [ 0.99999993]

```

```

...
[ 0.9999515 ]
[-2.440087 ]
[ 5.96078952]
[ 0.99999993]
[ 0.99999985]
[ 0.99999992]
[ 0.99999984]
[ 5.47928021]
[30.02656532]
[ 0.99999993]
[ 0.99999985]
[ 1.00002046]
[ 1.00004099]
[ 0.99999993]
[ 0.99999985]

```